

assessment report

Peer Review

Environmental and Sustainability Sciences
including SENSE Research School

2014

assessment report

***Research Assessment of the Environmental and
Sustainability Sciences, including SENSE Research School
2007 - 2013***

June 2014

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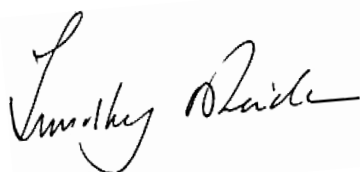
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Preface

This report embodies the findings and recommendations of an international peer review of the Dutch national Graduate School SENSE undertaken over five days from June 9 to June 13, 2014. The review consisted of peer assessments of the progress and achievements of the School as a whole as well as its constituent departments and research groups, based on their own evaluations over the past six years. This overall report is both prospective and retrospective and has relied on a combination of quantitative as well as qualitative analysis of the School, its institutes and its research groups. This report presents findings on the School SENSE and its partner institutes as a whole and on the individual research groups making up the School. The review has resulted in a set of specific recommendations and some more general observations. Its purpose is to guide and to encourage the SENSE family in pursuing research excellence over the coming six years and to suggest productive and fruitful areas for innovation in both teaching and learning

Overall, and in assessing the progress of the network since that last review of this kind (2007), the Review Committee was impressed by the nationally and internationally high standards of the scientific quality of the total research output of the SENSE network. The Committee also noted with much appreciation the very hard work in all of the teams to increase the productivity of publications in many forms of outlet, and in improving the academic standing of the research publications as measured by the international reputation of the journals successfully selected. The Committee admired the huge commitment to supervising and nurturing of all PhD students who revealed their enthusiasm and pleasure at being part of this active and exciting research family.

September, 2014

A handwritten signature in black ink, appearing to read 'Tim O'Riordan', written in a cursive style.

Prof. Tim O'Riordan
Chairman, International Peer Review Committee SENSE

1. Introduction

1.1 The evaluation

All publicly funded university research in the Netherlands is evaluated at regular intervals, as agreed by the Association of Universities in the Netherlands (VSNU), the Netherlands Organisation for Scientific Research (NWO) and the Netherlands Academy of Sciences (KNAW). The evaluation process, which is applied at the research unit level, consists of a systematic external peer review conducted every six years and a three-year interim review, often based on an internal self-reflection, focused on what is achieved since the last external peer review.

The evaluation system aims to achieve three objectives:

- *improvement* in the quality of research through an assessment carried out according to international standards of quality and relevance;
- *improvement* in research management and leadership; and
- *accountability* to the higher management levels of the research organisations and to the funding agencies, government and to society at large.

The intention is that these responsibilities of SENSE and its partner institutes are evaluated in this peer review with the overall aim of achieving an accurate view of the performance of these institutes and in particular the position of its research (chair) groups within the (inter)national science and education arena (retrospective) and to find ways for further improvement (prospective). Therefore the peer review takes into account not only the quality of the work conducted and the ways that the results are communicated, but also the institution's broader missions. This includes evaluation of the arrangements and programmes for PhD students, who conduct much of the scientific research, and also of the relevance, quality and effectiveness of the work in terms of the institution's wider missions and public accountability.

1.2 The assessment procedure

The evaluation procedures followed by the Review Committee were those set out in the NWO/VSNU/KNAW "Standard Evaluation Protocol 2009-2014 for public research organizations" as agreed by the SENSE board and all partnering university boards.

This Standard Evaluation Protocol entails two main characteristics (annex 1):

- *Two levels of assessment (with their own terms of reference)*: The A-level, a general level reflecting the activities / responsibilities of the research school SENSE and its partnering institutes, and the B-level, that reflects the performance of the research groups;
- *Four main criteria*: The assessment entails four main criteria, i.e. scientific quality, productivity, societal impact and vitality & feasibility (viability).

The evaluation committee was requested to report its findings on the research groups in line with the four main criteria. With respect to the evaluation of SENSE and its institute the findings should be reported in qualitative terms with a focus on policy and management questions. For the assessment of the research (chair) groups, the verdict should be cast in both qualitative and quantitative terms. In the text, the most important considerations of the committee should be clarified, while the conclusion should be summarized in a single term according to a five point scale, "excellent" meaning world class research, and "unsatisfactory"

meaning below standard (annex 1). Checklists and excerpts of the standard evaluation protocol were provided as a tool for assisting in assessment. The four criteria should always be reviewed in relation to the group's mission, especially if this mission restricts the group to operate only for / in a national scientific community.

The assessment was based on and supported by three main components of evidence:

- substantial self-evaluation reports detailing the operation, management, research activities, outputs, and SWOT analysis of the SENSE research school, its partnering institutes and their research / research groups; these self-evaluation reports were written as prescribed in the national standard evaluation protocol;
- copies of the selected papers from each research / research group and dissertations, to allow the Committee to examine in detail examples of published work;
- discussions with boards, researchers, PhD students and council, academic staff and research managers about the details and conduct of the programmes of work.

The site visit was undertaken during the period 9 June - 13 June, 2014 and consisted of a number of components, which can be summarised as follows (annex 2):

- a plenary introduction to the SENSE research school and its institutes by the chairman of the SENSE-Board and the Directors of SENSE, followed by an explanation of the review process by the secretary of the committee;
- sub-committee visits on site at all individual SENSE institutes and interviews with their directors, staff and PhD-students / -council.
- sub-committee sessions with all individual research groups (leaders and key staff);
- sub-committee session with staff, directors and board of SENSE;
- a meeting with the SENSE student council
- a final plenary debriefing meeting with invited boards, directors and staff of institutes

The Peer Review Committee comprised 39 peer members and a 3-staffed secretary (annex 3). Despite a full programme (annex 4) and a tight schedule the Committee was able to complete all the interviews in a satisfactory way. Consequently the final report with the conclusions and recommendations was formulated according to the formats that were made at disposal of the peer review committee. The draft reports was presented to the director of SENSE and the research institutes to redress any (factual) errors.

