



# **Wageningen Institute for Environment and Climate Research (WIMEK)**

## **Self Evaluation Report 2001 - 2006**

**May 2007**



**WAGENINGEN UNIVERSITY**  
*University for Life Sciences*

**University:** Wageningen University

**Research Institute:** Wageningen Institute for  
Environment and Climate  
Research (WIMEK)

**Directors** Prof. Dr. L. Hordijk  
(January 2001 - September 2002)

Prof. Dr. S.E.A.T.M. van der Zee  
(February 2003 – September  
2005)

Prof. Dr. R. Leemans  
(Since October 2005)

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## 1. Introduction

### 1.1 The establishment of WIMEK and SENSE

WIMEK was founded in 1993 as one of the Wageningen graduate schools to bring together the environmental-change expertise of natural and socio-economic scientists at Wageningen University. In subsequent years, WIMEK played an important role in establishing a strong inter-university graduate school in the field of environment and climate research. This became the Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment (SENSE)<sup>1</sup>. Research groups from eight Dutch universities and UNESCO-IHE (from 01-01-2007) collaborate in SENSE and WIMEK is currently the largest participant. In June 1997, SENSE was accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW) and re-accredited in 2002 for a second five year period (i.e. 2002 – 2006). Since 2005 Wageningen-UR and Vrije Universiteit jointly preside over SENSE.

### 1.2 Position of graduate schools within Wageningen University and Research Centre

Wageningen University (WU) is part of the Wageningen University and Research Centre (Wageningen-UR or WUR), a joint venture of the University with the Specialized Research Institutes (DLO), Experimental Research Stations, the International Agricultural Centre (IAC) and the higher professional educational Polytechnic Van Hall – Larenstein (Figure 1). The Ministry of Agriculture, Nature and Food Quality (LNV) is a major sponsor and much of the WUR research is targeted towards LNV issues.

WUR has integrated their participating organisations into five so-called Science Groups (i.e. Agrotechnology and Food, Animal, Environmental, Plant, and Social Sciences). These groups form the pillars of Wageningen-UR and bring together fundamental, strategic and applied research, legal tasks, human resource management, consultancy and education at several different levels. Wageningen University (WU) has only one faculty: the Faculty of Agricultural and Environmental Sciences. The University is subdivided in five departments following the five Science Groups (Figure 1).

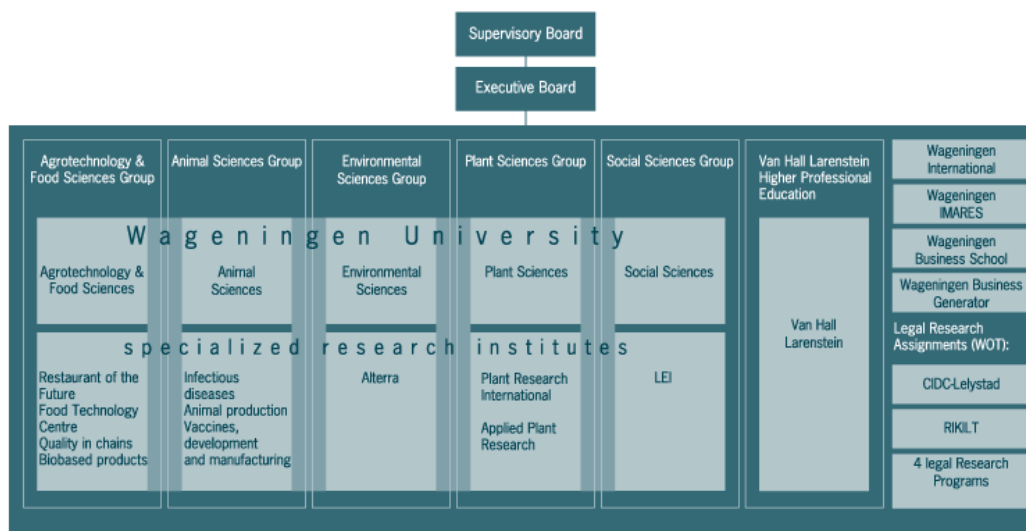


Figure 1: Organisational chart of Wageningen-UR

<sup>1</sup> Detailed Information on SENSE and its activities can be found in the SENSE self-evaluation report. In this report we will not duplicate the information from this SENSE report but focus on specific and additional aspects of the WIMEK research institute.

Most education and research programmes of Wageningen University have a strong multidisciplinary and interdisciplinary character and have been organised in cross-department BSc, MSc, PhD and research programmes. These programmes together with the science groups thus form the Wageningen University organisational matrix structure (Figure 2). The WU research programmes are co-ordinated by the Wageningen Graduate Schools.

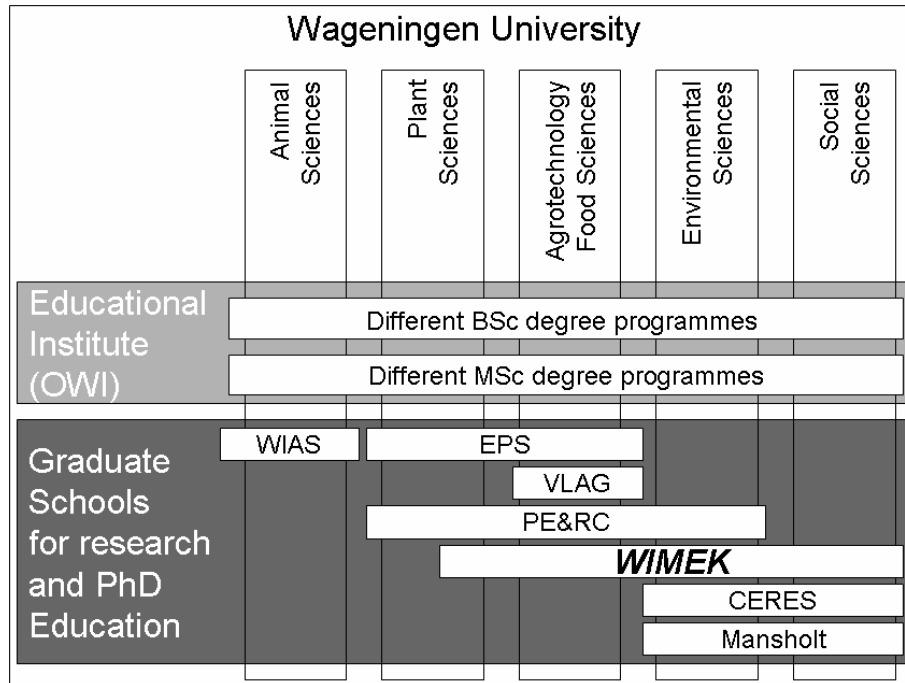


Figure 2: Organisational matrix of Wageningen University with the five Science Groups, the educational institute, which is responsible for all BSc and MSc education, and the seven different graduate schools, which are responsible for research quality and PhD education.

The Wageningen Graduate Schools (WGS) or Research Schools are the focal points of fundamental and strategic research and the education and training of PhD and post-doc researchers. They have three main tasks:

- To develop and co-ordinate post-graduate education and training,
- To stimulate and co-ordinate the development of a coherent academic research programme of high quality within the mission of the research school and Wageningen-UR at large,
- To improve and safeguard the quality of academic research (PhD, post-doc and staff).

The major part of the university research projects and almost all PhD projects are embedded in the Wageningen Graduate Schools. Some graduate schools also participate in inter-university research schools. So, WIMEK is a WU graduate school, to a large extent comparable with other WU Graduate Schools, participating in the SENSE Research School at national level.

### 1.3 Chair Groups participating in WIMEK

In the review period eighteen chair groups from four WUR Science Groups participated in the WIMEK research programme (Table 1). Besides, some senior researchers of Alterra Green World Research (contract research organisation at Wageningen-UR) and UNESCO-IHE Institute for Water Education (IHE-Delft) have been accepted as full member of WIMEK/SENSE on the basis of a positive assessment of their individual scientific contributions.

Table 1. The WUR chair groups that participate in WIMEK

Environmental Sciences Group (ESG)							
		Research Group Leader	RC*	Core			
				1	2	3	4
AEW	Aquatic Ecology and Water Quality Management	Prof. M. (Marten) Scheffer	1.0	X	X		
ESA	Environmental Systems Analysis	Prof. L. (Leen) Hordijk (until 30 October 2002) Prof. R. (Rik) Leemans (from 1 September 2003)	1.0		X	X	X
HWM	Hydrology and Quantitative Water Management	Prof. P.A. (Peter) Troch (until 31 December 2005) Prof. R. (Remko) Uijlenhoet (from 1 April 2007)	1.0		X	X	
IWE	Irrigation and Water Engineering Group	Prof. B. Schultz (IHE/WU) / Dr. F.P. Huibers	0.2		X		
LUP	Land Use Planning	Prof. P.F.M. (Paul) Opdam	0.2		X	X	
NCP	Nature Conservation and Plant Ecology	Prof. F. (Frank) Berendse	1.0		X	X	
SFI	Soil Formation and Ecopedology	Prof. N. (Nico) van Breemen (until 31 December 2005)	1.0		X		
ESS	Earth Systems Science	Prof. P. (Pavel) Kabat (from 1 April 2006)			X	X	
SOQ	Soil Chemistry and Chemical Soil Quality	Prof. W.H. (Willem) van Riemsdijk	1.0	X	X		
SAG	Soil physics, Agrohydrology and Groundwater management	Prof. R.A. (Reinder) Feddes (until 30 November 2004)	1.0		X	X	
SEG	Soil physics, Ecohydrology and Groundwater management	Prof. S.E.A.T.M. (Sjoerd) van der Zee (from 1 July 2005)			X	X	
MAQ	Meteorology and Air Quality	Prof. A.A.M. (Bert) Holtslag Prof. M. (Maarten) Krol	0.0		X	X	
Agrotechnology and Food Sciences Group (AFSG)							
		Research Group Leader	RC*	1	2	3	4
ETE	Environmental Technology	Prof. W.H. (Wim) Rulkens / Prof. C.J.N. (Cees) Buisman	1.0	X			X
MIB	Microbiology	Prof. W.M. (Willem) de Vos / Prof. A.J.M. (Fons) Stams	0.3	X			
PCC	Physical Chemistry and Colloid Sciences	Prof. M.A. (Martien) Cohen Stuart / Dr. H.P. (Herman) van Leeuwen	0.3	X			
SCO	Systems and Control	Prof. G. (Gerrit) van Straten / Dr. K. (Karel) Keesman	0.2	X		X	X
TOX	Toxicology	Prof. I.M.C.M. (Ivonne) Rietjens / Dr. A.J. (Tinka) Murk	0.2	X			
Social Sciences Group (SSG)							
		Research Group Leader	RC*	1	2	3	4
ENR	Environmental Economics and Natural Resources	Prof. E.C. (Ekko) van Ierland	0.7			X	X
ENP	Environmental Policy	Prof. A.P.J. (Arthur) Mol / Prof. G. (Gert) Spaargaren	0.7				X
Plant Sciences Group (PSG)							
MAT	Mathematical and Statistical Methods	Prof. J. (Johan) Grasman	0.2		X	X	

\* Relative contribution (RC): If only part of the chair group participates in WIMEK, its relative contribution is listed.

During the review period, the characteristics of the participation and/or focus of some of the chair groups has changed. The major changes are:

- The chair group NCP, led by Prof. Berendse, changed its research focus from applied towards fundamental ecology. NCP decided to switch from participation in WIMEK/SENSE to participation in the WU Graduate School Production Ecology and Resource Conservation (PE&RC). As this will only be effective from 01/01/2007, NCP participates for the full review period in WIMEK/SENSE.
- After the retirement of Prof. van Breemen in 2004, the focus of the chair group shifted from Soil Formation and Ecopedology (SFI) into Earth System Science (ESS). The new chair group leader, Prof. Kabat, transferred in September 2006 part of his former Alterra research group to the renewed chair group. Together they form the new chair group ESS. This caused a significant change in research focus and staff members.
- After the retirement in 2004 of Prof. Feddes, who led the Soil physics, Agrohydrology and Groundwater management (SAG), the focus of the new chair group Soil physics, Ecohydrology and Groundwater management (SEG), led by Prof. van der Zee, shifted slightly from 'agrohydrology' to 'ecohydrology'.

- The Meteorology and Air Quality (MAQ) group participated in the inter-university Buys Ballot Research School, which addressed fundamental processes in the climate system and was co-ordinated by Utrecht University (UU). At the same time MAQ participated as an associated member in WIMEK. UU decided not to apply for re-accreditation of the Buys Ballot Research School. The WUR policy, however, obliges that every chair group participates in an accredited research school. Therefore MAQ decided to join WIMEK/SENSE as a full member as from 01/01/2007. As MAQ has been reviewed recently and graded excellent, it was decided that they will not participate in this ongoing SENSE review.

## **2. Mission of the Institute**

### **2.1 Mission statement**

The Wageningen Institute for Environment and Climate Research (WIMEK) aims to develop an integrated understanding of environmental change and its impact on the quality of life and sustainability, by (i) conducting innovative scientific research, (ii) offering PhD training and education and (iii) dissemination of emerging insights and recent research results.

### **2.2 Elaboration of the mission statement**

#### **Research**

WIMEK combines fundamental, strategic and participatory research in natural and social environmental sciences. WIMEK especially promotes interdisciplinary research focusing on the interactions between ecological, chemical and physical processes and their interactions with society, which is considered to be essential for a solid contribution towards solving complex environmental problems.

Research in WIMEK concentrates on the components of the cause-effect chain of environmental problems:

- The causes of environmental deterioration and climate change (human activities, sources and determinants of these activities);
- The behaviour of compounds within and transfer between the environmental compartments;
- The effects on ecosystems and society;
- The prevention, abatement and/or mitigation of the effects of environmental stress.

WIMEK's research programme is fully embedded in SENSE. In its research programme, SENSE concentrates on environmental problems in a multidisciplinary approach. The four Core Themes reflect the main research effort of SENSE with regard to environmental change:

- Core 1: Micropollutants, including environmental technology
- Core 2: Environmental change and ecosystem dynamics
- Core 3: Global change: climate, land use and biogeochemical cycles
- Core 4: Industrial transformation – towards sustainable use of energy and materials.

These Core Themes are fully described in the SENSE self-evaluation report. In this report only a short summary of the Core Themes is given in chapter 4 together with an overview of the main contributions of the WIMEK research groups presented in Annex 2. Table 1 lists the contribution of each chair group to the Core Themes.

#### **PhD training and education**

One of the most important tasks of all research schools is the education and training of young researchers. All WIMEK PhD students participate in the SENSE PhD training programme. SENSE offers PhD students a tailor-made education and training programme to deepen their disciplinary and interdisciplinary knowledge and to develop their research and management skills. WIMEK's PhD policy is presented in more detail in chapter 11.

#### **Dissemination of scientific knowledge**

Special attention is given to effective communication and dissemination of newly developed scientific knowledge, contributing to policy development and advancing the public debate on environmental



issues. New emerging insights and recent results of scientific research are rapidly embedded in the BSc, MSc and PhD courses offered by the WIMEK chair groups. Moreover, WIMEK research leaders are actively involved in scientific assessments, like the Intergovernmental Panel on Climate Change (IPCC), the Millennium Ecosystem Assessment and national Bsic research programmes. All aim at improving the scientific underpinning of decision making. Besides, WIMEK researchers actively raise public awareness by participating in public lectures and debate organised by newspapers, television and other organisations.

### **3. Management and Organisation**

#### **3.1 WIMEK a research institute at intermediate organizational level**

The WU chair groups that participate in WIMEK (Table 1) are hierarchically embedded in one of the WU Departments and participate in one or more Graduate Schools. The Science Groups and WIMEK have different tasks and responsibilities. The staff members, PhD researchers and post-docs are appointed at a chair group within a WU-department (one of the columns in the matrix structure; Figures 1 and 2) and not at the graduate school. The main WIMEK task is to co-ordinate, facilitate and safeguard high quality fundamental and strategic research within the framework of its multidisciplinary cross-department research programme (one of the rows of the Wageningen-UR matrix-structure; Figure 2). All WUR staff with a research task are accepted as a WIMEK-SENSE researcher if they meet the minimum scientific requirements of the SENSE research school. The WUR Executive Board also stimulates that senior researchers of the Specialized Research Institutes become recognized by the graduate schools.

So, WIMEK acts at an intermediate level in-between the WUR Executive Board, Science Groups and WU chair groups at the one hand and at an intermediate level in-between the SENSE Research School and the WU chair groups at the other. The main interacting responsibilities are:

- WU (central level) and the Science Groups are responsible for (i) human resource management policy, (ii) general financial policy and (iii) education and research facilities.
- SENSE is responsible for the development of the research programme (Core Themes and research foci) and the assessment of the general framework for PhD training and supervision.
- WIMEK is responsible for support and quality assessment of participating research groups, research staff, post-docs and PhD students. Moreover, WIMEK funds yearly (i) a few strategic PhD or post-doc research proposals; (ii) research fellowships and (iii) the development and organisation of PhD courses and activities.
- Chair Groups are responsible for the innovation and scientific quality of education (BSc, MSc and PhD courses) and research projects.

#### **3.2 WIMEK organization**

The organization of WIMEK consists of:

- the WIMEK General Board,
- the Scientific Director and executive staff,
- the WIMEK PhD Council.

Standing Committees on Research and Education have been set up within SENSE. These have not been duplicated in WIMEK. The same holds for the overall co-ordination of the WIMEK/SENSE Core Themes, for which the SENSE Core Managers are responsible.

#### **WIMEK General Board**

As the SENSE research school is functioning as an interuniversity network organisation, SENSE has delegated the responsibility for the execution of its research and PhD policy to the SENSE partner institutes and thus the WIMEK General Board. The board consists of five chair group holders, a research leader from Alterra Green World Research and a PhD student (see annex 6). The members of the Board are officially appointed by the WUR Executive Board. The Board is responsible for the functioning and performance of WIMEK within the general guidelines on strategy and policy determined by the WUR Executive Board and the SENSE Research School. The Board is also responsible for the quality assessment and the quality control of the WIMEK chair groups, staff members and PhD projects. Furthermore the Board decides on the spending of specific budgets (i) to improve PhD education, (ii) to execute strategic research priorities and (iii) to stimulate the international exchange of researchers. Besides, the Board advises the WUR Executive Board on matters such as the general research

strategy, chair group policies and PhD policy. The WUR Executive Board allocates a yearly budget to WIMEK covering the overhead costs. Furthermore, central budgets are allocated to WIMEK (i) to set out strategic research projects; (ii) to compensate chair groups for their efforts to set up and organise PhD courses and (iii) to grant research fellowships for foreign scientists (see also chapter 9). The WIMEK board allocates these budgets to different activities and projects.