1.3 Results of the assessment

This report summarises the findings, conclusions and recommendations of an international peer review of the SENSE research School, undertaken in June 2014. The peer review covered the period between 2008 and 2013.

The written and oral information provided by the various research teams offered the Review Committee a good understanding of the organisation by the Committee. The assessment of SENSE and its institutes and research groups was subsequently based and weighted according to the rationale explained in annex 1. This means that the performance of the groups was benchmarked against the performances of other groups in the global arena of comparable disciplines. The conclusions, as given in chapters 3 and 4 of this report, follow the structure and the criteria which are formulated in the Terms of Reference, annex 1. Chapter 3 gives an impression of the performance of the research school SENSE and its institutes and Chapter 4 elaborates on the performances of its individual research (chair) groups.

1.4 Quality of the information

The Committee was impressed by the quality of the information provided. The Self-Assessment Reports were all very well structured.

The SWOT analyses proved to be very valuable and were shown to be an accurate reflection of all of the positive and negative attributes of each group. The presentations during the site visit were in general well-structured and the Committee appreciated the uniform approach to the evaluation process that had been recommended by the SENSE management.

The Committee particularly appreciated the opportunities offered in the review process to meet with PhD students and to discuss with them the nature of their research experiences and opportunities.

Because of all of this, the Review Committee was able to achieve a full and fair impression of the qualities, strengths and weaknesses of the SENSE research school and its constituent partners.

2. Structure, organisation and mission of the research school

2.1 Introduction

The Netherlands Research School for Socio-Economic and Natural Sciences of the Environment (SENSE) was established in 1994, and formally accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW) in 1997 for the 5-year period 1997-2001. This accreditation has been renewed in 2002 and, most recently, in 2008 (for 2008-2013).

Today, twelve leading institutes at nine universities, as well as UNESCO-IHE and the Netherlands Environmental Assessment Agency, participate in SENSE, making it one of the largest research schools in the country. The last seven years have also shown a substantial growth in participating researchers, from faculty to PhD students. The number of tenured environmental scientists within SENSE grew from 150 to almost 250, and the number of involved PhD students nearly doubled in seven years from 350 PhD students in 2007 to more than 600 now.

The partnering institutes within SENSE are:

- Groningen University (RUG)
 - IVEM – Center for Energy and Environmental Sciences
- Leiden University (LU)
 - CML – Institute of Environmental Sciences
- Open University (OU)
 - School of Science
- PBL, Netherlands Environmental Assessment Agency
- Radboud University Nijmegen (RU)
 - Department of Environmental Science
- University of Amsterdam (UvA)
 - IBED – Institute for Biodiversity and Ecosystem Dynamics
- University of Twente (UT)
 - ITC: Faculty of Geo-Information Science and Earth Observation
 - Water Management Group
- UNESCO-IHE, Institute for Water Education, Delft
- Utrecht University (UU)
 - Copernicus Institute for Sustainable Development and Innovation
- VU University Amsterdam (VU)
 - IVM – Institute for Environmental Studies
 - IES – Institute of Ecological Science
- Wageningen University (WU)
 - WIMEK – Wageningen Institute for Environment and Climate Research

A few of these institutes have excused themselves for not taking part in this peer review because of a deviant review rhythm, resp. review planning. They have been reviewed recently or are going to be reviewed shortly in another setting.

- IES-VU and IBED-UvA: research groups have been evaluated in research assessment Biology (2011)
- IVEM-RUG: separate ESRIG review (2013)
- Environmental Sciences RU: separate review IWWR RU (2014)
- PBL: separate PBL review (2012)

2.2 Mission of the SENSE Research School

The SENSE Research School is dedicated to supporting the development and dissemination of cutting-edge disciplinary, interdisciplinary and transdisciplinary knowledge in the field of environmental and sustainability sciences, and to providing a stimulating and supportive context for PhD students and early-career researchers to develop their competencies towards professional leadership in science and society. Its field may be defined as environmental and sustainability sciences, that is, research that advances knowledge for responding effectively to the risks and opportunities of local and global environmental change and for supporting a transformation towards global sustainability.

To this end, the SENSE Research School fulfils three vital functions for the environmental and sustainability sciences community in the Netherlands:

First, the School provides a high-level programme of courses, classes and training programmes for its PhD students in a diversity and quality that individual universities in the Netherlands cannot offer ('education/training function').

Second, the School serves as a catalyst for top-quality research of the participating research groups, through convening meetings and conferences; maintaining virtual and real networks and exchange structures; and providing and coordinating systems of quality assessment and quality control in the environmental and sustainability sciences in the Netherlands ('research function').

Third, SENSE functions as a platform and network for its members to synthesize and disseminate research results nationally and internationally. SENSE aspires to serve as representative and collective voice of the environmental and sustainability sciences community in the Netherlands with regard to other organizations, including the Netherlands Organization for Scientific Research (NWO), the Royal Netherlands Academy of Arts and Sciences (KNAW), and relevant ministries ('bridge function').

2.3 Management and organization

The highest decision-making body is the General Board of the School, which comprises of senior representatives of all participating institutions, usually at the level of institute director, as well as a representative of the PhD Council. The General Board meets usually twice a year, and decides on the general policies of the School.

A Board of Directors is responsible for the daily management of the School. It consists of the General Director, the Director of Research, and the Director of Education. The Board meets once a month and is supported by an executive secretary and support staff (e.g. web-management, outreach, administrative support).

In addition, SENSE has two advisory committees: a Research Committee (convened by the Director of Research) and an Educational Committee (convened by the Director of Education). These committees include faculty and PhD candidates from all SENSE partner institutes, and advise the Board of Directors on SENSE policy and developments. The committees meet once or twice a year.