### **Scientific Director and executive staff**

The Scientific Director, Prof. Leemans<sup>2</sup>, is also appointed by the WUR Executive Board. He is responsible for the daily management and all WIMEK's executive affairs. He attends the meetings of the WIMEK Board as advisor. He reports both to the WIMEK Board and the WUR Executive Board. The director is supported by an executive staff, consisting of a secretary and an administrative-secretarial assistant. The director and his secretary participate in the regular consultation meetings of the Wageningen Graduate Schools. Annually, they meet in separate sessions with PhD students and research group leaders to discuss progress, problems and opportunities. Finally, he reports to the Directors of the different Sciences Groups and the Rector of the University. WIMEK's Scientific Director currently also chairs the General Board of SENSE (see below).

### **WIMEK PhD Council (WPC)**

The PhD students are represented in WIMEK by the WIMEK PhD Council (WPC). The WPC advises the WIMEK Scientific Director and the WIMEK General Board on their request or on its own initiative. Moreover, WPC delegates one member to the WIMEK General Board, the Wageningen University PhD Council and the SENSE education committee.

## **3.3 WIMEK part of SENSE**

### **SENSE co-ordinators**

Wageningen-UR and Vrije Universiteit Amsterdam jointly co-ordinate the SENSE Research School since 1 January 2005. Both partners pay an extra financial contribution to express their direct involvement.

### **General Structure of SENSE**

Details on the management structure of SENSE and its responsibilities are provided in the SENSE self-evaluation report. SENSE consist of a general board, a board of directors, the Standing Committees on Research and Education and supporting and executive staff.

The General Board of SENSE consists of the directors or chairs of the participating SENSE institutes. As a consequence, the Scientific Director of WIMEK, Prof. Leemans, is also member of the General Board of SENSE. The SENSE Board of Directors consists of a General Director, Prof. Verhoef (VU), a Director of Research, Prof. Martens (MU) and a Director of Education, Dr. Kroeze (WUR). Dr. Kroeze is the WIMEK member at the board of directors.

The standing committee on research is composed of the four Core Theme Managers and chaired by the SENSE Director of Research. Prof. van Ierland (WIMEK) directs Core 3 'Global Change'. The standing committee on education, chaired by the Director of Education, Dr. Kroeze, consists of the PhD education and training co-ordinators of all participating SENSE institutes and representatives of local PhD councils or PhD platforms.

The standing committees advise the General Board and Board of Directors on issues concerning the general policy and strategy on research and PhD training and education and decide on matters delegated to these committees by the Board of Directors.

The supporting staff members (Deputy Director Dr. A. van Dommelen; Coordinator PhD Research and PhD Education Mr. J. Feenstra; Webmaster Drs. M. Vorenhout; and Secretary Mrs. Hoonhout)

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<sup>2</sup> Prof. Hordijk directed WIMEK from the start in 1993. In July 2002 he was appointed general director of IIASA in Austria and had to discontinue his position as scientific director of WIMEK per 1 September 2002. He was succeeded by Prof. van der Zee from February 2003. Due to his appointment as full professor of Soil Physics, Ecohydrology and Groundwater Management, he terminated the WIMEK directorship at the end of September 2005. Since October 2005, Prof. Leemans directs WIMEK.

have been appointed at Vrije Universiteit and Wageningen-UR. The WIMEK staff supports the SENSE Directors of Research and Education in the co-ordination of the SENSE research programme and the PhD training and supervision programme.

### **3.4 WIMEK part of Wageningen-UR**

#### **Wageningen Graduate Schools (WGS)**

All research schools with a substantial research input from WU cooperate in the platform Wageningen Graduate Schools (WGS), chaired by the dean of the faculty, Prof. Kok. The main tasks of WGS are:

- to stimulate co-operation and synergy between the WU research schools,
- to set-up and organise general skills courses for PhD students,
- to discuss the general Wageningen-UR research strategy and PhD policy, and
- to enhance the mutual fine-tuning and cooperation with the applied Specialized Research Institutes.

WGS is also responsible for the assessment and selection of WU sandwich PhD fellowships and the pre-selection of WU-supported Veni–Vidi–Vici proposals submitted to NWO.

#### **3.5 WIMEK's management style**

The development of innovative fundamental and strategic research requires a stimulating academic environment in which researchers have ample freedom to develop and pursue their original ideas. Therefore, the WIMEK chair groups are autonomous in choosing and developing their own research topics. At the same time they are held responsible for the quality of their research activities in terms of (i) scientific productivity, (ii) scientific and social impact, (iii) attractiveness for PhD students and (iv) successful acquisition of projects.

The role of WIMEK's management is to stimulate and facilitate innovative interdisciplinary research of high quality that fits into WIMEK's research programme. In this regard WIMEK assesses:

- the quality of PhD research proposals, based on the judgement and comments of two independent external reviewers,
- PhD progress and the quality of supervision,
- Scientific quality (productivity, impact) of the participating research groups, and
- Scientific quality (productivity, impact) of individual research staff members.

These tasks are carried out by analysing input, output, citations and PhD progress data. Furthermore, the quality of PhD supervision, PhD education and training is evaluated by analysing the results of a two-yearly PhD inquiry, followed by discussions with PhD students.

The WIMEK Director and his secretary have management meetings with each chair group every year to discuss the general developments of the chair group and the assessment results; to signalise potential bottlenecks and to give feed-back on PhD progress and supervision. Feed-back on the assessment results is also given to the Directors of the Science Groups and the Executive Board. WIMEK's management style could be characterized as:

- Quality driven,
- Personal engagement,
- Facilitating and supporting, and
- Stimulating interdisciplinary co-operation.

#### **3.6 SENSE's management style**

The SENSE Board decides on the general strategy and policy of the research school, the general framework of the SENSE research programme, the framework of the SENSE PhD training and supervision plans, partnerships, admission criteria for new research groups and individual researchers, quality criteria for the SENSE research groups and individual researchers, the internal quality control system and the SENSE budget. The SENSE Research School functions as a network structure and has delegated most executive tasks to the partner institutes. For more details, see the SENSE self-evaluation report.

## 4. Strategy and policy

### 4.1 Research Programme

WIMEK aims to contribute to the development of national and international scientific research of high quality focused on the multidisciplinary and interdisciplinary understanding of environmental change and its impact on the quality of life and sustainability. WIMEK research leaders have developed a strong international network and participate successfully in national and international research programmes financed by NWO, EU, national and foreign governments, industries and other parties. WIMEK researchers thus strongly contribute to fundamental understanding of interactions between physical, chemical and ecological processes on environmental change and its impacts on society. This results in dissertations and publications in high impact scientific journals. But not only the scientific output is important. WIMEK researchers are also actively involved in international policy assessments, such as the IPCC and the Millennium Ecosystem Assessment, and in national research programmes, like Bsik 'Climate change and spatial planning' and 'Geoinformation'. This participation improves the scientific underpinning of policy development and decision making.

The WIMEK contributions to the SENSE Core Themes are listed in Annex 2.

### 4.2 Strategic research priorities

#### Wageningen-UR priorities and WIMEK strategic research funds

The WUR Executive Board has defined several research priorities for the coming years in consultation with the graduate schools and the science groups. These priorities are aiming at (i) strengthening the knowledge base (KB) of the specialized research institutes by allocation of strategic research funds financed by the national government (especially Min. LNV) and enhancing the synergy between the specialized research institutes and the university and (ii) identifying upcoming and fast developing research themes, which need extra financial investments in the coming years. These strategic priorities (SPs) are described in the Wageningen-UR Strategic Plan 2007 – 2010. For WIMEK, the following high priority research themes are of particular importance:

- KB1: Sustainable development and adaptation of ecosystems and landscapes in a metropolitan context (co-ordinator: Prof. Opdam, WIMEK),
- KB2: Climate change (co-ordinator: Prof. Kabat, WIMEK),
- SP1: Bio-based economy,
- SP2: Climate resistant coastal zones, and
- SP6: Integration of scale levels and governance.

WIMEK receives a yearly budget of approximately 350 k€ from the WUR Executive Board to support strategic research developments by financing or co-financing PhD and post-doc projects. This budget is used to support and stimulate (i) the interdisciplinary co-operation between WIMEK chair groups; (ii) the synergy with Wageningen-UR strategic research priorities and (iii) the participation of WIMEK chair groups in national and international collaborative research programmes within the WIMEK domain.

#### INREF: The Interdisciplinary Research and Education Fund (Wageningen-UR)

In 2000, the WUR Executive Board launched the Interdisciplinary Research and Education Fund (INREF) programme to contribute to the international aspects of the Wageningen-UR mission. INREF's main goal is to apply and develop interdisciplinary and participatory research approaches with a problem and social issue-oriented focus. This should strengthen national, regional and world-wide research and development partnerships. INREF aims at personal and institutional capacity building in the South. All INREF research programmes have to be submitted and supported by at least two graduate schools. The INREF contribution to a research programme has a maximum size of 200 k€ per year, with a maximum duration of 5 years. The programme should be co-financed by other parties in the programme and/or third parties like WOTRO, DGIS and EU. Each INREF research programme is elaborated in a coherent set of research projects, carried out by PhD students connected to universities and research institutes in their home countries.

In the review period two research programmes, co-ordinated by WIMEK, were funded by INREF:

- Agro-industrial Transformations towards Sustainability: South East and East Asia in Global Perspective (2002 – 2006) in collaboration with the Chulalongkorn University Thailand, Chiang Mai University Thailand, University Malaysia Sarawak, National University Malaysia and the University of California Berkeley USA, funded by the WU-INREF programme with € 0.8 million. WIMEK partners: ENP, ETE and ESA.
- In 2005 a new WIMEK/MGS-INREF research programme “*Partnership for Research on Viable Environmental Infrastructure Development in East Africa*” (PROVIDE) has been developed. This programme, started in 2006, focuses on the improvement of sanitation and solid waste management in East Africa (Uganda, Tanzania and Kenya), with an emphasis on the Lake Victoria region. WIMEK partners: ENP, ETE and ESA.

#### **4.3 Contribution to PhD courses and activities**

As part of the SENSE research school, WIMEK plays an important role in the training and supervision of its PhD students. These activities are described in chapter 11.

### **5. Processes in research; internal and external collaboration**

#### **5.1 Processes in research**

WIMEK’s research is carried out by the chair groups. In each chair group a full Professor, tenured staff, post-docs and PhD students work together in well-defined research projects. These projects fit their own research interests and fall within the scope of WIMEK’s research programme. Moreover, MSc students are stimulated to participate in these research projects by doing research for their MSc thesis. They are regarded as part of the scientific community and actively involved in colloquium series at chair group level.

The main task of a full Professor is to initiate and stimulate new innovative research initiatives with adequate scientific quality and output. He sets out the strategy and policy of his group and is ultimately responsible for the quality of research and education. However, in practice, also tenured staff members, post-docs and PhD students take their own responsibility for the planning, progress and quality of their work.

#### **5.2 Interdisciplinary research**

The analysis of complex environmental problems and identifying possible solutions requires multidisciplinary and participatory approaches. Therefore WIMEK stimulates participation in interdisciplinary and transdisciplinary (involving stakeholders) research approaches on programme (e.g. INREF, EU, Bsik) and project level. About 10% of the current WIMEK PhD students are supervised by research leaders from two chair groups. Besides, about 5% of the PhD students is co-supervised by research leaders at other universities and researchers at the specialized research institutes and others (e.g. ECN, MNP and TNO). Furthermore, all foreign sandwich PhD students have a supervisor at their home institute too.

The importance for advancing interdisciplinary research is also illustrated by the initiative of the WIMEK Director, Prof. Leemans, to co-host the symposium ‘Interdisciplinarity in Research Practice’ with the Royal Netherlands Academy of Arts and Sciences (KNAW), the Netherlands Organisation for Scientific Research (NWO), and the advisory Council for Research on Spatial Planning, Nature and the Environment (RMNO). One of the key-note speakers was Prof. Hordijk, the former WIMEK Director.

#### **5.3 Quality assessment**

##### **PhD project proposals and progress**

WIMEK is responsible for the assessment of PhD project proposals and the monitoring of the progress of the PhD students. All WIMEK PhD project proposals are assessed by two independent external reviewers on (i) scientific quality, (ii) social and environmental impact or relevance and (iii) feasibility. The PhD student and supervisor have to respond to the comments. In many cases the reviews result in the improvement of the project proposal.

The progress of the PhD research is discussed in the yearly management meetings between the WIMEK Directorate and each chair group leader. If necessary, the WIMEK director discusses

personal issues with individual PhD students and provides advice or communicates concerns with the supervisor. In case of severe problems also a councillor can be consulted. In the course 'Research in Context, he also meets all students personally.

### **Individual researchers**

The quality assessment of all tenured staff members is based on criteria determined by the SENSE Research School. To become a full member of the SENSE research School, staff members have to meet the following criteria. He or she:

- has obtained a doctoral degree (PhD),
- has published on average at least two refereed publications per year in international scientific journals and/or chapters in refereed books,
- is involved in PhD supervision, and
- contributes regularly to postgraduate education, such as PhD courses, summer schools, symposia and seminar series.

Once every three years the WIMEK Director evaluates the scientific output on basis of a list of publications, impact on basis of a citation analysis, and involvement in PhD supervision and postgraduate education of all WIMEK staff members. He discusses the results with the chair group leaders and afterwards with the Directors of the Science Groups.

### **Research groups / chair groups**

At the same time the WIMEK chair groups are evaluated on basis of input, output, impact, awards, NWO grants and other acquired research funds. These results are also discussed with the chair group leaders and afterwards with the Executive Board of Wageningen UR.

## **5.4 Collaboration**

### ***Collaboration at Wageningen-UR level***

#### **Wageningen Graduate Schools**

All WU graduate schools cooperate in 'Wageningen Graduate Schools' (WGS). The directors and secretaries meet monthly (i) to discuss the WUR strategy and policy (Wageningen-UR Strategic Plan; policy instruments to improve research quality; PhD policy; quality of WU PhD theses; development of research master courses; INREF; research priorities for the Knowledge Base Budget; etc.) and (ii) to be informed about new research developments and opportunities (new EU, NWO and Bsik research programmes).

The WU graduate schools work closely together in organising general skills courses for PhD students, like 'Scientific writing and presentation', 'Time planning and project management', 'Scientific publishing', 'Teaching and supervising MSc thesis students' and 'Career orientation'. Besides, WIMEK cooperates especially with the graduate schools Production Ecology & Resource Conservation (PE&RC) and Mansholt Graduate School to organise dedicated PhD courses on subjects of common interest.

On WIMEK's initiative the graduate schools developed a joint research programme "Spatial development and society: integrating analytical and design approaches". Within this framework three PhD students and one post-doc started their research in the course of 2005 and 2006.

#### **Specialized Research Institutions (DLO)**

WIMEK collaborates closely with the specialized research institutes on common research topics. Several of these common research projects are funded by the EU. The collaboration is most intensive with Alterra Green World Research. Several senior Alterra researchers participate as full member in WIMEK/SENSE.

On the research topic Climate Change, WIMEK, PE&RC and four specialized research institutes (Alterra, PRI, AFI and LEI) cooperate in the Wageningen-UR Climate Change and Biosphere Programme (CCB), chaired by Prof. Kabat.

## **National Collaboration**

### **SENSE**

WIMEK collaborates very closely with environmental research institutes and research groups at other Dutch universities in the Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment (SENSE). For more information see the SENSE self-evaluation report.

### **Darwin Center for Biogeology**

Four Dutch universities (UU, RU, VU and WU) and two research institutes (NIOO and RIKZ) participate in the Darwin Center for Biogeology, a center of excellence, which was established in 2004. The Center performs cutting-edge science in Biogeology where Biology and Earth Sciences meet. Its research mission is to understand the functioning of global, regional and local ecosystems, focussing on changes and feedbacks at all time scales in and between biotic and abiotic components of a changing Earth. Wageningen-UR participates with four WIMEK research groups: Aquatic Ecology and Water Quality Management (AEW), Nature Conservation and Plant Ecology (NCP), Microbiology (MIB) and Earth System Science (ESS).

### **Boussinesq Centre for Hydrology**

The Boussinesq Center for Hydrology was established in 2005 as a result of the Dutch Foresight Study on Hydrological Science (2005) performed by the Royal Netherlands Academy of Arts and Sciences (KNAW). The Boussinesq Center combines different hydrology groups of Delft University of Technology, Utrecht University, Vrije Universiteit Amsterdam and Wageningen University and the hydrology groups of the technological institutes UNESCO-IHE Delft and ITC Enschede. Wageningen-UR participates with two WIMEK research groups: Hydrology and Quantitative Water Management (HWM) and Soil physics, Ecohydrology and Groundwater Management (SEG). WIMEK supports the Centre financially.

### **ECN, TNO and MNP**

WIMEK collaborates closely with other non-university research institutes in the Netherlands, such as the Energy Research Centre of the Netherlands (ECN) and the Netherlands Organisation for Applied Scientific Research (TNO) and the Environmental Assessment Agency (MNP). The collaboration with TNO has been formalised in the *Centre of Expertise on Soil Management and Soil Sanitation Technology* and in the *Centre of Expertise on Emissions and Assessment*.

### **Bsik national research programmes**

Over the past years WIMEK research leaders initiated and established a large consortium of public and private partners for several BSIK projects on '*Climate changes spatial planning*', '*Living with water*', and '*System innovation urban and regional land use and area development*'. The main aim of these projects is to create an integrated, high-quality and low-threshold knowledge infrastructure for the interaction between climate change and multiple land use (land, water, spatial planning, traffic, urban and rural infrastructure). The Dutch Government approved the proposals and decided to invest € 92 million in these topics during the period 2004 – 2008. Within the framework of these research programmes 50 – 100 PhD students will start research projects in the period 2005 – 2007. Half of them is expected to participate in SENSE.