The SENSE PhD Council represents the collective input of the SENSE PhD candidates. Representatives of the SENSE PhD Council participate in the General Board of SENSE and in the Education Committee. The SENSE PhD Council also advises the SENSE Board of Directors on all issues regarding the SENSE PhD policy, either upon request or upon own initiative.

SENSE is organized in about twenty Research Clusters, which are generally comprised of faculty members and PhD students of several participating universities. These Research Clusters have been created 'bottom up' on the initiatives of researchers, often with encouragement and guidance by the SENSE directors and support staff. SENSE provides

limited resources to the Research Clusters, including material support for workshops and access to specialized websites.

Many Research Clusters have evolved into vibrant communities of highly energetic and enthusiastic young scholars and PhD students.

The set-up of Clusters reflects the research priorities of the SENSE partners, and it has been adapting over time to new member institutes and evolving research agendas.

3. Performance of the SENSE Research School and its partnering institutes

SENSE Research School

a. Mission, vision and policy

Overall, and in assessing the progress of the network since that last review of this kind (2007), we are collectively impressed by the nationally and internationally high standards of the scientific quality of the total research output of the SENSE network. We also note with much appreciation the very hard work in all of the teams to increase the productivity of publications in many forms of outlet, and in improving the academic standing of the research publications as measured by the international reputation of the journals successfully selected. We also admire the huge commitment to supervising and nurturing of all PhD students who revealed their enthusiasm and pleasure at being part of this active and exciting research family.

Our pleasing impression is that this is a network of excellence, a network which seeks to collaborate, and a network which cares for its emerging scientific generations.

Nevertheless, we would not be undertaking this task if we did not wish to support and guide the network over the next review period (probably to 2020/21). We found that that the evaluation process in which we were engaged was patchy in its approach to assessment and to grading. Not all institutes in the network hold the same research cultures and values. Nor do they have the same levels of resources and faculty to hand. Yet there was a tendency for evaluators (possibly inadvertently) to treat the assessment exercise as if all of the component research groups of the whole network were to be considered as equivalents in term of their research culture and ethos. We discovered that this is not the case and that this “assessment template” was not always appropriate. So there may be a case for a different approach and set of judgement criteria to have been considered and applied for some of the research groups.

We also discovered that, though there was a feeling of a “SENSE culture” throughout the network this was variably expressed. Some of the institutes clearly “got it”. But it seemed to us that some researchers we met did not feel so connected. In some cases this translated to a lack of any real awareness of the full capabilities or potential of the totality of the research opportunities on offer in the whole network. In other cases we heard that some supervisors could not advise their research students as to whom they should go if the student was genuinely interested in embarking on network-wide interdisciplinary research. Furthermore, this variation in “SENSE identity culture” revealed itself within research teams and between faculty and PhD students.

An important additional discovery was the apparent lack of any consistent approach to establishing a clear vision and research strategy for the future in any of the institutes we visited. This was not the case everywhere as some of the institutes we visited are seriously considering future research strategies. But these tended to be the exception. This lack of overall commitment to a comprehensive vision and supporting strategy is nevertheless surprising given the rapidly changing research opportunities and the imposing threats of

future restraints on established funding sources. There is also a general issue of “succession planning”. Here is where the network as a whole, but also its various research constituents, need to consider how to manage the possible departure of senior faculty or connected research teams when a critical research leader moves away.

We urge a collective attention to these related challenges. We feel that the research framework of sustainability science is rapidly evolving in a turbulent world. We are not assured that the network is collectively aware of the opportunities and triumphs which could be captured if this emerging world of sustainability science is to be grasped. We fully appreciate that not all faculty feel enamoured of this prospect and understand why some do not immediately wish to shift either research or teaching/learning gears.

But for the network as a whole there is a prospect here which is indeed very promising. It is also, we found, where the emerging cohort of research students would like to pitch their tents. This is an arena of even greater transdisciplinarity. It involves new approaches to metrics and to research methods. It attracts ways of capturing ephemeral feelings and inner convictions which guide individual and collective behaviour. It addresses moral and ethical aspects of consumption especially where the consequences of consuming and discarding create ecological stress, social disadvantage, and undermine the capabilities of all offspring to be able to live sustainably.

We conclude by encouraging the network to address these challenges and opportunities in the spirit in which we offer, namely that a network of renowned excellence wishes to advance and to evolve along with its research progeny into continued excellence and leadership. This is especially the case in the rapidly changing fields of environment and sustainability science, to which we turn our attention below. Such a dynamic covers new forms of learning as well as fresh patterns of engagement with the public, private and civil spheres. Increasingly the distinction between these spheres is disappearing as is the distinction between academia and so-called “external stakeholders”. And it is likely that by following such a path it will be possible to seek and to attract new sources of funding.

b. Research quality

We salute the academic reputation of SENSE network as a whole. Through the many self-assessment reports as well as during the interviews and subsequent meetings with the PhD students we received a very felicitous impression of intellectual rigour, of joy in being in this active research community, and of overall excellence. We were particularly impressed by the PhD students who were obviously very enthusiastic and excited about their training overall, and who enjoyed the opportunities for interdisciplinarity. We offer more comment on this aspect below.

One point of general relevance applies to the uniformity of handling large data banks. We asked several groups how the observational data they acquired was managed, and were told that every researcher essentially managed his or her data. This is a very unsatisfactory approach given the growing importance of data, and data science, in world-class research. More broadly, we missed the kind of strategic planning that is necessary today in the rapidly evolving world of IT, and which is essential for any group that wishes to hold onto an international reputation. This is an area where we feel SENSE could provide the leadership needed.

We feel the academic qualities of the network, which are already powerful, nevertheless could be upgraded even more with attention to greater interdisciplinarity (and transdisciplinarity) as a natural way of working rather than something to be undertaken self-consciously. This would be assisted through cooperative endeavour especially with regard to involvement with relevant stakeholders in civil society, in business (especially) and in the public sphere (at all levels of government). And, given the demands of predicting outcomes of policy options in a very uncertain world, there is scope for more creative approaches to visioning and predicting as well as to weighing outcomes (in social justice terms) of any policy measure or evolving circumstance, with regard to medium term (20 years) and longer term (over 50 years) consequences. This, in our view, requires even more involvement with the humanities as well as the creative arts especially in the use of scenarios through narrative, art, video-art and dance. Scientific knowledge is only a part of social learning. So to widen the basis of knowledge generation and communication would surely be a great asset to any researcher in the future.

This opens up the scope for new forms of learning. The modern age of the internet on the iPhone and iPad, along with the massive explosion of the various forms of social media, offer the chance for much more group based interactive and spontaneous learning and whole new forms of communication. By the early part of the coming decade most students and their research contacts in their stakeholder targets will be well acquainted with social media and Skype type communication. This suggests a model for learning which is much more student centred, much more student initiated, and much more interactive with the internal and external research communities.

c. Societal relevance

We are very impressed with the overall dissemination and general public outreach of the network. Indeed this is one of the most impressive aspects of the whole effort. We have already made the case for more involvement by PhD students both to cooperate with the faculty as well as to widen the students' research and communication experience.

As we remark above, we recognise and respect the role of the SENSE network as a whole in promoting science excellence within the national and international scientific scene. But such an impressive effort is not without costs on faculty time and travelling budgets. The conundrum of visibility and audibility in a world of greater noise and confusion on scientific endeavour and communication is not lost on us. We return to this in our recommendations below.

Those of us who visited WIMEK found their recent publication "Challenges and successes in interdisciplinary and transdisciplinary research and education" of considerable interest and value. This publication makes a strong case for interdisciplinarity as well as transdisciplinarity and provides showcase examples of practical case study research from all over the world. This kind of document should be encouraged in the Sense programme overall. It provides succour to researchers contemplating novelty, as well as offering to the paying public and to interested collaborators the merits of the research programme in its active disciplinary and methodological interfaces. Above all it offers a vision of improvement and practicality. It is long overdue that the adjective "academic" (often popularly interpreted as to be inconsequential or impractical) should be recognised and respected when applied to learning and investing in successful schemes to aid social and planetary betterment.

We also took an interest in the important theme of gender balance and the very real difficulty of ensuring appropriate and adequate female representation in professoriate and in innovative research leadership. Some of us became aware of the WU policy on gender balance (in retrospect of the WIMEK visit) and broadly support this initiative. We are reliably informed that other Dutch universities have similar policies. Nevertheless, even this commendable statement does not fill the recognition void facing the career futures of top class female researchers. We trust that this matter will continue to receive the highest level of attention throughout the Sense network, and that there will be further initiatives to overcome this continuing imbalance. Such moves should include appropriate representation from current and future PhD students.

d. PhD Policy

We are impressed by the number and quality of students in the PhD programme and by the intellectual excellence and enthusiasm of the young researchers in all of the institutes we visited. Indeed they provide huge scientific “energy” as well as forming the engine room of the evolving research effort.

We understand that the SENSE network has no uniform policy regarding the number and publishable status of research papers expected of every graduating PhD. However, the general policy of requiring a number of publishable papers from each graduating PhD student is understandable in this contemporary “high impact” research culture. But we believe it contains many drawbacks which bear adversely on both research students and faculty. We urge the network to review this practice, which we also believe is very differently interpreted within the participating institutions. For one thing not all research cultures are amenable to this form of “numbers game”. For another it may make it more difficult for very cross-disciplinary research (especially if conducted beyond the campus) to be completed in the allocated time. All of this can prove to be very demanding on students, on supervisors and on reviewers. There is clearly a plateau (variable for each institute and research grouping) for PhD intake given the complement of current resources. We were pleased to hear that in some of the SENSE institutions such a “plateau” is being actively considered. We are not sure if this assessment is commonplace amongst the network as a whole and hope this becomes the case if it is not yet so.

We also understand that the national policy is for funding for any research programme overall is very much dependent on successfully completed PhDs. This presents a conundrum (one of many for the network) over successful (and timely) completion rates and the time demands of interdisciplinarity and of policy related research with a component of outreach to external stakeholders. This is particularly the case if applied interdisciplinarity and policy evaluation research is attempted.

One possibility is to change the manner in which PhD students are evaluated so that their contribution to supporting their peers, to informal teaching and to organising research seminars is given appropriate weighting. This suggestion would extend to mentoring “younger” (in entry) PhD students and to supporting research effort by “twinning” research students in some variation of “dual disciplinarity”. Another possibility (already in hand) is more formally to provide “sequencing” of research where a successor PhD follows on with the data from the earlier PhD but with an extended continuation to the earlier research effort.

We are impressed to hear of the various courses offered to incoming PhD students and the scope for providing a stimulus for the interdisciplinary aspects of the research programme.

Again we look for even more attention to the introductory two day course (currently offered for SENSE overall), possibly by an extra day, to meet student expectations of meeting each other and of understanding the scope for taking courses in sister universities and research programmes. Some effort is needed to give the SENSE course a profile which makes it more attractive than the equivalent courses offered by individual Universities.

From the discussions with the research students we gathered a general view of overall satisfaction with the whole of the PhD programme. It was mentioned that there was some variability in the understanding and levels of commitment to supervision by faculty. Here we see an even greater role for the very successful appointment of the PhD coordinators who are already in place in some of the larger institutes of the network. Indeed these post holders should be given even more freedom to work with students on the twinning, sequencing, and mentoring aspects of their research contributions, as well as help to support students obtain the very best supervision available both within and across disciplines and research groups.

We also noted that there was a wish among some PhD students to have some formal education that directly prepares them for the practical aspects of their careers: ethics, career management, proposal writing and research attitudes, as well as leadership might be topics of interest in that context.