## **International Collaboration**

WIMEK researchers participate actively in several different international research programmes. For example, WIMEK research groups participate in several EU integrated Projects, such as AQUATERRA, SENSOR, ATEAM, ADAM, EWATER and FUNMIG. In INREF research programmes, WIMEK researchers also work closely together with universities and research institutes in developing countries, with a focus on South-East Asia and East Africa. Individual researchers contribute substantially to several integrating international programmes, such as the World Climate Research Programme (WCRP), the International Geosphere and Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP), Diversitas and the Earth System Science Partnership (ESSP).

## **Marie Curie Training Sites**

WIMEK has taken the initiative to develop two SENSE Marie-Curie Training Sites in 2002. These offer the opportunity to PhD students from EU and associated member states to carry out part of their PhD research (6 – 12 months) at one of the research groups participating in the Training Site. The sites which were evaluated positively and granted by the EU for the period 2002 - 2006 are:

- Chemical Speciation, biological availability and ecotoxicological effects of contaminants in soil and water (SPECIES: 63 fellow months), and
- Integrated Assessment of Global Change (INTEASS: 96 fellow months).

## **6. Academic reputation**

### **6.1 Previous Assessments**

#### ***VSNU research assessments***

All WIMEK chair groups have been reviewed by the various research assessment committees of the VSNU in the period 1999 – 2002 (annex 1). These assessments were organised for a coherent group of disciplines at all Dutch universities, like 'Biology', 'Earth Sciences' and 'Economy' and by exception for interdisciplinary research fields, like 'Environmental Sciences'. The results were generally good. For some new established chair groups (e.g. ENP and ENR) the assessment results reflect mainly the situation of the preceding chair group and give not a correct indication of the current quality.

#### ***SENSE assessments***

WIMEK has been evaluated several times as part of SENSE. The quality of the SENSE research school (including WIMEK) has been evaluated by an external review committee most recently in 2004 (SENSE Midterm Review 2001 – 2003, published on 24 November 2004). The general conclusion was that SENSE constitutes a research school with a high quality research programme, good educational activities, and an adequate management. The committee advises the participating universities to continue or strengthen their support of the SENSE research school. For more information see the SENSE self-evaluation report.

#### ***WIMEK Midterm Review 2001 - 2004***

WIMEK carried out a Midterm Review 2001 – 2004 at research group or chair group level and at the level of the WIMEK graduate school, in addition to the SENSE Midterm Review 2001 – 2003, because the latter was focused on the level of the Research School. The WIMEK Midterm self-evaluation report 2001 – 2004 has been discussed with and accepted by the Rector of the university (see also section 12.1).

The main concern of many WIMEK groups is the limited research budget allocated by the university. This restricts the opportunities for curiosity driven fundamental scientific research.

### **6.2 Bibliometric analysis of scientific results**

As part of the SENSE self-evaluation, a bibliometric citation analysis has been carried out over the period 1996 - 2005 for all WIMEK chair groups and for WIMEK and SENSE as a whole. The analysis shows that the relative impact of the refereed publications of three chair groups is around world average ( $0.8 < RI < 1.2$ ); two score well above world average ( $1.2 < RI < 1.5$ ); and six chair groups score far above world average ( $RI > 1.5$ ).

The average relative impact of the refereed publications of WIMEK showed a slight decline from 1.74 (1996 – 2000) to 1.62 (2001 – 2005), but was in both periods far above world average.

Some 254 publications, or 18 % of the total publications, belong to the top 10% highest cited publications in their field. Only 8% of the publications were uncited.

Moreover, 4 WIMEK research leaders belong to the exclusive category "Highly Cited Researchers" (top 250 most cited researchers in their research field): three in the ESI field Ecology / Environment (Prof. F. Berendse; Prof. N. van Breemen en Prof. G. Lettinga) and one in the ESI field Microbiology (Prof. W.M. de Vos).



### 6.3 WIMEK Top Publications

In the review period, WIMEK researchers published 7 articles in Nature, 4 articles in Science and 4 articles in PNAS (see annex 4). Moreover, a great part of the scientific articles have been published in high impact journals, some of them belonging to the so called "ISI hot papers", papers highly cited soon after publication. In annex 4 also some top book publications are listed. An overview of all WIMEK Key publications is shown in annex 3.

### 6.4 Rewards and prizes

WIMEK researchers received several individual (top) grants to support the development of their research lines and research career (see annex 5). The NWO-TOP grant (MIB, Prof. Fons Stams, 675 k€), NWO-VIDI grant (HWM, Dr. Remko Uijlenhoet); NWO-ASPASIA grants (ESA, Dr. Carolien Kroeze and TOX, Dr. Tinka Murk); and the EU Marie Curie Excellence grant (ETE, Dr. Piet Lens) are especially mentioned.

### 6.5 Memberships of editorial boards and leading scientific organisations

WIMEK researchers are member of many editorial boards of renown scientific journals. Additionally, they play a major role in the development of national and international scientific organisations, such as KNAW, NWO, WOTRO, EU, UN and ISCU. For details, see the individual CV of especially the research leaders.

## 7. External validation / relevance for society

### ***Policy documents and briefings***

WIMEK research leaders play an important role in the scientific underpinning of international policy documents regarding climate change, reduction of biodiversity, disturbing of ecosystems and an ecological reform of industrial production. WIMEK researchers contribute actively to IPCC and the Millennium Ecosystem Assessment. WIMEK researchers presented the findings of these assessments to Dutch parliament and ministries. At the recent Conference of Parties of the Climate Convention (UN-FCCC) several sessions focussed on Carbon sequestration policies and dangerous levels of climate change. Some of these discussions were introduced by a review compiled by WIMEK researchers<sup>3</sup>. Moreover, in September 2004, the Dutch Centre for Energy Savings (CE Delft) published, on request of Dutch Parliament a policy report "Climate Change, Climate Policy; Insight in policy choices for the Lower Chamber", with contributions of WIMEK researchers<sup>4</sup>. The report gives an overview of the current scientific insights in climate change, an evaluation of the current climate policy and suggestions for future climate policy.

### ***INREF***

Another good example of science for society is the Wageningen University INREF programme, which addresses interdisciplinary research and capacity building in developing countries. In 2001 the WIMEK/MGS INREF research programme "Agro-industrial Transformations towards Sustainability: South East and East Asia in Global Perspective" (AGITS) started. AGITS analysed new opportunities and challenges for environmental reforms in agro-industrial production and consumption, and contribute to the design of more sustainable production-consumption systems in Thailand and Malaysia. This INREF programme was coordinated by the ENP group.

In 2006 a new WIMEK/MGS-INREF research programme "*Partnership for Research on Viable Environmental Infrastructure Development in East Africa*" (PROVIDE) started with 11 PhD research projects. This programme contributes to the improvement of sanitation and solid waste management in East Africa, with an emphasis on the Lake Victoria region. It develops and assesses an integrated approach - labelled the modernized mixtures approach - that integrates the well-known western large-scale high-technological grid based systems and the familiar small-scale, low-tech, decentralized technologies that are currently applied in many African communities. The approach integrates the

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<sup>3</sup> For example: Leemans, R., and A. van Vliet. 2004. Extreme weather: Does nature keep up? Observed responses of species and ecosystems to changes in climate and extreme weather events: many more reasons for concern. Report Wageningen University and WWF Climate Change Campaign, Wageningen.

<sup>4</sup> Klimaatverandering, klimaatbeleid: inzicht in keuzes voor de Tweede Kamer (CE, September 2004)

(eco)technological, economic and socio-political dimensions of new environmental infrastructures against the background of specific local contexts. This INREF programme is coordinated by the ENP group too.

Besides, WIMEK also participates in the newly initiated INREF research programme "*Competing Claims on Natural Resources: Overcoming Mismatches in Resource Use through a Multi-Scale Perspective*" by a contribution of the Environmental Economics and Natural Resources Group (ENR) and the INREF programme *Rebuilding resilience of coastal populations and aquatic resources: habitats, biodiversity and sustainable use options (RESCOPAR)* by contributions of the Environmental Policy group (ENP) and the Aquatic Ecology and Water Quality Management group (AEW).

### **Environmental Technology**

Another important contribution of science for society is the research done by the Environmental Technology Group. The objective of this group is to contribute to a more sustainable world by linking depletion problems (energy, water, minerals and fertile soils) to pollution problems (greenhouse effect, water pollution, eutrophication/toxicity and contaminated soil/sediments). The group is very successful in the dissemination of scientific results into society. The most important example is the UASB reactor with over 2000 officially registered installations worldwide producing more than 5 million m<sup>3</sup> of biogas per day (equivalent to a recoverable electric potential of 870 MW).

On Friday 20 April 2007, the emeritus chair holder of Environmental Technology Professor Gatzke Lettinga received the prestigious Tyler Prize for Environmental Achievement in Los Angeles. He was awarded the prize – 200 thousand dollars and a gold medal – for his contribution to environmental protection. His research on anaerobic water treatment and biogas production has led to efficient and environment-friendly technology being used all over the world for treating waste and wastewater. By design, the core technology is freely available. Lettinga chose not to patent his invention. "The UASB-reactor concept is still completely open for everyone, consequently particularly also for the citizens in developing countries, and that is what I wanted and still want," Lettinga stated recently.

### **Climate Change in the Back Yard – the 'Natuurkalender'**

The Natuurkalender (translated: Nature's Calendar; [www.natuurkalender.nl](http://www.natuurkalender.nl)), which is coordinated by the Environmental Systems Analysis Group of Wageningen University, aims to monitor, analyse, predict and communicate climate change induced changes in phenology (e.g. flowering, leaf unfolding). The programme involves over 6000 volunteers and hundreds of school children. The findings are summarized weekly in the national radio program 'VARA's Vroege Vogels'. With contribution to over 20 national and international news paper articles, 30 radio shows and 33 television programmes in 2006 alone, it has become one of the most widely-known WUR activities. The project resulted in a large dataset with long observed trends on phenological change. Its internet-based observation software has recently been coupled to Google Earth, which increases the precision and scientific applicability of localizing the observations. The Nature's Calendar project closely cooperates with organisations involved in human health, agriculture, nature management and gardening in order to provide these sectors the possibility to adapt to climate change impacts.

### **Other high societal impact examples of WIMEK research**

- Prof. Scheffer's research (AEW) on the positive feedback between global temperature and atmospheric CO<sub>2</sub> levels (GRL) attracted much attention of the press worldwide. The BBC created a special web-page about the issue and numerous interviews were given to the international press.
- The NCP group published three studies on the efficacy of agri-environment schemes. These studies showed unambiguously that the effects of these schemes were negligible and had even negative effects on the abundance of some meadow bird species. These results received attention in many news media (e.g. USA Today, Financial Times, BBC, Frankfurter Zeitung) and were also discussed at a WTO meeting. In 2006 the Minister of Agriculture announced a new policy with respect to agri-environment schemes. He answered to questions in the Parliament that in the future only contracts with farmers would be funded that had proven to be effective and were "Wageningen University-proof" (These were his actual words!).
- The development of an operational RS monitoring system for Indonesia (in cooperation with the Indonesia ministry of Forestry and Agriculture and some partner organisations) by the SEG group boosted decision making in the area of peat swamp management and oil palm plantation development in 2006. A map of Borneo was made, that indicates go/no-go areas for oil palm

plantation development. The monitoring system caused the Indonesian government to stop the conversion of 1.8 million ha of pristine mountain forest along the Sarawak border into oil palm plantation.

## 8. Research input

### 8.1 Human Resource Management Policy

In accordance with the line-responsibilities, the Executive Board of Wageningen-UR and the Management of the science groups determine the outlines of the personnel and human resource management policy. The Wageningen Graduate Schools discuss relevant issues of such policies with the Rector and the directors of the science groups. Points of particular interest for the research schools are also the WUR-wide policies on PhD education, the financial ITSP incentives, young talented researchers, the personal chairs and the externally funded chairs. WIMEK further has developed policies to stimulate a more balanced gender mix, increase mobility and improve staff and PhD training.

### 8.2 WU PhD policy

Wageningen University distinguishes four categories PhD students: regular, sandwich, guest and external. At the end of 2006, in total *207 ongoing PhD students* have been registered at WIMEK. The division of WIMEK PhD students over these categories per 01-01-2007 is: 51% regular, 20% sandwich, 10% guest and 19% external PhD students. Moreover, 57% of the WIMEK PhDs have a Dutch nationality and 43% come from abroad. Most foreign WIMEK PhD students come from Asia (47%); the other foreign PhD students are quite equally spread over EU countries (18%), Middle & South America (17%) and Africa (15%).

#### ***Regular PhD students***

These PhD students, also known as AIOs (Dutch abbreviation for research trainees), are recruited via vacancy announcements, selected after competitive interviews and temporarily appointed at Wageningen University for a period of one year, with a possible extension for another three years. They are automatically enrolled in the Dutch social insurances and pension schemes and can use all HRM facilities at WUR. The candidate is selected on the basis of a relevant MSc degree, individual qualities and motivation. Nine month after the start, the functioning, ITSP and research progress of the PhD candidate is evaluated to reach a formal go/no-go decision for the extension of the contract. At the end of 2006 *106 regular PhD students* were registered at WIMEK (51% of all WIMEK PhD students).

#### ***Sandwich PhD student***

Many sandwich PhD students participate in WIMEK. These PhD students spend usually the first 6 – 8 months in Wageningen to study literature, to follow PhD courses and to elaborate a full PhD proposal. The following two - three years are spent at a research institute or university in their country of origin to collect relevant data and to carry out practical research. The last part of the PhD research (6 – 8 months) they return to Wageningen to analyse and discuss the research results, and to finalise and defend their thesis. If, at the end of their first stay, there is no approved PhD proposal and accepted ITSP, a formal no-go decision stops the continuation of the studies.

WU has funds for 15 individual sandwich PhD fellowships a year. These fellowships are primarily intended to give excellent MSc students from abroad the opportunity to continue their academic career with a PhD study at Wageningen-UR. Furthermore, WU sandwich PhD fellowships are offered by the INREF research programmes, by organisations for international development, like WOTRO (NWO) and Nuffic, and by foreign governments. At the end of 2006 *41 sandwich PhD students* were registered at WIMEK (20% of all WIMEK PhD students).

#### ***Guest PhD students***

This category is not appointed at Wageningen University, but gets financial support from external parties to do (the major part of) their PhD research at one of the research groups of Wageningen University. The financial support usually involves both a personal allowance, covering the costs of living, and an allowance for the host institution, covering the costs of the PhD training and research.

Before acceptance, the education and the diplomas of the candidate, and his proficiency in English are officially evaluated by the university. The Head of the hosting chair group assesses the disciplinary merits. During the first months of the stay, the student has to develop his research proposal. If, after nine months, there is no approved PhD proposal and accepted ITSP, a formal no-go decision stops the continuation of the studies.

At the end of 2006 *20 guest PhD students* were registered at WIMEK (10% of all WIMEK PhD students).

### **External PhD students**

These PhD students conduct their research at a research institute outside Wageningen University, supported by a local day-to-day supervisor and a WU Professor acting as the official academic supervisor (i.e. promotor). At the end of 2006 *40 external PhD students* were registered at WIMEK (19% of all WIMEK PhD students).

### **8.3 WU financial ITSP incentives**

Wageningen University attaches much importance to the training and education of PhD students. WU offers all PhD students, who have a training and supervision plan (ITSP) approved by the graduate school, an additional training budget of € 2.500. Moreover, the chair group bonus for PhD graduations differs for PhDs with and without a completed ITSP. The bonus for PhD candidates who have fulfilled all ITSP requirements (concluded with a certificate of the research school) is twice the bonus for PhD graduation without an ITSP certificate. This has become a strong incentive for all WU supervisors to stimulate their PhD students to follow the education and training programme of the research school completely.

### **8.4 WU policy for young talented researchers**

In 2000, NWO, KNAW and the universities jointly set up the Innovational Research Incentives Scheme. Its aim is to promote innovation in the academic research field. The scheme is directed at providing encouragement for individual researchers and gives talented, creative researchers the opportunity to conduct their own research programme independently and promote talented researchers to enter and remain committed to the scientific profession. Researchers from the Netherlands and from abroad may apply for:

- Veni grants: for researchers who have recently received their PhD, to allow them to continue to develop their ideas. These grants have a maximum of k€ 208.
- Vidi grants: for researchers who want to develop their own innovative line of research and appoint one or more PhD students and post-docs. These grants have a maximum of k€ 600.
- Vici grants open for application: for senior researchers to build their own research group. These grants have a maximum of k€ 1,250.

To improve the chances of WU candidates, the Wageningen Graduate Schools decided to set up a supporting action programme which consists of:

- A subsidy for promising candidates, selected on personal qualities and the quality of their pre-proposals, to elaborate their innovative research ideas in full proposals,
- An evaluation of the full proposals and the oral presentations of the candidates, resulting in a pre-selection of WU supported applications and suggestions for improvement, and
- A bonus for successful WU applicants, by means of an additional PhD or post-doc grant, financed by the research schools (strategic budget).

In 2001, Dr. Remko Uijlenhoet (WIMEK/HWM) was one of the first to receive such a prestigious Vidi grant.

### **8.5 WU personal chair policy**

Once every four years, the Board of Wageningen-UR, invites chair group leaders and directors of research schools to nominate excellent staff members for a personal chair. The aim of this policy is to spot, award and motivate excellent researchers to further develop new research lines at Wageningen University. In the review period 2001 – 2006 3 personal Professors have been appointed at WIMEK research groups (see annex 5)

## 8.6 WU policy on externally funded chairs

Wageningen UR has developed a policy to attract externally funded chairs. Externally funded chairs may be installed to improve the mutual cooperation with external research institutes and research departments of industrial enterprises or to develop new innovative research fields. At the end of 2006 eighteen externally funded chairs were connected to WIMEK chair groups: 7 professors from International Education and Research Organisations, such as UNESCO-IHE Delft and ITC Enschede; 7 professors working at external research institutes, such as Alterra, TNO, ECN, RIZA, Shell and 4 professors, funded for 0.2 fte by external organisations to stimulate new societally desired scientific developments, such as “environmental policy for sustainable life styles and consumption” (prof. Spaargaren); “Ecology of nature conservation” (prof. Schouten); “Nature conservation of farm land” (prof. De Snoo) and “ecological organisation and management of infrastructure” (prof. Sykora).

## 8.7 WIMEK Policy to stimulate a more balanced gender ratio

At Wageningen University there is still a big discrepancy between the number of female and male staff members, especially in higher positions, related to the employment potential (Table 2). The WIMEK chair groups are no exception to this trend and the situation is even worse compared with WU level. WIMEK tries to stimulate talented female researchers by supporting applications for specific grants. In the review period 2 female WIMEK researchers received a prestigious NWO Aspasia grant (including promotion to associate Prof. and a research grant) and 1 female researcher received a NWO Meervoud grant (talented post-doc).