We certainly understand the demanding requirements for all researchers concerned in making these observations.

e. SWOT

We have offered comprehensive commentary above on the many SWOT aspects of the SENSE network in our many research group evaluation reports. In summary, the overall strengths lie on the quality of the research effort, publications and outreach, and the many opportunities lie in the exciting realms of sustainability science. The weaknesses appear in the lack of a common vision and a coherent research strategy for the new research era, and the threats that may lurk in variable funding, research capability (without reform) and lack of clear succession planning.

Our main recommendation lies in the necessity of creating an innovation fund. This should be contemplated at the level of the individual institutes in SENSE network. There is already an annual pot of resource (for some institutes) which stems from successful PhD graduation. This could provide seed money for this fund which would be of the order of 250 000 Euros for each institute. Its purpose would be to stimulate new approaches to research, to encourage “risky” but exciting and potentially remunerative research, and to invest in fresh forms of supervision, work experience, apprenticeships, and mentoring. It would be handled by a mix of faculty and PhD students so the latter have buy-in to the future of their research. The fund could be fuelled in part by the fruits of successful research in the form of intellectual property rights, patents and consultancy money. It would also be available to fund a successful PhD student towards the end of their PhD career in the form of continuation support where the student is clearly productive, innovative and potentially lucrative.

f. Recommendations / suggestions on improvement

- This is an excellent overall network with high performing faculty and PhD students. It has a very commendable international and national reputation. Collectively (but with important

variations revealed in the individual evaluation reports) the Sense network succeeds in its performance measures for the review period, and it more than succeeds in its outreach and community involvement. Yet this network may no longer be so inclusive today. We feel there is a case for the SENSE network to review its membership and the scope for adding to its research portfolio.

- The Review Committee believes that the SENSE Research School performs exceedingly well in providing research preparation for all PhD candidates. The provision for PhD education and training are extremely well managed for the development and improvement of the personal and research skills of all PhD candidates. We strongly support the continuation of the full PhD programme over the next period and encourage even further the effective participation of all PhD students throughout SENSE institutes.
- At the network level and for some of the participating institutes there is a need to re-evaluate the social sciences, policy supporting and creative elements of the overall research programme. This is especially the case given the research attention which is now required for improving the effectiveness of policy making institutions in the fields of sustainability science. This covers both the operating relationships and cultures of such institutions as well as mindsets and accountability. One very important element is to devise measures for assessing the “brittleness” of policy making and delivering organisations in all sectors and at all scales and all across the world. Malleability and adaptability and accountability may have to be created in bodies which do not normally address such matters. In addition the social sciences and humanities can be used effectively to assess the conditions for influencing consumption and voting behaviour of citizens and communities as well as examining the frameworks for considering both the current and future distributional wellbeing across the human family and its progeny. All of these matters are highly important for the successful pursuit of environmental and sustainability science.
- Dealing with future impacts of current social behaviour and policy making with regard to both the social justice and the wellbeing of future generations requires more involvement and integration with the humanities and the creative arts, notably storytelling, art, dance and video presentations. We emphasise a more cooperative approach here: we do not expect all scientists to become artists or novelists! Such practices also offer exciting ways of assessing social justice and uncertain probabilities of the “what ifs” of effects on future generations.
- The PhD student should be enabled to provide more support for the whole research effort and be recognised in the overall performance review. There is a need for a fuller “account” of students’ roles and activities including mentoring, organising seminars and discussion groups working outside campus in business or government generally or civil society, and in supporting supervisions and parallel or sequential research with others. In general the PhD student should be an integral part of decision making over research vision, management, strategy and collective evaluation. This may lead to a reassessment of the “four paper” requirement code for PhD success, but we regard this as a matter for our colleagues to consider.
- There should be provision for an innovation fund of some magnitude. This should be made available on an institute level. This fund would not be tied to any given research element, let alone an individual research student of faculty. This would be a corporate fund run by a corporate research trust consisting of faculty and PhD students cooperating in concert. It would be funded by a combination of the “PhD student success” money, by

the receipts from patents and intellectual property rights, but outreach programmes, by research based consultancies, and by stakeholders (including charitable foundations). Its role and purpose could include:

- Supporting innovative research especially of a truly transdisciplinary nature
 - Various forms of work experience and ambassadorships by research students and faculty
 - New approaches to methodological training and to informal research group training
 - Improved outreach to local communities, to schools and to stakeholders
 - A wider communications and publications effort.
- We regard the introduction of an innovation fund as vital for the future viability of a highly successful research programme. It is also central to the future significance of the SENSE network overall. It should be designed to capitalise of the strengths and opportunities which we have identified above, and to overcome the weaknesses and threats which perpetually lurk in the shadows of the luminosities of any much praised research effort.
 - Finally we request that the SENSE Board consider carefully the criteria for future evaluation at all levels of engagement from individual research groups through the institute settings to the network as a whole. There is a need to reset the guidelines for some of the existing research groups and institutes to take into account their very different research and graduate training practices. But more importantly is that, if our recommendations offered above are to be accepted and acted upon, then there will have to be a significant shift in style and in judgement in the whole evaluation process. For example we found that some of the research groups and their institutional settings enjoyed a culture of research “styles” which were both distinctive and highly welcomed by all concerned. We feel that this important variability in research style should be encouraged.

CML – Institute of Environmental Sciences, Leiden University

a. Mission, vision and policy

CML currently comprises two groups – Industrial Ecology (IE) and Conservation Biology (CB) – with very different histories, research cultures and areas of interest and expertise. This is reflected in the assessments of the two groups, and in some of the comments made here. IE is a cohesive group with a long history and stable non-professorial staff, while CB has been formed more recently from the combination of two different groups and currently includes a number of part-time and retiring staff. It is clear to the review panel that, after a period of existential and administrative uncertainty, the position of CML in the University has now stabilised. This represents an opportunity to strengthen the whole institute, and it is to be hoped that the University will support CML in this, but it also brings some serious challenges, starting with finding a common mission and vision and identifying some common research areas. The review group recognises and supports the will of the two groups to find a common future built around a symbiotic research agenda. For CB, there is a strong motivation to remain separate from life sciences, mainly because life sciences at Leiden is moving towards concentration on human health, an area in which they do not see themselves contributing.