Table 2. Gender balance for the different staff categories at Wageningen University

	Full Professors		Associate Professors		Assistant Professors		PhD students	
	WU	WIMEK	WU	WIMEK	WU	WIMEK	WU	WIMEK
Male	89%	95 %	87%	90%	73%	93%	54%	62 %
Female	11%	5%	13%	10%	27%	7%	46%	38 %

## 8.8 WIMEK mobility policy

To stimulate the mutual international exchange of researchers, WIMEK grants research fellowships (3 – 12 months) twice a year. A research fellowship should contribute to the enhancement of a long-lasting collaboration between the involved research groups. Moreover, the research topic of the fellowship must fit into the priorities of the WIMEK research programme.

## 8.9 WIMEK staff and PhD training

In addition to the general WU training programme on educational and other skills, the Wageningen Graduate Schools offer a course “PhD supervision” for all WUR staff members to improve the quality of PhD students and other young researchers.

The SENSE research school and Wageningen Graduate Schools have developed a dedicated training and education programme for all WIMEK PhD students. WIMEK staff members are actively involved in the programme by organising SENSE and some WGS PhD courses and in the management of the SENSE PhD programme (see also chapter 11).

## 8.10 WIMEK research input

Table 3: WIMEK research input 2001 – 2006 in fte

	2001	2002	2003	2004	2005	2006	6 year Average	%
Tenured staff	20.3	20.9	20.9	20.9	19.8	18.9	20.3	21
Non-tenured staff	13.5	17.2	19.6	19.4	17.0	16.6	17.2	18
AIO/OIOs	40.0	43.0	43.5	43.7	47.4	49.6	44.5	46
Other PhD students <sup>1</sup>	15.4	13.7	13.9	15.7	16.6	15.1	15.1	16
<b>Total research staff</b>	<b>89.2</b>	<b>94.7</b>	<b>97.9</b>	<b>99.7</b>	<b>100.8</b>	<b>100.2</b>	<b>97.1</b>	<b>100</b>

<sup>1</sup> fte research time of external and sandwich PhD students is counted only as far as spent at the institute

Table 3 shows that about 61% of the WIMEK research is carried out by PhD students. As the research input of sandwich PhD students is only counted for 25% of their research time and the research input of external PhD students is not counted at all, this estimation is probably conservative. The research input shows a slightly upward increase during the assessment period.

## 9. Resources, funding and facilities

### 9.1 Funding research groups

#### **Base budget**

The WUR Executive Board determines the general policy on the allocation of budgets among the chair groups. The basic budget for research and education of an average chair group allows the employment of:

- 1 Professor (chair),
- 1 associate Professor (UHD),
- 2 assistant Professors (UD), and
- 1 technical assistant or secretary.

The budget for education is based on the real teaching and supervising efforts made by the chair group. For each BSc and MSc course the effort is calculated taking into account the contact and supervision intensity of the course and the number of students who passed the course exam.

On average, 40 – 45% of tenured staff time is available for research. This includes supervision of PhD students. Extra research budget is granted for having attracted NWO funded post-docs or PhD students (k€ 10 per person-year) and for PhD graduations (k€ 25 per graduation). This budget may be used to employ extra staff members.

#### **Research bonus**

In April 2004 the Executive Board of Wageningen-UR decided to grant research bonuses to 19 WU chair groups, based on an analysis of the scientific research performance. Among them four WIMEK research groups: Physical Chemistry and Colloid Science (PCC; excellent), Soil Quality (SOQ; very good), Microbiology (MIB; very good) and Aquatic Ecology and Water Quality Management (AEW; good / very promising).

#### **Externally research funds**

Furthermore, extra research budget may be generated by externally funded research projects. Non tenured staff (in most cases post-docs and PhD students) is funded by a variety of resources subdivided into three main categories:

- University funding (1<sup>st</sup> flow of funds),
- Netherlands Organisation for Scientific Research (NWO) (2<sup>nd</sup> flow of funds), and
- Third parties (3<sup>rd</sup> flow of funds).

Table 4: WIMEK Funding in fte

Funding	2001	2002	2003	2004	2005	2006	6 year average	%
University funded	31.5	32.7	35.7	34.3	29.7	28.6	32.1	33
NWO funded	22.0	26.3	26.5	22.7	20.0	17.6	22.5	23
Contract funded	35.6	35.7	35.7	42.7	51.2	53.9	42.5	44
<b>Total</b>	<b>89.2</b>	<b>94.7</b>	<b>97.9</b>	<b>99.7</b>	<b>100.8</b>	<b>100.2</b>	<b>97.1</b>	<b>100</b>

WIMEK was quite successful in generating externally funded projects. Table 4 shows that about 67% of the WIMEK research programme is externally funded, of which one third is funded by NWO and two thirds by other external organisations.

The acquisition of competitive research funding of national and international organisations (such as NWO, Dutch Ministries, Bsik, EU) is not only prestigious (selection on quality), but also enables research groups to refocus its research programme and to develop new lines of research. As a consequence, the research priorities of the chair groups and WIMEK are determined more and more in line with the research priorities of the dominating research funding agencies like local and national governments, NWO and EU. However, the very limited research budget allocated by the university

makes it difficult to strongly invest in such programmes or develop new fundamental curiosity-driven research lines, especially if no other external funds are available to support the research topic. Moreover, participation in many of these programmes requires a shared-costs basis. WIMEK is concerned about this tendency, because the current opportunities to enter new research areas or to explore new pathways turn out to be limited whereas original ideas of independent and sometimes persistent scientists have often led to unexpected totally innovative scientific insights. This basic role of universities to do independent curiosity driven research should be strengthened in future.

## **9.2 WIMEK's Financial Resources**

The Board of Wageningen-UR has earmarked a yearly budget of k€ 190. This budget is used to partly compensate the efforts of the WIMEK Director (~ k€ 56), to employ a small office (0.8 fte executive secretary and 0.9 fte secretarial assistance), to pay the SENSE contribution and few funds to cover material costs and to subsidize the organisation of international scientific conferences. Furthermore, the WUR Executive Board allocates budgets (i) to finance strategic research projects (k€ 350 per year), (ii) to compensate staff efforts in PhD training and education (k€ 45 per year) and (iii) to grant research fellowships (k€ 37 per year).

WIMEK supports national and international co-operation by granting strategic research funds or limited financial subsidies to strategic research developments, which are relevant and important for WIMEK chair groups. Examples include the co-financing of a staff member at the Environmental Policy Group to develop and implement a joint PhD Programme with universities in South-East and East Asia, the financial matching of PhD projects to enable WIMEK research groups to participate in the Darwin Institute for Biogeology, a subsidy for the WIMEK participation in the Boussinesq Centre for Hydrology and a subsidy to set up a joint PhD Programme in Resilience and Sustainability Studies between South American Institute for Resilience and Sustainability Studies (SARAS) and WIMEK.

### ***WIMEK's Strategic Research Fund***

The budget amounts about k€ 350. That is sufficient to finance the personnel costs of two PhD projects or one PhD and one post-doc project yearly. In the past WIMEK has organised open calls for proposals. All proposals have been assessed anonymously by independent external reviewers (peers). The strategic research funds were granted to the proposals with the best score on the assessment criteria (i) originality and/or innovative character; (ii) scientific quality; (iii) feasibility and (iv) strategic surplus value for the WIMEK/SENSE research programme.

Besides the WIMEK Board decided to spend part of the research funds to stimulate strategic scientific developments like (i) the development of a joint WIMEK-PE&RC-MGS-CERES research programme "Spatial development and society: integrating analytical and design approaches" (k€ 180) and (ii) matching PhD projects of WIMEK participants in the Darwin Center for Biogeology (k€ 180). The WIMEK policy also stimulates WIMEK research leaders to attract Veni-Vidi-Vici candidates by granting an extra budget or an extra PhD student to successful WIMEK groups.

### ***WIMEK's PhD Training and Education Budget***

The yearly budget adds up to k€ 46. The WIMEK board has decided to spend this budget for (i) the preparation and organisation of WIMEK/SENSE PhD courses (maximum € 2.500 for a one week course); (ii) the reduction of course fees of other relevant PhD courses (maximum € 250 per WIMEK PhD student per course week); (iii) travel and accommodation expenses of guest lecturers (internationalisation) and (iv) staff support for the co-ordination of the SENSE Training and Education Programme.

### ***WIMEK research fellowships***

This fund aims at the improvement of strategic long-term co-operation with research groups and research institutes abroad of relevant and strategic importance for the core research themes of WIMEK/SENSE. Twice a year WIMEK research leaders may send their proposals for research fellowships to the WIMEK Director. Every year WIMEK grants about € 37.000 to research fellowships for a period of one to nine months. WIMEK granted on average 8 research fellowship or 36 fellow months per year.

## 10. Research output – overview of scientific results

### 10.1 WIMEK key publications 2001 – 2006

For our key publications we have selected five WIMEK key publications with a high scientific impact and five key publications with a high societal impact. The first three mentioned key publications in box 1 illustrate the broad international scientific cooperation of WIMEK researchers.

The choice of the publications in box 2 is explained per publication.

#### ***I: high scientific impact***

Scheffer, M., Carpenter, S., Foley, J.A., Folke, C., & Walker, B. (2001). Catastrophic shifts in ecosystems. *Nature*, 413(6856), 591-596: Sustainability Science Award of the Ecological Society of America (2004). (425 times cited on 08-04-2007)

Schröter, D., Cramer, W., Leemans, R., Prentice, I.C., Araujo, M.B., Arnell, N.W., Bondeau, A., Bruggemann, H., Carter, T.R., Gracia, C.A., Vega-Leinert, A.C. de la, Erhard, M., Ewert, F.A., Glendinning, M., House, J.I., Kankaanpää, S., Klein, R.J.T., Lavorel, S., Lindner, M., Metzger, M.J., Meyer, J., Mitchell, T., Reginster, I., Rounsevell, M., Sabate, S., Stich, S., Smith, B., Smith, J., Smith, P., Sykes, M.T., Thonicke, K., Thuiller, W., Tuck, G., Zaehle, S., & Zierl, B. (2005). Ecosystem Service Supply and Vulnerability to Global Change in Europe. *Science*, 310(5752), 1333-1337. (17 times cited on 08-04-2007)

Milne CJ, Kinniburgh DG, Van Riemsdijk WH, Tipping E. (2003). Generic NICA-Donnan model parameters for metal-ion binding by humic substances *Environmental Science & Technology* 37: 958-971 (61 times cited on 08-04-2007)

Jonker, M.T.O. & A.A. Koelmans, 2002. Sorption of polycyclic aromatic hydrocarbons and polychlorinated biphenyls to soot and soot-like materials in the aqueous environment mechanistic considerations. *Environmental Science and Technology*. 36: 3725-3734. (79 times cited on 08-04-2007)

Mol, A.P.J.; 2001. *Globalization and Environmental Reform. The ecological modernization of the global economy.* Cambridge, Mass.: The MIT Press. (73 citations registered by Google Scholar).

#### ***II: high societal impact***

Kleijn, D., Berendse, F., Smit, R., & Gilissen, N. (2001). Agri-environment schemes do not effectively protect biodiversity in Dutch agricultural landscapes. *Nature*, 413, 723-725. These studies showed unambiguously that the effects of these schemes were negligible and had even negative effects on the abundance of some meadow bird species. (113 times cited on 08-04-2007) These results received attention in many news media (e.g. USA Today, Financial Times, BBC, Frankfurter Zeitung) and were also discussed at a WTO meeting.

Mahmoud, Nidal, Grietje Zeeman, Huub Gijzen and Gatze Lettinga. Anaerobic sewage treatment in a one-stage UASB reactor and a combined UASB-Digester system. *Water Research*, 38 (9), May 2004, Pages 2348-2358. In April 2007 Lettinga has been awarded the prestigious Tyler Prize for Environmental Achievement for his research and development of an environmentally sound novel process for the treatment of polluted wastewater and its implementation worldwide, especially in developing countries

Millennium Ecosystem Assessment. 2005. *Living beyond our means: Natural Assets and human well-being.* Island Press, Washington DC. (In total 5 synthesis reports, 4 assessment volumes and 1 assessment framework book published in the period 2003-2006; with major contributions by Leemans and De Groot): the report received much media attention. WIMEK researchers gave many interviews and presented the findings of these assessments to Dutch parliament and ministries.

Klimaatverandering, klimaatbeleid: inzicht in keuzes voor de Tweede Kamer (CE, September 2004): a policy report "Climate Change, Climate Policy; Insight in policy choices for the Lower Chamber", published by the Dutch Centre for Energy Savings (CE Delft), on request of Dutch Parliament with major contributions of the WIMEK researchers Kabat and Van Ierland.

Climate Change 2001: Impacts, adaptation and vulnerability; Contributions of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC); Cambridge University Press, 2001; with SENSE contributions of L. Bouwer (VU); H. Dolman



(WUR); R. Leemans (WUR/RIVM); P. Martens (MU); R.S.J. Tol (VU); S.C. van de Geijn (WUR) and P. Vellinga (VU).

## 10.2 Numerical research output – scientific productivity

Table 5: WIMEK programme results: numerical research output

		2001	2002	2003	2004	2005	2006	6 year average
1.	PhD theses	32	37	23	19	23	33	28
2.	Academic publications	<b>195</b>	<b>238</b>	<b>228</b>	<b>226</b>	<b>237</b>	<b>271</b>	<b>232.5</b>
	a. in refereed journals	92	111	122	133	125	144	121.2
	A-category	73	80	83	47	66	83	72.0
	B-category	30	47	23	46	46	44	39.3
	C-category							
	<i>Guest editorships special issues refereed scientific journals</i>	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	b. in other journals	15	13	20	15	17	5	14
	c. refereed book chapters	<b>13</b>	<b>32</b>	<b>34</b>	<b>35</b>	<b>21</b>	<b>35</b>	<b>28.3</b>
	A-category	2	3	3	1	1	9	3.2
	B-category	11	19	25	29	12	23	19.8
	C-category	0	10	6	5	8	3	5.3
	d. non-refereed book chapters	20	23	18	22	11	8	17
	e. monographs	2	3	6	1	10	2	4
	f. edited books	6	11	7	10	6	6	8
	g. proceedings (full papers only)	96	141	87	79	89	62	92
	h. scientific reports ordered by an external contractor	37	24	24	18	25	14	24
	<b>Total Academic Publications</b>	<b>384</b>	<b>485</b>	<b>424</b>	<b>406</b>	<b>416</b>	<b>403</b>	<b>420</b>
3.	Professional publications and products (incl. inaugural presentations)	70	49	41	47	33	29	45
4.	Publications for the general public (optional)	14	4	5	9	6	6	7

Note: In the presented number of publications not only the publications of the 11 WIMEK research groups involved in this review are included, but also the number of publications of research groups which partly participate in WIMEK (IWE, LUP, MAT, PCC, SCO and TOX).

### Explanation

The SENSE General Board has decided to distinguish three categories refereed scientific journals and also three categories scientific book publishers. The definitions of A, B and C publications are as follows:

#### **Refereed scientific journals:**

- A. The top 33% of all refereed scientific journals per domain covered by the Web of Science (ISI journals), based on the journal's Impact Factor;
- B. All other refereed scientific journals covered by the Web of Science
- C. Other refereed scientific journals, which are not included in the Web of Science

#### **Refereed book publications:**

- A: refereed book publications published by the world top of publishers
- B: refereed book publications published by the world's semi-top of publishers
- C: refereed book publications published by other publishers

For more information on this rating system see the SENSE self-evaluation report.

Table 4 shows that 52% of all WIMEK's refereed scientific articles have been published in A rated journals (top 33%); 31% in B rated journals and only 17% in C rated journals. Most of the refereed book publications have been published by B rated scientific book publishers. These data illustrate that most WIMEK researchers publish their articles in the better rated international journals. For comments on the ABC-rating of journals and book publishers see the SENSE self-evaluation report.

Table 6: Output / Input ratio of refereed scientific publications 2001 – 2006 (average)

Refereed articles / research input tenured staff	Refereed book chapters / research input tenured staff	Dissertations / research input tenured staff	Total number of refereed publications / research input tenured staff
11.4	1.4	1.4	14.2

Table 6 shows that WIMEK researchers have overall a quite high productivity, i.e. on average more than 14 refereed scientific articles, book chapters and dissertation per 1.0 fte research input per year.

### 10.3 Results publication analysis 2001 – 2006 and citation analysis 1996 - 2005:

The bibliometric analysis provides an overview of the publication output and international impact of WIMEK. from 1996 through 2005. This overview is based on a quantitative analysis of scientific articles published in journals and serials covered by the web version of the Science Citation Index, the Social Sciences Citation Index and the Arts & Humanities Citation Index of Thomson Scientific, formerly the Institute of Scientific Information (ISI) in Philadelphia also known as Web of Science (WoS). The annual number of peer reviewed articles retrieved from WoS is presented in Figure 1. The number of publications increased from 100 articles in 1996 to 180 in 2005.

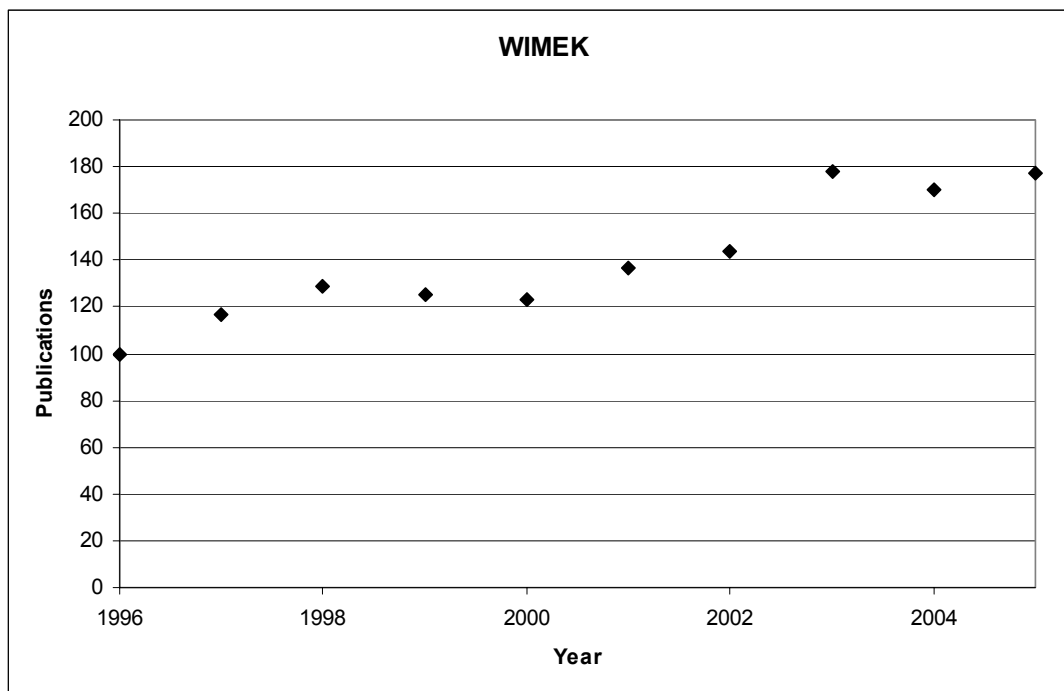


Figure 3. Number of ISI-covered publications from WIMEK members per year (1996-2005).