A full professor has recently been appointed as the head of CML; his background is industrial ecology and a further senior appointment is to be made in the biological area. Once the appointment is made, it will be important for the CB group to define and articulate its research identity, and to identify how it can relate synergistically with IE. Given the profiles and status of the two groups (see section 2), it is clear that the strategic question to be addressed is “how to develop the bioscience research area to achieve symbiosis with IE” rather than “how to align IE with CB”. It may be that, once this has been worked out, a name other than the historical title “Conservation Biology” will be considered more appropriate for the biosciences group.

For the IE group, a joint activity is planned with groups at Delft and Erasmus Universities: the Leiden-Delft-Erasmus Centre for Sustainability, LDE-CfS. This clearly could bring considerable benefits for IE, opening up possible synergies with the more technological focus of Delft and the social and economic approach of the business school at Erasmus. Capitalising on this opportunity represents another major managerial challenge. It is to be noted that neither of the other groups (i.e. at Delft and Erasmus) is involved in SENSE; quite how this will affect the involvement of CML and LDE-CfS in SENSE is another matter to be worked out.

It is not clear how the CB group might participate in and benefit from LDE-CfS, nor even whether this would be the most appropriate trajectory for CB. Some possible directions were suggested by the staff in CB but the review group found none of them really convincing; this is another strategic matter to be addressed once the new appointment is made to CB.

b. Research quality

Research in CML has been awarded a grade of 5 for IE and 3.5 for CB. The group assessing the CML institute endorses this classification – the research in IE is universally seen as world-leading and focussed while that in CB is seen as valuable but lacking in coherence and much of it is not widely cited. This is important, for reasons adumbrated above: it means that research in the biological area needs to be refocused and the possibility of alignment with the successful research in IE needs to be explored, rather than redefining IE. Some of the research cited by the CB group refers to activities which are being wound down as a result of staff changes; this provides an opportunity for a major re-think of the research agenda. The review group notes that ecotoxicology research in CB is strong and should be considered an important part of the group's future work.

The research facilities are good. This is particularly important for CB, because IE does not require laboratory facilities. In part due to sharing of resources with other groups (see below), the ecotoxicology research is particularly well equipped.

The two groups receive roughly the same proportion of their funding from the university and from external research funders. However, the basis for the university funding appears to differ between the groups: IE earn more of their university funding from masters teaching while the funding to CB is more strongly associated with PhD graduations. A clearer understanding of the relationship between activities and income will be needed to inform strategic planning. Now that the institute has a clearer and stable position within the university, it should be possible to stabilise the population of PhD students with a better balance between the two groups (see section 4). Serious consideration should be given to employing post-doctoral researchers (see section 5).

c. Societal relevance

The institute works on important questions, relevant to some of the most critical problems facing humanity. Some of its work has been taken up in policy and practice, for example by the UN Environment Programme (IE) and in regulation of pesticides and agrochemicals (CB). However, particularly in the case of the IE group, the research at CML has been largely methodological so that the application of the research has been carried out by other groups. As a result, the institute does not have the high profile in society at large which it deserves. To rectify this, the institute needs a planned programme of engagement in public debate, for example by producing and publicising a series of papers on issues of current concern.

The institute should also explore working with commercial/industrial bodies, not just as sources of funding but with a view to establishing mutually beneficial long-term relationships.

d. PhD policy

This is another area in which the two groups in CML currently differ completely; CB has a relatively high population of PhD students (although the numbers include “sandwich” students and students on field work so that the community of students actually at the university is smaller than the total numbers would suggest) while there are fewer students at IE and their number is only slowly increasing. Plans within the institute are appropriately to achieve a better balance, with a significant increase in the number of students in IE.

PhD supervision arrangements and access to research facilities appear to be good in both groups. For CB, there is productive pooling of facilities with other groups at Leiden and with RIVM. Personal development modules (e.g. writing and ethics) are required and provided by the graduate school at Leiden; they are taken by all students in CML in preference to modules provided by SENSE, and are considered to be good. The graduate faculty at Leiden requires fewer general courses than SENSE; a few students have taken SENSE courses to obtain a SENSE diploma but this is not seen as particularly valuable or prestigious. Apart from the faculty courses, students from the two groups do not share modules.

The students themselves design social activities to involve students across the whole institute, including a weekend exercise on writing papers. They are evidently enthusiastic about doing this, but the review group was unable to detect any sense of community in scientific matters. From our meetings, we have to conclude that the students see themselves as two scientifically distinct groups. This represents another challenge to be addressed in future developments.

Several of the students who met the review panel have been involved in international exchanges, for example under a Marie Curie scheme. They spoke very positively about this experience, which has led to real collaborations and some jointly-authored publications. SENSE activities are clearly regarded as less beneficial and lower priority.

e. SWOT

CML has a good reputation and a strong base from which to develop. The future of the institute depends to a large extent on how the two constituent groups can be integrated and how the biosciences research can be articulated with IE and the joint LDE-CfS centre with Delft and Erasmus; this strategic planning must be a high priority. If the changes can be managed effectively and creatively, the institute should continue to be successful with international recognition.

However, the role of the CB group in the institute depends on the expertise and interests of the person appointed to lead the group; therefore this appointment must be made as soon as possible. Various possible research areas might be suggested as routes to integration but the review panel refrains from making specific proposals because it must be for the staff in CML to determine the Institute's future trajectory.

Once these important strategic questions are resolved, the staff of a redefined and reinvigorated CML need to articulate what their joint role and aspirations are. This will be essential if the group is to continue to attract external research funding and good doctoral students.