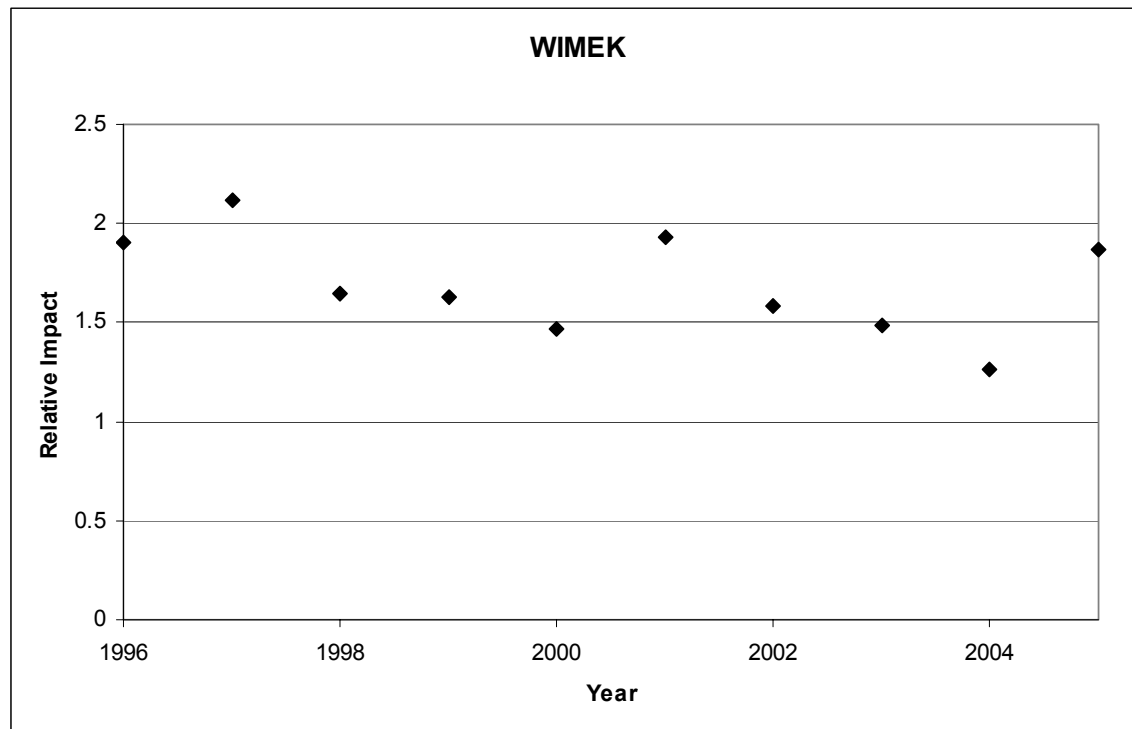


Figure 4. Relative impact of WIMEK publications (1996-2005).

In Figure 4 the relative impact of WIMEK publications per publication year is shown. In all years the relative

impact of WIMEK publications was well above world average. In most years the relative impact has been about 1.5, i.e. 50% above world average and in some years (1996, 1997, 2001 and 2005) the relative impact was even about 2.0, i.e. far above world average.

Most of the publications (528) are categorized in the field of Environment/Ecology, these have a far above world average impact of 1.93. The second largest group of publications (224) are categorized in the field of microbiology; these have a relative impact of 1.50. Followed by Biology & Biochemistry (181 publications) with a relative impact of 0.83, Agricultural Sciences (106 publications) with a relative impact of 2.03 and Plant and Animal Sciences (103 publications) with a relative impact of 1.77.

Despite the increase in number of peer reviewed publications by WIMEK staff the relative impact has been maintained at a high level. The number of top publications, those publications that belong to the top 10% publications for each research area, was 254 over the whole period, i.e. 18% of the total number of publications.

## 11. PhD policy

### 11.1 WIMEK/SENSE PhD training programme

All WIMEK PhD students have to participate in the SENSE training programme and develop a training and supervision plan (STP) soon after they start. SENSE aims at training PhD students to conduct high-quality environmental research in the natural or social sciences. The emphasis lies on specialisation in environmental sciences, including either mono-disciplinary research or integrated research in multidisciplinary teams.

The goal of the SENSE training programme is to train PhD students to become qualified scientific researchers who are able to:

- conduct research in a systematic and productive way,
- work effectively in an international arena,

- contribute to an improved understanding of the causes and effects of environmental problems and of possible solutions,
- position their own research in a multidisciplinary context, and
- translate environmental problems into relevant sound research proposals.
- The compulsory components of the PhD programme consist of:
  - individual scientific research within one of the disciplines or interdisciplines covered by SENSE, which results in a dissertation, and
  - an individual tailor-made training programme with compulsory multidisciplinary training components.

The individual training programme should be well balanced, aiming at broadening the PhD candidate's knowledge of the multidisciplinary field of environmental science as well as deepening their specialised knowledge of a discipline. Furthermore, courses are offered to improve general skills needed for a post-graduate research career. The individual training programme consists of various types of course elements, with a minimum size of 30 ECTS in total. One ECTS is approximately equivalent to a work load of 28 hours. A detailed description of the SENSE PhD training programme can be found in the SENSE self-evaluation report.

The results of the PhD cohort analysis (annex 7) show that the number of WIMEK PhD students with an approved ITSP increased significantly from 22% (start years 1996 – 2000) to 65% (start years 2001 – 2006). As about 20% of all WIMEK PhDs are external PhD students (often research staff at research institutes who want to graduate on the basis of their past and current research results), for whom the ITSP is less valuable in most cases, we may conclude that most other WIMEK PhD students have a Training and Supervision Plan which has been assessed and approved by the SENSE research school.

The same tendency may be noticed for the increasing number of WIMEK PhD graduates with a SENSE PhD education certificate: 10% of the PhD graduates who started in the period 1996 – 1998 and 29% of the PhD graduates, who started in the period 1999 – 2001! We expect a further fast increase of the percentage of WIMEK PhD graduates with a SENSE certificate in the coming years.

## **11.2 Admission to the SENSE Research School**

SENSE has delegated the responsibility for the admission of PhD candidates to the partner institutes. To be accepted as WIMEK PhD student at the SENSE research school requires the following steps:

- Formal admission of the PhD candidate to the WU PhD programme, based on (i) previous academic training (at least MSc level); (ii) proficiency in English language and (iii) sufficient financial support;
- Submission of a full PhD proposal to the WIMEK desk for approval, at least 6 months after the start date of the PhD student;
- Assessment of the full PhD project proposal by two independent external experts on (i) scientific quality, (ii) scientific and societal relevance and (iii) feasibility;
- Drawing up an Individual Training and Supervision Plan and submission to the SENSE education desk for approval, within six months after the start of the PhD student.

## **11.3 Introductory meetings and courses**

The WIMEK PhD Council and WIMEK co-organise introductory meetings for new PhD students once or twice a year. The aim of these meetings is to inform the PhD students about WIMEK, SENSE and the PhD training programme and to get to know each other in an informal setting.

For SENSE, all new PhD students are stimulated to participate in the introductory course 'Research in Context' during their first year. The course is organised by Drs. Tromp-Meesters and Prof. Leemans, in close collaboration with SENSE management. This course introduces the various aspects of SENSE, trains communicative skills, introduces policy assessments and provides ample opportunity to create research networks of fellow students from different universities and backgrounds.

## **11.4 WIMEK PhD training and education activities**

WIMEK staff members are actively involved in the management, coordination and organisation of PhD activities. The WIMEK secretary also runs the SENSE Education Desk and the SENSE Director

of Education is a WIMEK associate. Moreover, WIMEK staff members are responsible for the organisation of 14 SENSE PhD courses, including:

- Introductory Course Environmental Research in Context (mandatory for all SENSE PhD students)
- Topics in Ecotoxicology,
- Understanding Global Environmental Change (international PhD summer course),
- Integrated assessment of global environmental change (international PhD course), and
- Superpowers in global environmental politics: China and the US.

Furthermore, WIMEK is involved in the organisation of WGS general skills courses, for instance:

- Techniques for writing and presenting a scientific paper,
- Media skills training, and
- Creating your scientific network.

An overview of all SENSE and WGS PhD courses is listed in the SENSE self-evaluation report.

### **11.5 Assessment of PhD supervision and the SENSE PhD training and education**

In January 2006, WIMEK sent a questionnaire to all WIMEK PhD students to evaluate the quality of PhD supervision and the SENSE training and education plan. The PhD Questionnaire has been sent to 145 WIMEK PhD students, of which 74 (i.e. 51%) replied. This questionnaire has been repeated for all SENSE PhD students in February 2006. The results of the SENSE questionnaire are presented in the SENSE self-evaluation report. To avoid too much overlap between the WIMEK and SENSE report, only the most remarkable results of the WIMEK inquiry (January 2006) are mentioned here.

#### ***Progress in PhD research***

Most PhD projects are quite on schedule, but about 20% of the PhD students have a serious delay. The most important courses of a delay include a delay in start experiments due to unforeseen problems (5x), unclear (2x) or overambitious (2x) research proposal, too much time spent on experiments and/or data collection (7x), location to another building and restart laboratory experiments (3x), change in research set-up due to unexpected results (2x), lack of data availability or access to necessary information (2x), lack of technical or analytical assistance (2x), insufficient supervision (2x) or just bad luck (2x).

#### ***PhD Supervision***

Most PhD students (58%) agree with the intensity of the PhD supervision, but 18% do not. 65% of the PhD students are satisfied with the supervision, but still 11% are not. The main reasons for dissatisfaction are not enough time or priority for supervision (5x) and inadequate communication (2x).

#### ***SENSE PhD training and education***

- A significant part (37%) of the WIMEK PhD students is poorly informed about the role of the WIMEK/SENSE research school and the ITSP requirements at the start of their study. Improving information and communication with new PhD students will be an important issue in the coming years.
- WIMEK PhD students appreciate the general skills courses most; the specialised PhD courses offered by SENSE do not always fulfil the needs of all SENSE PhD students, but the overall assessment of the SENSE PhD training programme is satisfactory.
- SENSE e-news is highly appreciated as an important and useful communication tool; the SENSE website is also appreciated positively.

#### ***Median duration for finishing PhD***

The results of the PhD cohort analysis of WIMEK PhD students (annex 7) show that the median duration for PhD students to finish their PhD is on average 61 months (about 5 years). The median PhD period does not differ significantly for the PhD students started in the period from 1996 to 2001 (the median duration fluctuates between 58 and 63 months). It should be realised that the duration of the PhD period is often longer than the standard period of four years as a result of (i) illness, (ii) pregnancy and maternity leave, (iii) a part time appointment, (iv) job obligations in addition to the PhD research and (v) acceptance of a demanding job directly after the PhD contract before the thesis is written. WIMEK will discuss preferred conditions, supportive activities and positive incentives to finish

a PhD in time with the chair groups, but we realise there are many factors causing a delay which could hardly be influenced by the graduate school.

### ***Job opportunities for WIMEK PhDs***

The job analysis shows that the first job of far most WIMEK PhD students (81 %) after graduation is a research position, of which a quarter becomes a postdoc and three quarters another research function. Another 10 % of the PhD graduates is appointed in policy advisor or consultancy functions. About half of the PhD graduates (46%) start their career at a university; 28% at other research institutes and 10 % at national, regional or local governmental organisations. About 4 % of the graduates get their first job at consultancy agencies and another 4% get a job in industry. As far as we know there are no PhD graduates unemployed in the first years after graduation. As we do not have a continuous monitoring system for PhD graduates yet, we do not have a good view on the career perspectives of our graduates in the long term.

## **11.6 WU PhD policy**

### *PhD education and training budget*

All WU PhD students with an approved TSP (so also all WIMEK PhD students with an TSP approved by SENSE) get a budget of € 2.500 to (partly) cover the costs of PhD courses (course fees) and participation in international symposia and congresses. This financial policy seems to be quite unique for universities in the Netherlands.

### *WGS General skills courses*

Another unique selling point of Wageningen UR is the joint offer of a relatively large list of general skills courses for PhD students by the cooperative Wageningen Graduate Schools. The general skills courses are subdivided in six categories: (i) Language related courses, (ii) skills courses, such as Project and time management, Personal Efficacy and Scientific Publishing; (iii) Career oriented courses; (iv) PhD assessments; (v) other general courses, such as “ethics” and (vi) courses for PhD supervisors.

### *PhD dissertation bonus*

Chair groups get a financial bonus for all finalised PhD theses (about k€ 25 in the period 2001 – 2006). The full bonus is only granted for PhD graduates with a PhD education and training certificate awarded by the graduate or research school. PhD graduates without a Research School certificate are granted only a half bonus. This policy applies to all PhD students who started their PhD research after 1 January 2002. It will be evident that this policy means a big incentive for all chair groups to stimulate their PhD students to follow a complete education and training programme, which meet the requirements of the research school.

## **12. Analysis, perspectives and expectations for the research programme**

### **12.1 Reflection on the previous assessment**

#### WIMEK research groups

A quantitative summary of the previous assessments of the participating research groups in the institute is presented in Annex 1.

The VSNU quality assessment of research results for the WIMEK groups are generally good – very good. Two groups (Environmental Sociology and Environmental Economics) were evaluated only satisfactory, but in both cases a new chair holder has been appointed quite recently. The assessment results refer mainly to the former chair groups and have very little to do with the renewed chair groups.

#### SENSE and WIMEK

The previous assessments of the SENSE Research School as a whole are mentioned in the SENSE self-evaluation report. In the past six years the WIMEK graduate school has not been evaluated by external reviewers separately, but an internal Midterm Review over the period 2001 – 2004 has been carried out. The WIMEK Midterm self-evaluation report 2001 – 2004 has been discussed with and accepted by the Rector of the university. The main conclusions of the Executive Board are summarised below:

- The Executive Board (EB) is pleased with the conscientious self-evaluation report and has respect for the excellent scientific achievements of the WIMEK graduate school.
- Every WU chair group should be evaluated as a whole once every six years. This means that (i) the chair group Meteorology and Air Quality should become a full member of WIMEK; (ii) the chair group Microbiology will be evaluated as a whole within the assessment of the VLAG graduate school and (iii) the relatively small contributions to WIMEK of the chair groups IWE, LUP, PCC, SCO, TOX and MAT will be evaluated in other assessments.
- The midterm self-evaluation report of a WU Graduate Schools should be discussed with and assessed by an International Advisory Board (IAB) of the graduate school. Neither WIMEK, nor SENSE have installed a standing IAB. The EB has asked the WIMEK director to take care of the installation of an IAB at least for WIMEK (or at SENSE level) for the next period.
- The EB has observed that several tenured staff members of the WIMEK chair groups have not been accepted by WIMEK as a research school member on the basis of an individual quality assessment. The EB is surprised that some tenured staff members do not meet the research school criteria for full membership and considers this as an undesirable situation. The EB will ask the directors of the science groups to set out a strategy to assure the scientific qualifications of all tenured staff members of chair groups in the future.

## 12.2 SWOT – analysis WIMEK graduate school

### Strengths

- *Research niche:* WIMEK combines fundamental, applied and participatory research in natural and social sciences. This unique combination enables WIMEK researchers to integrate contributions from natural and social science research, which is considered essential to analyse complex environmental issues and develop appropriate solutions.
- *Interdisciplinary research:* WIMEK chair groups have much experience with joint interdisciplinary research programmes and projects and integrated system approaches. Intensive co-operation exists for example, between the Environmental Policy Group (ENP) and the Environmental Technology Group (ETE), between the Environmental Economics Group (ENR) and the Environmental Systems Analysis Group (ESA), and between the Hydrology and Quantitative Water Management Group (HWM) and the Soil physics, Ecohydrology and Groundwater Quality Group (SEG).
- *Quality:* WIMEK has a strong scientific basis, both in disciplinary research and in interdisciplinary research. The scientific quality, productivity and relative impact of the WIMEK chair groups is in general good to excellent.
- *International network:* WIMEK research leaders participate actively in national and international research networks, editorial boards of scientific journals, scientific advisory boards and environmental management boards.
- *International attractiveness for PhD students:* High numbers of foreign PhD students want to carry out their PhD research at WIMEK.
- *External funded research:* High success rate in the acquisition of externally funded projects (about 23% of the WIMEK research is NWO funded and about 44% is contract funded by third parties like EU, governments and industries).
- *WIMEK - SENSE:* WIMEK has a strong position in the SENSE research school. WIMEK PhD students follow the SENSE PhD education and raining programme. This inter-university co-operation increases the number of PhD students in all environmental disciplines and enables SENSE to offer a large number of PhD courses in various disciplines.
- *PhD policy:* The financial bonus of Wageningen UR for PhD graduates with a SENSE certificate is a strong incentive to stimulate all PhD students to complete their PhD education and training programme.

### Weaknesses

- *WU research budget:* The very limited research budget (financial basis) per chair group from Wageningen-UR limits the initiation of curiosity-driven new research projects.
- *Steering the research agenda:* Research and Graduate Schools in the Netherlands have very limited management tools to advance new scientific developments and to implement a comprehensive research strategy. This holds for WIMEK too. Although WIMEK is able to grant two

PhD or post-doc projects yearly, the WIMEK research agenda is mainly determined by the activities of our research groups.