The review group recommends strongly that the institute should plan to employ post-doctoral research fellows. This stratum, normally considered important for the functioning of a research group and for development of new ideas, is almost completely missing at present. There is also an argument that, by not employing research fellows, the institute is not making its full contribution to the development of human capital in the research community in the Netherlands. It is understood that there are currently perceived to be administrative barriers to the employment of such staff, and that these barriers are not limited to Leiden. However, we consider this need to be so clear and potentially limiting, with implications for the whole University sector in the Netherlands, that all possible efforts should be made to remove the barriers, at institute, faculty and university levels. We recommend that SENSE as a whole

should develop a strategy to help research institutes and groups which are not focussed on conventional single-discipline science to flourish in a climate of hybrid funding.

f. Recommendations / suggestions on improvement

CML is starting to emerge from a period of uncertainty; the institute faces major issues of change management but has the potential to emerge with new vigour and should be supported in making the developments needed.

The review panel notes the following strategic challenges in particular:

- Appoint a new full professor in the biological science area;
- Develop a more concrete vision and strategy for the new LDE-CfS centre;
- Define the future direction for the biological sciences research and define its role in LDE-CfS;
- Articulate a clear strategic vision for CML and publicise it to funding bodies and potential research students;
- Remove (or at least lower) barriers to employment of post-doctoral research fellows; this may require developing a strategy for the whole of SENSE;
- Develop a strategy for increased engagement in public debate.

Programme 1:	Conservation Biology	
Programme leaders:	Prof. H. de Iongh (since 01-09-2012); Prof. G. de Snoo (until 01-09-2012)	
Research input 2013:	tenured staff:	1.9 fte
	total staff:	4.5 fte
Assessment scores:	Scientific quality	3.5
	Productivity	4.5
	Societal impact	4
	Viability	3.5

Scientific quality

The Conservation Biology group produces original research in a number of diverse fields that seem to have limited coherence between them. Some of their papers are well cited, comparable to the average of the other SENSE groups, but the score for quality represents an average over the whole output. The citation rate has increased in 2012 but it remains to be seen if this will be sustained; if the group concentrates on topics where it has a leading position, the citation rate and quality score could increase. Evidence for academic leadership is variable among staff members: some have a proven international academic reputation, others much less so, and overall citation profiles are not very strong ($h < 10$ for several senior staff members). As a group there is a lack of a coherent identity and research strategy, which hampers international visibility. At this moment CB cannot be regarded as being a world-leader in its field. The number and completion rate of PhD students are high. There is a clear vision and strategy for supervising students. A point of attention is that many PhD's are awarded to students with "sandwich" scholarships who spend limited time in Leiden and therefore have limited interactions with other students and staff. The community of PhD students actually present at the University is therefore smaller than the numbers would at first suggest. Another point of attention is the absence of postdoctoral researchers who could play an important role both in expanding the research and in creating an optimal training environment for the PhD students.

Productivity

The output of refereed papers – around 40 per year – is very good but not exceptional with considerable variation between different staff members. The output per staff is difficult to evaluate because the many part-time and mixed affiliations and multiple authorships, as well as recent changes in the group, make it difficult to relate the output to the number of FTE staff in the group; the score of 4.5 is uncertain and possibly generous. The group has a good but not excellent earning capacity (ca 50% of their income) resulting from NWO, EU (Marie curie, FP7), contract research, and individual scholarships. Earning capacity is particularly strong for the ecotoxicology line (M. Vijver). The number of PhDs awarded is high and has increased in recent years. This appears to have been a significant source of the group's direct funding.

Societal impact

The research addresses important questions and has a clear societal relevance. The group has strong and diverse relationships with stakeholders at the national and international level (e.g. pesticide atlas, link with RIVM, representation in IUCN and other committees). The research has clearly achieved public notice through different media channels. Recruitment of non-OECD members with sandwich scholarships is a cost-effective method of contributing to capacity building in less developed countries. Societal impact could probably be strengthened by stronger focusing so that the research is spread over a less diverse range of topics.

Vitality and feasibility (Viability)

The group has a consistent track record in publication output, funding and recruitment of PhD students. Since the previous evaluation the embedding within the Faculty of Sciences has been made secure and the core funding has increased again. The technical collaboration with the Cell Observatory is a strong asset and collaboration with Naturalis could open up new possibilities, although the nature and significance of this collaboration was not clear to the panel and needs to be articulated. However the group is clearly in a transition phase and lacks leadership at the moment: several senior scientists are close to retirement or have taken up managerial roles. This will in particular affect the research line on human-wildlife interactions and sustainable land use in the tropics; this research area must be reviewed once the new senior appointment, of a full professor, is made. The subgroup led by Vijver and Peijnenberg, focusing on ecotoxicology, is clearly growing and dynamic. The contribution of a recently hired assistant professor (Matthijs Vos) was less clear to the review group.

The panel considers the research mission of the group, as set out in the SER, to be too broad and overambitious, involving multiple stressors (pollution, climate change, invasive species, agricultural practices, human-wildlife conflict...), a broad range of ecosystems and organisms, and a diversity of approaches from population and community ecology to ecotoxicity modelling and socio-economic evaluation. This huge diversity hampers interactions within the group on one hand and limits visibility to the outside world on the other hand. The group has an obvious problem in defining its own research identity and selling its strengths to the outside world. An important task for the new professor will be to provide more focus and strengthen the synergies among the staff members and projects.

An additional challenge at the institute level is the weak scientific interaction with the Industrial Ecology group. At present the two groups within CML interact well at structural and social levels but not scientifically. While the CML-IE group will clearly benefit from the collaboration with Erasmus and Delft (LDE-Cfs), the panel did not get a clear answer on how the CML-CB group could benefit from this structure. This represents another urgent task for the new professor, working with the relatively new head of CML.

Recommendations

- The panel recommends that when the new full professor is appointed, he/she takes the lead in redefining the group's research profile and research identity, building on the strengths of the current staff. The new profile should make clear what makes the group unique compared with other research groups in the field. The group may also want to

reconsider whether “Conservation Biology” is the most appropriate name for this research group.