- *Many disciplines involved:* Both WIMEK and SENSE cover a very broad range of environmental disciplines, which makes it difficult to provide in the demand of specialised PhD courses in all desired disciplines.
- *Limited participation of social science groups.* Compared to the considerable number of natural science research groups, the number of social scientists is relatively modest both in WIMEK and in SENSE.

### **Opportunities**

- *Solving pressing environmental problems:* WIMEK and SENSE have unique opportunities to contribute to the integrated analysis and solving of complex environmental problems.
- *External research funds:* The public and policy awareness of some threatening environmental issues, like global and climate change, disturbance of ecosystems, reduction of biodiversity and particulate matter have resulted in large national and international research programmes and funding opportunities for WIMEK/SENSE PhD and post-doc projects.
- *Joint PhD course:* Stronger co-operation with other research schools may lead to a joint offer of PhD courses, which fulfils the demand of specialised disciplinary PhD courses.
- *Local Graduate Schools:* The expected establishment of local graduate schools, responsible for both the research masters and the PhD programme, may lead to an intensive co-operation between local university based organisations and the inter-university research school SENSE, resulting in a jointly supported PhD education and training programme of high quality.
- *International visibility:* Good international contacts result in much interest from foreign PhD students to carry out their PhD research at WIMEK.

### **Threats**

- *Shifting research interests and priorities:* The WIMEK groups are very dependent on external environmental research funds. This means that the research opportunities of WIMEK chair groups are highly dependent on the rather unpredictable and often changing interests of governmental and intergovernmental science bodies, which finance large national and international environmental research programmes.
- *Workload:* High teaching workload of many WIMEK staff members reduces the willingness to contribute to the PhD education and training programme and to general activities of the SENSE research school (symposia, Core Theme workshops)
- *Low BSc influx:* The decreasing influx of Dutch students in the BSc of environmental sciences studies may undermine the strong scientific position of environmental chair groups in future.
- *Local Graduate Schools:* The current discussion about the establishment of local graduate schools may undermine the position of inter-university research schools, like SENSE, if the desired intensive co-operation can not be realised.

### **Analysis**

- WIMEK has a strong position in environmental and climate research. The adjustment of the chair Soil Formation and Ecopedology in the direction of Earth System Sciences and the repositioning of the research field Integrated Water Management will strengthen the focus on integrated analysis and assessment of complex environmental problems in the coming years.
- The international dimension of environmental issues requires active participation in international scientific research networks and intensive co-operation with foreign high quality research groups.
- The quality of the WIMEK/SENSE PhD education programme can still be improved.

### **Adjusted goals**

There is no need to adjust our general goals at the moment.

### **Adjusted strategy**

- WIMEK will stimulate a gradual extension of structural international scientific co-operation, for instance with the Potsdam Institute for Climate Impact Research and Max Planck Institutes in the



University: Wageningen University  
Research Institute: Wageningen Institute for Environment and Climate Research (WIMEK)  
Directors: Prof. dr. L. Hordijk, Prof. dr. S.E.A.T.M. van der Zee, Prof. dr. R. Leemans

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research field Global and Climate Change and with South-East and East Asian research institutes  
in the research field Sustainable Production and Consumption.

- The co-operation between local Graduate Schools and national Research Schools should be strengthened further in order to improve the quality of the PhD education and training programme.

## Annex 1 Quantitative results VSNU Assessments of Research Quality

Please note that the VSNU assessment scale differs from the current SEP assessment scale

Results VSNU assessments of research

WIMEK Research Groups 1999 – 2002

Q = Quality  
 P = Productivity  
 R = Relevance  
 V = Viability

1 = poor  
 2 = unsatisfactory  
 3 = satisfactory  
 4 = good  
 5 = excellent

### 1999 BIOLOGY

	<b>Programme</b>	<b>Programme Dir.</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V</b>
WU	Microbiology	De Vos	5	3	4	4
WU	Nature conservation and plant ecology	Berendse	4	5	4	3

### 2000 Environmental Sciences

	<b>Programme</b>	<b>Programme Dir.</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V</b>
WU	Environmental systems analysis	Hordijk	4	3-4	4	4
WU	Environmental technology	Rulkens	4	5	3-4	4
WU	Aquatic ecology and water quality management	Scheffer	4	5	3-4	3-4

### 2001 Socio-Cultural Sciences

	<b>Programme</b>	<b>Programme Dir.</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V</b>
WU	Environmental sociology <sup>1</sup>	Nooij	3	M	4	3

### 2002 Chemistry and Chemical Engineering

	<b>Programme</b>	<b>Programme Dir.</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V</b>
WU 03	Colloids and Interfaces	Cohen Stuart	5	5	5	5
WU 08	Microbiology	Vos	5	4	4	5
WU 13	Soil Chemistry and Chemical Soil Quality	Riemsdijk Van der Zee	5	4	5	5

### 2002 Earth Sciences

	<b>Programme</b>	<b>Programme Dir.</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V</b>
WU 01	Soil Chemistry and Chemical Soil Quality	Riemsdijk Van der Zee	5	4	4	4
WU 02	Soil Formation and Ecopedology	Van Breemen	4	4	4	4
WU 04.1	Soil Physics, Agrohydrology and Groundwater	Feddes	4	4	4	4
WU 04.2	Hydrology and Quantitative Water Management	Troch	4	4	4	4

### 2002 Economics

	<b>Programme</b>	<b>Programme Dir.</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V</b>
WUR 05	Environmental Economics and Natural Resources <sup>2</sup>	Van Ierland	3	3	4	4

<sup>1</sup> During most of the period, the programme lacked a chair and a Professor. In 2000, a new Prof. has been appointed: Prof. A.P.J. (Arthur) Mol.

<sup>2</sup> Comments Review Committee: "This is a relatively new group of researchers established in 1996 so it is not appropriate to evaluate it as if it were fully established. (...) The programme appears to have a promising future. The trend of publication is upward and the group is well lead."

## **Annex 2 WIMEK research items per Core Theme**

### **SENSE Core 1: Micropollutants (Dr. de Voogt, UvA)**

#### **Aim**

Core 1 aims to study the environmental occurrence, behaviour, fate and effects of micro-pollutants. To explain the biological effects and the hazards of pollutants for adjacent environmental compartments, understanding the complexity of factors and processes that control biological availability and mobility is important. The research therefore also involves the characterisation of complex environmental samples in order to determine, explain, or predict a wide variety of ecotoxicological responses, including physiological effects and genetic adaptation. Besides, the development of environmental technologies to abate or prevent adverse effects is a major activity.

#### **WIMEK contributions**

##### **Transport, fate and risk assessment of micropollutants**

- The effects of biota on the transport and fate of micropollutants and nutrients (AEW)
- The use of bioassays to evaluate the ecological risks associated with contaminated sediments (AEW)
- The use of semi-field experiments for the evaluation of the ecological risk assessment of pharmaceuticals (AEW)
- Study of the speciation and transport of both naturally occurring chemicals (e.g. salt, metals, nutrients), of contaminants (chemicals occurring in too large concentrations), and of chemicals not naturally occurring in soil and ground water, such as de-icing chemicals, radionuclides, and BTEX (SEG, SOQ)
- Of: transport of biogeochemically reacting chemicals in water and gas phases of natural porous media and translation of understanding towards risk assessment and remediation strategies (SEG)
- Temporal profiles of pollutant species in aquatic systems (SEG and PCC)
- Rhizosphere modelling of water flow and solute transport (SEG)
- Development of molecular based fundamental understanding of important soil chemical processes with the objective to improve soil quality and the aquatic environment (SOQ)
- Development and application of toxicological risk assessment for environmental contaminants (TOX)
- Marine environmental Toxicology (TOX)
- Study of non-additive mixture effects (TOX)
- Development of biomarker techniques for tracing contaminants and measuring toxic effects (TOX)

##### **Endocrine Disrupters**

- Endocrine disruption in developing organisms by environmental contaminants (TOX)

##### **Persistent Organic pollutants (POPs)**

- The influence of black carbon on the fate and effects of persistent organic pollutants (POPs) and pesticides (AEW)
- Fate of POPs in engineered microbial systems under different redox conditions such as anaerobic, aerobic, anoxic, sulphate reducing (ETE)

##### **Heavy Metals**

- Quantifying and understanding the temporal variation in metal behaviour and availability in dynamic flood plains lake sediments (AEW)
- Dynamic speciation and bioavailability of pollutant metal species in the aquatic environment (PCC)
- Lability and mobility of metal species in biogels (PCC)
- Development and testing of the Donnan Membrane Technique for the measurement of very low free metal concentrations in samples of natural systems as surface water (SOQ)
- Development of the Reversed Donnan Membrane Technique for dosing of heavy metals as micronutrients in anaerobic wastewater treatment systems to prevent spillage and overdosing (ETE)

## **Environmental Technology**

- Inorganic bioconversions for gas and water cleaning processes, with the objective to recover and reuse minerals (sulphur) and heavy metals (ETE)
- Bioconversions of organic materials (for example originating from organic wastes) into CO<sub>2</sub> neutral fuels and electricity (ETE)
- Development of (bio)technological processes to clean municipal and industrial wastewater streams in order to reuse valuable substances, energy and clean water (ETE)
- Novel approaches for linking municipal wastewater to agricultural reuse to prevent non-controlled usage and discharge (ETE)
- Bioaccumulation and bioaugmentation of slowly growing microbial species for the specific conversion of priority pollutants (ETE)
- High-rate membrane assisted bioprocesses for reducing emissions of micropollutants (ETE)
- Biological and chemical processes (including bioavailability) to protect and remediate groundwater in polluted soils and sediments (ETE)
- Selective removal and recovery of heavy metals from polluted groundwater and industrial wastewater (ETE)
- Transport phenomena in packed bed reactors (SEG)
- Water, air, energy and solute dynamics in situ/ex situ contaminated sediments: innovative measurements and modelling (SEG)
- The study of anaerobic bacteria that play an important role in biotechnological processes such as wastewater treatment and soil bioremediation (MIB)
- Microbiological production of hydrogen and methane (MIB)
- Microbiological desulphurisation of hydrocarbon waste streams with sulphate and elemental sulphur as end product (MIB)
- Oxidative and reductive conversions of xenobiotics (chlorinated hydrocarbons and aromatic compounds) by micro-organisms (MIB)
- Utilization of uncommon electron acceptors by microorganisms (MIB)
- Study of bacterial diversity, evolution and activity in natural and man-made ecosystems, such as sludge, river, grassland and subsurface soil (MIB)
- Anti-fouling coatings for potable water preparation (PCC / ETE)

## **SENSE Core 2: Environmental change and ecosystem dynamics (Prof. Hendriks, RUN)**

### **Aim**

Core 2 aims to contribute significantly to the analysis of environmental change and ecosystem dynamics, and to possible solutions for related environmental problems. The research should improve our understanding of the main forces that drive the dynamics of human societies, biological communities and the environment as one interactive complex system. The research focuses on the interaction of ecosystems and their components with chemical and physical stressors on the one hand, and global change on the other. Considering the level of integration, most research projects focus on specific local and regional problems.

### **WIMEK contributions**

#### **Fate of substances and their role in ecosystem functioning**

- The effects of substances on the functioning and biodiversity of natural aquatic communities (AEW)
- Chemical communication in aquatic ecosystems (AEW)
- Effects of changes in atmospheric N deposition on biodiversity and functioning of bog and heathland ecosystems (NCP)

### **Structure and functioning of populations, communities and ecosystems**

- Effect of spatial heterogeneity on the stability of ecosystems (AEW)
- Effects of biodiversity losses on ecosystem functioning (NCP)
- Mechanisms responsible for the maintenance of biodiversity (NCP)
- Carbon sequestration and the dynamics of plant species in peatlands (NCP)
- Effects of fragmentation and management on vegetation and insect biodiversity (NCP)

### **A-biotic and biotic regulation of natural systems and ecosystems**

- Interaction between biotic and abiotic soil processes (SOQ)
- Flow and transport in heterogeneous terrestrial ecosystems (SEG)
- Hydrological and transport controls of 'complex systems' at different spatio-temporal scales and different physical and biogeochemical feedback mechanisms (SEG)
- Soil – Water – Atmosphere – Plant (SWAP) modelling for water and energy balances in natural and agro ecosystems (SEG)
- Density driven flow caused by saline groundwater underlying fresh water lenses in deltaic areas and relationships between fresh water lenses and chemically different groundwater on vegetation development (SEG)
- Feedback processes between catchment-landscape scale hydrology, and chemical transport, and land use under a changing climate (SEG)
- Catchment-scale hydrological processes and river basin water management (HWM)
- The development of physically-based and conceptual models of surface and subsurface flow processes to examine the hydrological system and its component processes and to study the effects of climate change, land-use change and other human influences on the water and solute balance of catchments (HWM)
- Characterization of the hydrological response of complex hillslopes (HWM)
- River hydraulics and morphology as an element of hydrological modelling and to support sustainable river and land management planning (HWM)
- The study of advanced (geo-)statistical data mining techniques to improve model calibration and validation procedures and to improve on-line and off-line simulation (HWM)
- To synthesize hydrological processes towards a better understanding of hydrological extremes (droughts and floods) (HWM)
- The role of ectomycorrhizal fungi in biogeochemical cycles (ESS)
- Dynamics of soil organic matter in various soils (ESS)
- The feedbacks between physical dynamics (flow conditions, turbulence) and biota in aquatic systems (AEW)
- Explaining and projecting changes in ecosystems (ESA)

### **Nature conservation and sustainable land use management**

- Effectiveness of EU-policies and agri-environment schemes for the restoration of biodiversity in agricultural landscapes (NCP)
- The development of integrated water resources management combining knowledge about catchment-scale hydrological processes with additional information (rules and regulation, stake holders interests) to improve policy and decision making at the national and international level (HWM)
- The impact of climate change on biodiversity and ecosystems; for example contributions to the Millennium Ecosystem Assessment (ESA)
- Quantification and valuation of ecosystem functions and services (ESA)
- Phenological research related to climate change and human health (pollen allergies) (ESA)
- Wastewater use in irrigated agriculture (IWE)
- Sustainability of Waste water use in irrigated agriculture with regard to salts, nutrients, and pollutants, at local up to river-basin scales (SEG)

## **SENSE Core 3 – Global change: climate, land use and biogeochemical cycles (Prof. van Ierland, WU)**

### **Aim**

Core 3 aims to analyse causes and effects of, and possible solutions to global change with emphasis on changes in climate, land use and biogeochemical cycles. Global change is the ultimate result of economic growth, rapid expansion of international trade and population growth. Major changes are taking place in climate, land use, and biogeochemical cycles, with serious potential impacts on environmental quality and biodiversity. Risks of climate change are intricately linked to other important global environmental change problems such as acidification, eutrophication, loss of biodiversity, desertification, and enhanced UV-B radiation. The ultimate aim of the various foci of the programme is to analyse global change and its impacts, to develop models for simulation and prediction, and assess management and policy implications under different scenarios. The research addresses various spatial, temporal and organisational scales.

### **WIMEK contributions**

#### **Role of land cover and land use in hydrological and biogeochemical cycles**

- Understanding of processes in the Atmospheric Boundary Layer, with particular emphasis on the interaction of the atmosphere with the (vegetated) land surface (MAQ)
- Measuring and modelling of the relevant atmospheric and related land-surface processes on the local and regional scale (MAQ)
- Modelling of atmospheric pollutants and greenhouse gases (MAQ)
- Improved understanding of soil moisture dynamics (HWM)
- The role of soils and forests as carbon sinks under increasing atmospheric CO<sub>2</sub> concentrations (ESS)
- Ecophysiology, Land-Atmosphere Interactions (ESS)
- Soil Biogeochemistry, Carbon Cycle, Climate Change Ecology (ESS)
- Atmospheric Chemistry, Nitrogen exchange (ESS)
- The use of radar remote sensing techniques for forest and wetland monitoring and for the development of hydrological models (SEG)
- Feedbacks between hydrology, land use, and biogeochemical cycles (SEG)
- Effects of climate change on carbon sequestration in peatlands (NCP)
- Effects of vegetation changes in the arctic on the energy balance of the earth surface and its implications for the climate system (NCP)
- Analysis and modelling of emission inventories and biogeochemical cycles (ESA)
- Projective modelling of uncertain environmental systems (SCO)

#### **Consequences of global change for river basins and coastal management**

- Quantification of the impact of climate change on salt water intrusion for coastal regions (SEG)
- Changes in the chemical mass response of large river basins due to global change (SEG)
- Hydrological modelling of climate change impacts on water availability in large river basins (HWM)
- Exchange processes between the terrestrial and the atmospheric part of the hydrological cycle: precipitation and evaporation (HWM)
- Investigate the land-surface hydrological models, global hydrological models and river basin hydrological models to better understand droughts considering climate change (HWM)
- Climate Change, Adaptation, Water Cycle (ESS)
- Water management in large river basins (ENR)

#### **Integrated assessment of socio-economic and policy aspects**

- Analysis of the stability of international climate coalitions (ENR)
- Cost effective emission reductions (ENR)
- Participatory Integrated assessment - Environmental Impact Assessment (ESA)
- Mitigation and adaptation strategies (ESA)
- Integrated cost-benefit analysis of multifunctional land (and water) use (ESA)
- Decision support systems (including ecological-economic modelling) (ESA)

## **SENSE Core 4 – Industrial transformation – towards sustainable use of energy and materials (Prof. Blok and Prof. Glasbergen, UU)**

### **Aim**

Important changes in production and consumption systems are required to meet the needs and aspirations of a growing world population while using environmental resources in a sustainable manner. The complex character of such changes is labelled with the term 'industrial transformation'. Industrial transformation research seeks to understand complex society-environment interactions, identify driving forces for change, and explore development trajectories that have a significantly smaller burden on the environment. Core 4 thus aims to analyse the feasibility of such a transformation. A basic question is how to produce and consume energy and materials in a more sustainable way. The research emphasis is more and more on strategies that can help in developing and adopting these sustainable ways of production and consumption. Technological, social and environmental aspects are dealt with in a coherent way.

### **WIMEK contributions**

#### **Sustainable technologies**

- Cleaner production in industries, urban sanitation and integrated solid waste management, focused on recovery of resources and prevention of emission (ETE)
- Integrated soil remediation and cluster approach in delta regions (ETE)
- Energy recovery in the biocascading of industrially processed agricultural crops and residues using anaerobic technologies (ETE)
- Development of "fossil-fuel-free" treatment techniques for industrial wastewaters and process waters (ETE)
- Development of low-voltage desalination techniques for sweet water reclamation (ETE)
- Development of biotechnologies for the treatment of process waters under extreme conditions for internal water loop closure (ETE)
- Provision of sanitation and solid waste infrastructures in East Africa (ENP/ETE/ESA)

#### **Social change and sustainable development**

- Transition of consumption and production for sustainable lifestyles (ENP)
- Analysis of transformations in local, national and global environmental governance arrangements and environmental management (ENP)
- Analysis of the ways individuals, groups and modern organizations deal with and respond to new environmental and health risks and uncertainties (ENP)
- Developing the institutionalisation of environmental and sustainability requirements and criteria in (international) processes, networks and chains of production and consumption (ENP)
- Nature policy, biodiversity and land use management (ENP)
- STACO (Stability of Coalitions): an analysis of the formation and stability of international climate agreements (ENR)
- General equilibrium modelling of energy, pollution, and waste (ENR)
- Economics of water management (ENR)
- Development of a decision support model on integral sustainable solid waste management in the Ho Chi Minh City area in Vietnam (ETE)

#### **Methodological development and integration**

- Integrated assessment of vulnerability and adaptation options to climate change (ENR)
- Participatory Integrated assessment - Environmental Impact Assessment (ESA)
- Analysis of pollution and climate change management; scenario analysis (ESA)

#### **WIMEK Methodological research**

- Uncertainty analysis (ESA, SCO)
- Stochastic modelling, spatial averaging, and homogenization for upscaling water flow and solute transport (SEG)
- Scale issues in modelling (ESA, ESS, MAT, SEG)

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- Systems theory and robust control, optimal control, system identification, model building and uncertainty assessment in the field of water and environment (SCO)
- Statistical Design and Analysis in Carbon sequestration (MAT)



## **Annex 3 WIMEK Key Publications listed per SENSE Core Theme 2001 - 2006**

### **SENSE Core 1: Micropollutants**

#### **Aquatic Ecology and Water Quality Management Group (WIMEK-WU)**

Jonker, M.T.O. & A.A. Koelmans, 2002. Sorption of polycyclic aromatic hydrocarbons and polychlorinated biphenyls to soot and soot-like materials in the aqueous environment mechanistic considerations. *Environmental Science and Technology*. 36: 3725-3734.

Cornelissen, G., O. Gustafsson, T. D. Bucheli, M. T. O. Jonker, A. A. Koelmans & P. C. M. Van Noort, 2005. Extensive sorption of organic compounds to black carbon, coal, and kerogen in sediments and soils: Mechanisms and consequences for distribution, bioaccumulation, and biodegradation. *Environmental Science & Technology* 39: 6881-6895.

#### **Environmental Technology Group (WIMEK-WU)**

Sipma, J., Svitelskaya, A.V., Mark, B. van der, Hulshoff Pol, L.W., Lettinga, G., Buisman, C.J.N., & Janssen, A.J.H. (2004). Potentials of biological oxidation processes for the treatment of spent sulfidic caustics containing thiols. *Water Research*, 38(20), 4331-4340.

Mahmoud, Nidal, Grietje Zeeman, Huub Gijzen and Gatze Lettinga. Anaerobic sewage treatment in a one-stage UASB reactor and a combined UASB-Digester system. *Water Research*, 38 (9), May 2004, Pages 2348-2358

Vermeulen, J., T. Grotenhuis, J. Joziassse, W. Rulkens, 2003, Ripening of clayey dredged sediments during temporary upland disposal; a bioremediation technique, *Journal Soils and Sediments*, 3:49-59.

Rozendal, R.A., Hamelers, H.V.M., Euverink, G.J.W., Metz, S.J., & Buisman, C.J.N. (2006). Principle and perspectives of hydrogen production through biocatalyzed electrolysis. *International Journal of Hydrogen Energy*, 31(12), 1632-1640

Zandvoort M.H., van Hullebusch E.D., Gieteling J., Lettinga G. & Lens P.N.L. 2005. Effect of sulfur source on the performance and metal retention of methanol-fed UASB reactors. *Biotechnology Progress* 21(3), 839-850.

Jeison, D. and Van Lier J.B. (2006). Cake layer formation in anaerobic submerged membrane bioreactors (AnSMBR) for wastewater treatment. *J. Membrane Sciences*, 284: 227-236

Elissen, H.J.H., Hendrickx T.L.G., Temmink H, Buisman, C.J.N. (2006). A new reactor concept for sludge reduction using aquatic worms. *Wat. Res.* 40 (20), 3713-3718.

#### **Microbiology Group (only the Environmental Microbiology part) (WIMEK-WU)**

Smidt H, de Vos WM (2004) Anaerobic microbial dehalogenation. *Annu Rev Microbiol* 58:43-73

Roest K, Heilig GHJ, Smidt H, de Vos WM, Stams AJM and Akkermans ADL (2005) Community analysis of a full-scale anaerobic bioreactor treating paper mill wastewater. *Syst Appl Microbiol* 28: 175-185

van Doesburg W, van Eekert MHA, Middeldorp PJM, Balk M, Schraa G and Stams AJM (2005) Reductive dechlorination of beta-hexachlorocyclohexane (beta-HCH) by a Dehalobacter species in coculture with a Sedimentibacter species. *FEMS Microbiology Ecology* 54: 87-95

Parshina SN, Sipma J, Nakashimada Y, Henstra AM, Smidt H, Lysenko AM, Lens PNL, Lettinga and Stams AJM (2005) *Desulfotomaculum carboxydovorans* sp.nov., a novel sulfate-reducing bacterium capable of growth at 100% CO. *Int J Syst Evol Microbiol* 55: 2159-2165

De Bok FAM, van Leerdam RC, Lomans BP, Smidt H, Lens PNL, Janssen AJH and Stams AJM (2006) Degradation of methanethiol by methylotrophic methanogenic archaea in a lab-scale upflow anaerobic sludge blanket reactor. *Appl Environ Microbiol* 72: 7540-7547

#### **Soil Chemistry and Chemical Soil Quality Group (WIMEK-WU)**

Weng LP, Temminghoff EJM, Van Riemsdijk WH. Contribution of individual sorbents to the control of heavy metal activity in sandy soil. *Environmental Science & Technology*, 35, 4436-4443, 2001

Milne CJ, Kinniburgh DG, Van Riemsdijk WH, Tipping E, Generic NICA-Donnan model parameters for metal-ion binding by humic substances *Environmental Science & Technology* 37: 958-971 2003

Hiemstra T., Van Riemsdijk W.H. On the relationship between charge distribution, surface hydration, and the structure of the interface of metal hydroxides. *J.Colloid Interface Sci* 301: 1-18 , 2006

Weng LP, Van Riemsdijk WH, Hiemstra T. Adsorption free energy of variable-charge nanoparticles to a charged surface in relation to the change of the average chemical state of the particles. *Langmuir*, 22, 389-397, 2006

## **SENSE Core 2: Environmental change and ecosystem dynamics**

### **Aquatic Ecology and Water Quality Management Group (WIMEK-WU)**

Scheffer, M., S.R. Carpenter, J.A. Foley, C. Folke, & B. Walker, 2001. Catastrophic shifts in ecosystems. *Nature*. 413: 591-596.

Scheffer, M. & S. R. Carpenter, 2003. Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends in Ecology & Evolution* 18: 648-656.

Berkes, F., T. P. Hughes, R. S. Steneck, J. A. Wilson, D. R. Bellwood, B. Crona, C. Folke, L. H. Gunderson, H. M. Leslie, J. Norberg, M. Nystrom, P. Olsson, H. Osterblom, M. Scheffer & B. Worm, 2006. Ecology - Globalisation, roving bandits, and marine resources. *Science* 311: 1557-1558.

### **Soil Formation and Ecopedology Group (WIMEK-WU)**

Breemen, N. van; 2002. Natural organic tendency. *Nature* 415 (2002). - ISSN 0028-0836. - p. 381-382

Hoosbeek, M.R.; Breemen, N. van; Vasander, H.; Buttlers, A.; Berendse, F.; 2002. Potassium limits potential growth of bog vegetation under elevated atmospheric CO<sub>2</sub> and N deposition. *Global Change Biology* 8 (2002). - ISSN 1354-1013. - p. 1130-1138

Denier van der Gon, H.A.C.; Kropff, M.J.; Breemen, N. van; Wassmann, R.; Lantin, R.S.; Aduna, E.; Corton, T.M.; Laar, H.H. van; (2002). Optimizing grain yields reduces CH<sub>4</sub> emissions from rice paddy fields. *Proceedings of the National Academy of Sciences of the United States of America* 99 (2002) 19. - ISSN 0027-8424. - p. 12021-12024

Hoosbeek, M.R., Vos, J.M., Bakker, E.J., & Scarascia-Mugnozza, G. (2006). Effects of free atmospheric CO<sub>2</sub> enrichment (FACE), N fertilization and poplar genotype on the physical protection of carbon in the mineral soil of a poplar plantation after five years. *Biogeosciences*, 3(4), 479-487.

Amezquita, M.C., Ibrahim, M., Llanderal, T., Buurman, P., & Amezquita, E. (2005). Carbon sequestration in pastures, silvo-pastoral systems and forests in four regions of the latin American Tropics. *Journal of Sustainable Forestry*, 21(1), 31-49.

### **Environmental Systems Analysis Group (WIMEK-WU)**

Millennium Ecosystem Assessment. 2005. Living beyond our means: Natural Assets and human well-being. Island Press, Washington DC. (In total 5 synthesis reports, 4 assessment volumes and 1 assessment framework book published in the period 2003-2006; Major contributions by Leemans and de Groot).

### **Hydrology and Quantitative Water Management Group (WIMEK-WU)**

Troch, P.A., C. Paniconi, and E.E. van Loon (2003): The hillslope-storage Boussinesq model for subsurface flow and variable source areas along complex hillslopes: 1. Formulation and characteristic response. *Water Resour. Res.*, 39, 1316, doi:10.1029/2002WR001728.

Peters, E., H.A.J. van Lanen, P.J.J.F. Torfs, and G. Bier (2005): Drought in groundwater – drought distribution and performance criteria. *J. Hydrol.*, 306, 302-317, doi:10.1016/j.jhydrol.2004.09.014.

Berne, A., and R. Uijlenhoet (2005): A stochastic model of range profiles of raindrop size distributions: Application to radar attenuation correction. *Geophys. Res. Lett.*, 32, L10803, doi:10.1029/2004GL021899.

Teuling, A.J., R. Uijlenhoet, and P.A. Troch (2005): On bimodality of warm season soil moisture observations. *Geophys. Res. Lett.*, 32, L13402, doi:10.1029/2005GL023223.

Bogaart, P.W., and P.A. Troch (2006): Curvature distribution within hillslopes and catchments and its effect on the hydrological response, *Hydrol. Earth Syst. Sci.*, 10, 925-936.

### **Nature Conservation and Plant Ecology Group (WIMEK-WU)**

Kleijn, D., F. Berendse, R. Smit, N., Gilissen, N. (2001). Agri-environment schemes do not effectively protect biodiversity in Dutch agricultural landscapes. *Nature* 413:723-725

Fransen, B., H. de Kroon, F. Berendse (2001). Nutrient heterogeneity changes competition between plant populations of *Festuca rubra* L. and *Anthoxanthum odoratum* L. *Ecology* 82: 2534-2546

Van Ruijven, J. & F. Berendse (2005). Diversity-productivity relationships: Initial effects, long-term patterns and underlying mechanisms. *PNAS* 102: 695-700.

Biesmeijer, J.C., S. P. M. Roberts, M. Reemer, R. Ohlemuller, M. Edwards, S.T. Peeters, A. P. Schaffers, S. G. Potts, R. Kleukers, C. D. Thomas, J. Settele, W. E. Kunin (2006) Parallel Declines in Pollinators and Insect-Pollinated Plants in Britain and the Netherlands. *Science* 313: 351-354

#### **Soil Physics, Ecohydrology and Ground Water Quality Group (WIMEK-WU)**

J.P.M. Witte, and P.J.J.F. Torfs, Scale dependency and fractal dimension of rarity, *Ecography* 26, 1, 60-68, 2003

G.M.C.M. Janssen, O.A. Cirpka, and S.E.A.T.M. van der Zee, Stochastic analysis of nonlinear biodegradation in regimes controlled by both chromatographic and dispersive mixing, *Water Resour. Res.*, 42, 2006

R.A. Feddes, G.H. de Rooij, and J.C. van Dam, *Unsaturated zone modeling*, Kluwer Academic Publishers, 2004

Q. de Jong van Lier, K. Metselaar, and J.C. van Dam, Root water extraction and limiting soil hydraulic conditions estimated by numerical simulation, *Vadose Zone Journal* 5(4), 1264-1277, 2006

De Rooij, G.H., and F. Stagnitti. 2002. Spatial and temporal distribution of solute leaching in heterogeneous soils: analysis and application to multisampler lysimeter data. *J. Contam. Hydrol.* 54:329-346.

#### **Soil Chemistry and Chemical Soil Quality Group (WIMEK-WU)**

Janssen, G. M. C. M., Cirpka O.A., Van der Zee SEATM. Stochastic analysis of nonlinear biodegradation in regimes controlled by both chromatographic and dispersive mixing, *Water Resour. Res.*, 42: 2006

### **SENSE Core 3 – Global change: climate, land use and biogeochemical cycles**

#### **Earth System Science Group (WIMEK-WU)**

Araújo, A. C., A. D. Nobre, B. Kruijt, J. A. Elbers, R. Dallarosa, P. Stefani, C. von Randow, A. O. Manzi, A. D. Culf, J. H. C. Gash, R. Valentini, and P. Kabat (2002). Comparative Measurements of Carbon Dioxide Fluxes from Two Nearby Towers in a Central Amazonian Rainforest: The Manaus LBA site. *Journal of Geophysical Research*, Vol. 107, D20, 8090, 58/1- 58/20

Janssens, I. A., A. Freibauer, P. Ciais, Pete Smith, Gert-Jan Nabuurs, Gerd Folberth, Bernhard Schlamadinger, Ronald W. A. Hutjes, Reinhart Ceulemans, E.-Detlef Schulze, Riccardo Valentini, and Johannes Dolman (2003). Europe's Terrestrial Biosphere Absorbs 7 to 12% of European Anthropogenic CO<sub>2</sub> Emissions. *Science*, 300, 1538-1542

Kabat, P., M. Claussen, P. Diemeyer, J. Gash, Guenni, M. Meybeck, R. Pielke, Ch. Vorosmarty, R. Hutjes and S. Lutkemeier (eds), (2004). "Vegetation, Water, Humans and the Climate: a new perspective on an interactive system." *Springer Verlag; ISBN 3 – 540 – 42400 – 8, 566 p*

Kabat, P., Vellinga, P., Aerts, J., Veraart, J., & van Vierssen, W. (2005). Climate Proofing The Netherlands. *Nature*, 438, 283-284

Maat, H.W. ter, R.W.A. Hutjes, R. Ohba, H. Ueda, B. Bisselink, and T. Bauer (2006). Meteorological Impact Assessment of Possible Large Scale Irrigation in Southwest Saudi Arabia. *Global and Planetary Change*, 1- 19

Groenigen, Kees-Jan van, Johan Six, Bruce A. Hungate, Marie-Anne de Graaff, Nico van Breemen, and Chris van Kessel (2006). Element interactions limit soil carbon storage. *Proceedings of The National Academy of Sciences of the USA (PNAS)*, Vol.103, No.17, 6571-6574

#### **Environmental Economics and Natural Resources Group (WIMEK-WU)**

Kuosmanen, T., Pemsil, D., Wesseler, J.H.H. (2006) Specification and Estimation of Production Functions Involving Damage Control Inputs: A Two-Stage, Semi-Parametric Approach; *American Journal of Agricultural Economic* 88(2), pp. 499-511.

Schmieman, E.C., Verland, E.C. van Hordijk, L. Dynamic Efficiency with Multi-Pollutants and Multi-Targets : The case of Acidification and Tropospheric Ozone Formation in Europe *Environmental and Resource Economics* 23 (2002). - ISSN 0924-6460. - p. 133-148

Weikard, H.P. Diversity Functions and the Value of Biodiversity *Land Economics* 78 (2002) 1. - ISSN 0023-7639. - p. 20-27

Zhu, X., Verland, E.C. van The Enlargement of the European Union: Effects on Trade and Emissions of Greenhouse Gases *Ecological Economics* 57 (2006) - p. 1-14

#### **Environmental Systems Analysis Group (WIMEK-WU)**

- De Groot, R.S., M. Wilson, R. Boumans. 2002. A typology for the description, classification and valuation of Ecosystem Functions, Goods and Services (pp. 393-408). In: "The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives". Special issue of Ecological Economics Volume 41, Issue 3: 367-567.
- Dumont E., J.A. Harrison, C. Kroeze, E. J. Bakker, and S.P. Seitzinger (2005). Global distribution and sources of DIN export to the coastal zone: results from a spatially explicit, global model. *Global Biogeochemical Cycles* 19, GB4S02, doi:10.1029/GB2005002488. 13 pp.
- Leemans, R., and B. Eickhout. 2004. Another reason for concern: regional and global impacts on ecosystems for different levels of climate change. *Global Environmental Change* 14:219–228.
- Millennium Ecosystem Assessment. 2005. Living beyond our means: Natural Assets and human well-being. Island Press, Washington DC. (In total 5 synthesis reports, 4 assessment volumes and 1 assessment framework book published in the period 2003-2006; Major contributions by Leemans and de Groot).
- Schröter, D., W. Cramer, R. Leemans, I. C. Prentice, M. B. Araujo, N. W. Arnell, A. Bondeau, H. Bugmann, T. R. Carter, C. A. Gracia, A. C. de la Vega-Leinert, M. Erhard, F. Ewert, M. Glendining, J. I. House, S. Kankaanpää, R. J. T. Klein, S. Lavorel, M. Lindner, M. J. Metzger, J. Meyer, T. D. Mitchell, I. Reginster, M. Rounsevell, S. Sabate, S. Sitch, B. Smith, J. Smith, P. Smith, M. T. Sykes, K. Thonicke, W. Thuiller, G. Tuck, S. Zaehle, and B. Zierl. 2005. Ecosystem Service Supply and Vulnerability to Global Change in Europe. *Science* 310:1333-1337.
- Hein, L. and N. de Ridder, 2006. Desertification in the Sahel: a reinterpretation. *Global Change Biology* 12 (5), 751–758.

#### **Nature Conservation and Plant Ecology Group (WIMEK-WU)**

- Berendse, F., N. van Breemen, H. Rydin, A. Buttler, M. Heijmans, M.R. Hoosbeek, J.A. Lee, E. Mitchell, T. Saarenin, H. Vasander, B. Wallén (2001). Raised atmospheric CO<sub>2</sub> levels and increased N deposition cause shifts in plant species composition and production in Sphagnum bogs. *Global Change Biology* 7: 591-598.

#### **Soil Physics, Ecohydrology and Ground Water Quality Group (WIMEK-WU)**

- Hoekman, D.H. and C. Varekamp, 2001, Observation of tropical rain forest trees by airborne high resolution interferometric radar, *IEEE Transactions on Geoscience and Remote Sensing*, Vol.39, No.3, pp.584-594.

### **SENSE Core 4 – Industrial transformation – towards sustainable use of energy and materials**

#### **Environmental Policy Group (WIMEK-WU)**

- Ho, P.P.S. (2001) Greening without conflict? Environmentalism, Green NGOs and Civil Society in China, *Development and Change* 32, pp. 893 – 921
- Mol, A.P.J.; 2001. Globalization and Environmental Reform. The ecological modernization of the global economy. Cambridge, Mass.: The MIT Press.
- Spaargaren, G.; 2003. Sustainable Consumption: A Theoretical and Environmental Policy Perspective. *Society and Natural Resources* 16, 8, p. 687-701
- Oosterveer, P. (2005) Global Food Governance. Wageningen: PhD-Thesis Wageningen University.
- Gert Spaargaren, Arthur P.J. Mol, and Frederick H. Buttel (eds.) (2006). *Governing Environmental Flows : Global Challenges to Social Theory*. Cambridge Mass.: The MIT Press

#### **Environmental Technology Group (WIMEK-WU)**

- Chavalparit O., Rulkens, W.H., Mol, A.P.J., Khaodhair, S. (2006). Options for environmental sustainability of the crude palm oil industry in Thailand through enhancement of industrial ecosystems. *Environ., Developm. Sustain.* 8, 271-287.

#### **Environmental Economics and Natural Resources Group (WIMEK-WU)**

- Chen, M.C.\Ruijs, A.J.W.\Wesseler, J.H.H. (2005). Solid waste management on small islands: the case of Green Island, Taiwan *Resources Conservation and Recycling*, 45(1), 31-47.

## Annex 4 Articles in Nature, Science and PNAS

In the review period 2001 – 2006 WIMEK published 15 articles in Nature, Science and PNAS.

### **Aquatic Ecology and Water Quality Management Group (AEW)**

Scheffer, M., Carpenter, S., Foley, J.A., Folke, C., & Walker, B. (2001). Catastrophic shifts in ecosystems. *Nature*, 413(6856), 591-596.

Scheffer, M., Szabo, S., Gragnani, A., Nes, E.H. van, Rinaldi, S., Kautsky, N., & Norberg, J. (2003). Floating plant dominance as a stable state. *Proceedings of the National Academy of Sciences of the United States of America*, 100(7), 4040-4045.

Hughes, T.P., Berkes, F., Steneck, R.S., Wilson, J.A., Bellwood, D.R., Crona, B., Folke, C., Gunderson, L.H., Leslie, H.M., Norberg, J., Nystrom, M., Olsson, P., Osterblom, H., Scheffer, M., & Worm, B. (2006). Keeping bandits at bay? *Science*, 313(5787), 612-614.

Berkes, F., Hughes, T.P., Steneck, R.S., Wilson, J.A., Bellwood, D.R., Crona, B., Folke, C., Gunderson, L.H., Leslie, H.M., Norberg, J., Nyström, M., Olsson, P., Osterblom, H., Scheffer, M., & Worm, B. (2006). Globalization, roving bandits, and marine resources. *Science*, 311(5767), 1557-1558.

Scheffer, M., and E. H. Van Nes. 2006. Self-organized similarity, the evolutionary emergence of groups of similar species. *Proceedings of the National Academy of Science of the United States of America* 103:6230-6235.

### **Environmental Systems Analysis Group (ESA)**

Schröter, D., Cramer, W., Leemans, R., Prentice, I.C., Araujo, M.B., Arnell, N.W., Bondeau, A., Bruggemann, H., Carter, T.R., Gracia, C.A., Vega-Leinert, A.C. de la, Erhard, M., Ewert, F.A., Glendinning, M., House, J.I., Kankaanpää, S., Klein, R.J.T., Lavorel, S., Lindner, M., Metzger, M.J., Meyer, J., Mitchell, T., Reginster, I., Rounsevell, M., Sabate, S., Stich, S., Smith, B., Smith, J., Smith, P., Sykes, M.T., Thonicke, K., Thuiller, W., Tuck, G., Zaehle, S., & Zierl, B. (2005). Ecosystem Service Supply and Vulnerability to Global Change in Europe. *Science*, 310(5752), 1333-1337.

Reid, W., Mooney, H.A., Capistrano, D., Carpenter, S.R., Chopra, K., Cropper, A., Dasgupta, P., Hassan, R., Leemans, R., May, R.M., Pingali, P., Samper, C., Scholes, R., Watson, R.T., & Zakri, A.H. (2006). Nature: the many benefits of ecosystems services. *Nature*, 443(7113), 749.

### **Meteorology and Air Quality Group (MAQ-WU)**

Krol, M. C., J. Lelieveld, G. A. Sturrock, S. A. Penkett, C. A. M. Brenninkmeijer, V. Gros, J. Williams, and H. A. Scheeren (2003), Continuing emissions of methyl chloroform from Europe, *Nature*, 421, 131-135.

### **Nature Conservation and Plant Ecology Group (NCP)**

Kleijn, D., Berendse, F., Smit, R., & Gilissen, N. (2001). Agri-environment schemes do not effectively protect biodiversity in Dutch agricultural landscapes. *Nature*, 413, 723-725.

Sankaran, M., Hanan, N.P., Scholes, R.J., Ratnam, J., Augustine, D.J., Cade, B.S., Gignoux, J., Higgins, S.I., Roux, X. Le, Ludwig, F., Ardo, J., Banyikwa, F., Bronn, A., Bicini, G., Caylor, K.K., Coughenour, M.B., Diouf, A., Ekaya, W., Feral, C.J., February, E.C., Frost, P.G.H., Hiernaux, P., Hrabar, H., Metzger, K.L., Prins, H.H.T., Ringrose, S., Sea, W., Tews, J., Worden, J., & Zambatis, N. (2005). Determinants of woody cover in African savannas. *Nature*, 438(7069), 846-849.

Ruijven, J. van, & Berendse, F. (2005). Diversity-productivity relationships: Initial effects, long-term patterns, and underlying mechanisms. *Proceedings of the National Academy of Sciences of the United States of America*, 102(3), 695-700.

Biesmeijer, J.S., Roberts, S.P.M., Reemer, M., Ohlemüller, R., Edwards, M., Peeters, T., Schaffers, A.P., Potts, S.G., Kleukers, R., Thomas, C.D., Settele, J., & Kunin, W.E. (2006). Parallel Declines in Pollinators and Insect-Pollinated Plants in Britain and the Netherlands. *Science*, 313(5785), 351-354.

### **Soil Formation and Ecopedology Group / Earth System Science Group (SFI – ESS)**

Breemen, N. van (2002). Natural organic tendency. *Nature*, 415, 381-382.

Kabat, P., Vellinga, P., Aerts, J., Veraart, J., van Viersen, W. (2005) Climate Proofing The Netherlands. *Nature*. 438 283-284.

University: Wageningen University  
Research Institute: Wageningen Institute for Environment and Climate Research (WIMEK)  
Directors: Prof. dr. L. Hordijk, Prof. dr. S.E.A.T.M. van der Zee, Prof. dr. R. Leemans

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Groenigen, Kees-Jan van, Johan Six, Bruce A. Hungate, Marie-Anne de Graaff, Nico van Breemen, and Chris van Kessel (2006). Element interactions limit soil carbon storage. *Proceedings of The National Academy of Sciences of the USA (PNAS)*, Vol.103, No.17, 6571-6574

#### **TOP Book Publications**

##### **Environmental Policy Group (ENP)**

A.P.J. Mol (2001), *Globalization and Environmental Reform. Ecological Modernization and the Global Economy*, Cambridge: MIT Press (reprinted in 2003)

P.Ho (2005), *Institutions in Transition. Landownership, Property Rights and Social Conflict in China*, Oxford: Oxford University Press

G. Spaargaren, A.P.J. Mol and F.H. Buttel (2006), *Governing Environmental Flows. Global Challenges to Social Theory*, Cambridge: MIT Press

## **Annex 5 Other quality indicators: grants and honours awarded to WIMEK researchers**

*For example:*

### **NWO – VIDI grants**

- Dr. ir. R. Uijlenhoet (2001); Hydrology and Quantitative Water Management Group (WIMEK-WU): Unravelling the microstructure of rainfall with a revolutionary doppler-polarimetric atmospheric research radar.

### **NWO –TOP grant:**

- Prof.dr. A.J.M. Stams (2006), Microbiology Group (WIMEK-WU): k€ 675: Exocellular electron transport in anaerobic microbes

### **NWO – ASPASIA grants:**

- Dr. Carolien Kroeze (2002), Environmental Systems Analysis Group (WIMEK-WU): The disturbance of the natural nitrogen cycle in terrestrial and aquatic systems: a systems analysis approach.
- Dr. Tinka Murk (2002), Toxicology Group (WIMEK-WU): Toxic effects of diffuse contaminants in the food chain on the endocrine function of man and wildlife species.

### **NWO – MEERVOUD grants:**

- Dr. Caroline M. Plugge (2002), Microbiology Group (WIMEK-WU): Interactions and intercellular communication in methanogenic syntrophic consortia.

### **EU - MARIE CURIE grant:**

- A. (Alexis) Berne (HWM-WU; 2002): Marie Curie post-doctoral fellowship for the project "The hydrometeorology of mountainous areas – case studies for two Ardennes catchments using a new weather radar and an innovative hydrological modelling approach" (2003-2005; host: R. Uijlenhoet).

### **EU - MARIE CURIE EXCELLENCE grant:**

- Dr.ir. Piet Lens (2003), Environmental Technology Group (WIMEK-WU): Novel biogeological engineering processes for heavy metal removal and recovery: 1.67 million Euro

## **PERSONAL PROFESSORSHIPS**

### *WAGENINGEN UNIVERSITY:*

- Prof. Fons Stams (2001), Microbiology Group (WIMEK-WU): to acknowledge his scientific expertise and contribution to microbial physiology.
- Prof. Jacob de Boer (2005), Analytical Environmental Chemistry (WU-TOX): to acknowledge his scientific quality and his important contributions to method development in the field of micro-contaminants.
- Prof. Bart Koelmans (2005), Aquatic Ecology and Water Quality Management Group (WIMEK-WU): to acknowledge his scientific quality and his important contributions to developing a field of research at our university: the 'eco-chemical' approach to assessment of risks and flows of environmental contaminants.
- Prof. John van der Oost (2005), Microbiology Group (WIMEK-WU): to acknowledge his important scientific contributions to bacterial genetics.

### *ZAYED PRIZE for ENVIRONMENTAL LEADERSHIP*

- *In 2005, one of the most prestigious environmental prizes in the world has been awarded to all 1360 co-authors of the Millennium Ecosystem Assessment, including the SENSE researchers Prof. R. Leemans (WIMEK-WU), Prof. P. Kabat (WIMEK-WU), Prof. M. Scheffer (WIMEK-WU), Dr. RS de Groot (WIMEK-WU), Prof. P. Martens (ICIS-MU), Dr. SB Amelung (ICIS-MU) en Prof. J. Gupta (IVM-VU) for the high impact of their scientific and technological achievement.*

### **PHD DISSERTATION AWARDS:**

- R. (Remko) Uijlenhoet (HWM-WU; 2002): Recipient of the tri-annual Hydrology Prize (1998-2000) of the Dutch Hydrological Society (NHV) for the PhD thesis "Parameterization of Rainfall Microstructure for Radar Meteorology and Hydrology" (Wageningen University, 1999).

- Juliette Legler (TOX-WU, 2002): PhD dissertation award from the Dutch Society of Toxicology
- Chiel Jonker (AEW-WU, 2004): PhD thesis 'Black Magic in the Aquatic Environment' won the National Award for best thesis in the field of Environmental Chemistry & Technology.
- Lucas Seghezzo (ETE-WU, 2005): PhD thesis 'Anaerobic treatment of domestic wastewater in subtropical regions' won the DOW Benelux Dissertation Award (under the auspices of the KNAW) for its contribution to further sustainable development in the processing industry.

#### **BEST PAPER – BEST ARTICLE**

- David Kleijn (NCP-WU; 2001): "Landschapsprijs 1999-2000" of the Dutch Society for Landscape Ecology for the best paper in the 1999 and 2000 issues of the Journal "Landschap".
- Harmke van Oene (NCP-WU; 2003): Wageningen University award of Wageningen University Fund for the most important scientific article in the years 2001 and 2002
- Legler J, Zeinstra LM, Schuitemeaker F, Lanser PH, Bogerd J, Brouwer A, Vethaak AD, de Voogt P, Murk AJ, van den Burg B (2002) SETAC-Europe Best publication award 2003 for "Comparison of in vivo and in vitro reporter gene assays for short-term screening of estrogenic activity. Environ. Sci. Technol. 36, 4410-4415"
- Marten Scheffer et al (AEW-WU; 2004): Sustainability Science Award of the Ecological Society of America for the *Nature* paper by Scheffer and colleagues (2001), qualifying it as the most important contribution to the field of the past five years.
- J.P.M. (Flip) Witte (SEG-WU; 2004) and P.J.J.F. (Paul) Torfs (HWM-WU; 2004): Research Prize 2000-2003 of the Wageningen University Foundation for the 2003 publication "Scale dependency and fractal dimension of rarity", *Ecography*, 26 (1), 60-68.
- Hiemstra T., Van Riemsdijk W.H. (SOQ-WU): feature article on special request: On the relationship between charge distribution, surface hydration, and the structure of the interface of metal hydroxides. *J. Colloid Interface Sci* 301: 1-18 , 2006



## **Annex 6 Composition WIMEK's Management Bodies on 31-12-2006**

### **WIMEK General Board**

- Professor F. Berendse
- Professor E.C. van Ierland (Chairman)
- Professor W.H. Rulkens
- Professor M. Scheffer
- Professor S.E.A.T.M. van der Zee
- Dr. H. Siepel (Alterra DLO)
- Ir. Christian Jagersma (PhD researche)

### **WIMEK scientific director and staff**

- Professor R. Leemans (Director)
- Mr. J. Feenstra (WIMEK General Secretary)
- Mr. E. Nab (Secretarial assistant)

### **WIMEK PhD Council (WPC)**

- Christian Jagersma (MIB)
- Neslihan Tas (MIB)
- Loes Harmsen (ETE)
- Bjorn Robroek (NCP)
- Olaf Vellinga (MAQ)

## Annex 7 Results PhD cohort analysis WIMEK PhD students

PhD cohort analysis, WIMEK, Wageningen University				
		number	%	
<b>Gender</b>	Female	127	36	
	Male	219	63	
	Not filled in	4	1	
	<b>Total</b>	<b>350</b>	<b>100</b>	
<b>PHD category</b>	AIO	175	50	
	Guest	39	11	
	Sandwich	69	20	
	Extern	57	16	
	Staff	10	3	
	<b>Total</b>	<b>350</b>	<b>100</b>	
<b>Funding source</b>	University	64	18	
	NWO	59	17	
	Contract, third party	223	64	
	Multiple funding sources	4	1	
	<b>Total</b>	<b>350</b>	<b>100</b>	
<b>Home country</b>	Netherlands	199	57	
	Other country	151	43	
	<b>Total</b>	<b>350</b>	<b>100</b>	
<b>Home continent</b>	Africa	22	6	
	Asia	69	20	
	European Union	226	65	
	Rest of Europe	5	1	
	Middle & South America	26	7	
	Unknown	2	1	
	<b>Total</b>	<b>350</b>	<b>100</b>	
<b>Median promotion duration (months)</b>	Cohort 1996	59		
	Cohort 1997	61		
	Cohort 1998	62		
	Cohort 1999	58		
	Cohort 2000	63		
	Cohort 2001	61		
	<b>All PhD graduates</b>	<b>61</b>		
		<b>number</b>	<b># ITSP</b>	<b>% ITSP</b>
<b>SENSE ITSP</b>	Starting years 1996 - 2000	145	32	22
	Starting years 2001 - 2006	205	133	65
	All PhD students started in 1996 - 2006	350	165	47
		<b>number</b>	<b># certificates</b>	<b>% certificates</b>
<b>SENSE Certificate</b>	Starting year 1996 - 1998	72	7	10
	Starting year 1999 - 2001	55	16	29
	All PhD graduates started in 1996 - 2001	127	23	18

PhD cohort analysis, WIMEK, Wageningen University				
		number	# stopped	% stopped
<b>Stopped</b>	AIO	175	11	6
	Guest	39	5	13
	Sandwich	69	8	12
	Extern	57	1	2
	Staff	10	0	0
	<b>All PhD students</b>	<b>350</b>	<b>25</b>	<b>7</b>
		<b>number</b>		<b>%</b>
<b>First job function</b>	Postdoc	31		19
	Researcher, scientific officer, assistant professor	94		59
	Research manager, senior researcher, associate professor, professor	5		3
	Policy officer	9		6
	Public relations officer, advisor, consultant	6		4
	IT specialist, automation expert	2		1
	System or model developer	2		1
	Head of department, General manager, General Director, Director	1		1
	Self-employed, freelance, small businessman / - woman, trader	2		1
	Househusband, housewife; not a job seeker	1		1
	Unknown	7		4
<b>Total</b>	<b>160</b>		<b>100</b>	
<b>First job organisation</b>	Universities	73		46
	Other Research Institutes	45		28
	National Government Departments	12		8
	Regional and Local Government / Authorities	5		3
	Consultancy agencies	7		4
	Industry, trade and distribution	6		4
	PR, marketing, communication	1		1
	Healthcare, welfare and social services	1		1
	Unknown	8		5
	Other market sectors	2		1
<b>Total</b>	<b>160</b>		<b>100</b>	