- The group is encouraged to seek more synergies with the CML-IE group, and more broadly within the LDE-Cfs network as well.
- The group would benefit from employing post-doctoral research fellows, and should at least attempt to remove or circumvent the barriers to employing such researchers.
- The group should continue to seek external funding where there is still scope for improvement, and become less dependent on core funding from the University.
- Integration of PhD students with sandwich scholarships requires continuing attention.

Programme 2:	Industrial Ecology	
Programme leaders:	Dr G. Huppes (until 18-6-2011); Dr E. van der Voet (from 18-6-2011 to 1-10-2013); Prof. dr. A. Tukker (since 1-10-2013)	
Research input 2013:	tenured staff:	3.7 fte
	total staff:	11.3 fte
Assessment scores:	Scientific quality	5
	Productivity	4.5
	Societal impact	4
	Viability	4

Introduction

The following assessment recognises that this group has had a “difficult” recent history. It has been kept in existence for several years, outside the usual university structure, by a small but cohesive group of staff who do not have full professorial status. The status of the group is now more stable: after a period of reduced direct University funding, CML became a regular Institute in the Faculty of Science in 2014, with restored direct funding and, in 2013, appointment of a full professor in industrial ecology. Research performance over the years 2007-2013 must be seen against this background. Some scores are lower than those awarded in 2007 because of the group’s specific circumstances. It is to be hoped that the University will recognise that the group is pulling itself out from a problematic period and will continue to support it.

Scientific quality

CML-IE have concentrated on producing high-quality publications, rather than a high volume of more routine publications. Quality of research and leadership are demonstrated by the consistently high citation scores of papers (amongst the highest in SENSE) and participation in international research projects, organisations and committees. The strategy has probably resulted in part from the relatively low number of PhD students but, whatever the reason, the review panel commends the group for it. Their focus has been on methodological development in the tools of industrial ecology (IE) - particularly life cycle sustainability assessment, material flow accounting and environmentally-extended input/output analysis - and there is no doubt that their research has been central in the global development of these tools.

Productivity

The output of refereed papers – around 14 per year – is good but not exceptional. Output of PhD graduates has been relatively low, at least in part because of the uncertain relationship of CML-IE relative to the Faculty and University. The group should define its preferred size (allowing for the two tenured positions currently available to be filled) including its ideal steady-state PhD population, allowing for the resultant level of direct university funding.

Societal impact

The research of this group is resolutely multidisciplinary, within the emerging field or grouping of disciplines known as industrial ecology; it addresses some of the most critical and difficult issues confronting society. Its output has been taken up by super-national bodies, most notably the UNEP resource programme. It has also been influential amongst academics and practitioners who have applied their methodologies in work for national and local bodies and commercial organisations, but CML-IE have done little work themselves in this arena – the application of their research is to a large extent due to other groups. As a result, the work of CML-IE is less well known than it could be. More effort should be devoted to activities which will expand the group's range of public recognition and external contacts, including NGOs and commercial organisations, to bring its work to the attention of a larger range of bodies and individuals.

Vitality and feasibility (Viability)

This group is currently involved in developing a joint venture with groups at Delft and Erasmus (Rotterdam) universities. The proposed strategy is appropriate; this combination has the potential for beneficial synergies, not just by ensuring that the group is clearly above critical mass but also by bringing in the more technological focus of Delft and the social science expertise (including economics) at Erasmus. The LDE development and the recent appointment of the group's first full professor suggest that the potential is good, but realising the potential requires considerable effort and it is not clear how the development of the group will work out. The grade of 4 reflects this status and the recommendation that, after the past difficulties, IE needs a period of stability to realise its potential. It is noted that the groups at Delft and Erasmus are not members of SENSE; it therefore remains to explore how to ensure that the joint activity will be compatible with continued involvement in SENSE.

The group has few (if any!) post-doctoral research fellows; this comment applies to the whole of CML, i.e. both IE and the companion group Conservation Biology. The lack of a whole stratum in the composition of the group means both that their scope for expanding their range of research is constrained and that they are not meeting what should be one of their roles in developing the academic community in the Netherlands and more widely. The review panel was told that there are structural barriers to employing post-doctoral fellows, but these seem to be to some extent self-imposed by Leiden University.

Recommendations

- The proposed joint activity with Delft and Erasmus has the potential to bring benefits to all three parties and is therefore to be pursued positively, with the group's engagement with SENSE as a less significant issue. However, this will require CML-IE to define their role more clearly, both with respect to the LDE centre and relative to the group within CML-IE which is currently termed "Conservation Biology" (see parallel assessments). It may also require a reconsideration of the relationship with SENSE.
- The group should develop a strategy to become more visible in national and more local bodies, in addition to bodies like UNEP. As part of this, a recommended approach is to develop a series of "Working Papers" on current and topical issues, directed at a different readership from refereed publications, and to use this as the basis for more exposure in

popular media. Strategic partnerships with commercial organisations should also be part of this strategy.

- The group seems to be very dependent on the EU for funding; they should develop a strategy to broaden the funding base.
- The group would benefit from employing post-doctoral research fellows, and should at least attempt to remove or circumvent the barriers to employing such researchers.

**ITC - Faculty of Geo-Information Science and Earth Observation,
University of Twente**

1. Mission, vision and policy

ITC is in the midst of a decade-long reorientation away from its original mission as an independent educational institute, training students from developing countries in remote sensing and GIS, to a world-class, research-oriented university faculty, focused on leveraging remote sensing and GIS in the environmental sciences and related areas. Some aspects of ITC have proven easier to change than others, and it is easy to see the influence of the earlier mission in the ITC of today. ITC continues to attract large numbers of students from developing countries, where its reputation is unchallenged, and it continues to benefit from a staff that was originally selected for its expertise in training for all aspects and applications of remote sensing and GIS.

In addition to its relatively new responsibilities as a university faculty, ITC is also required to adhere to policy directives from the Dutch government. These now require ITC to focus on certain areas of the Global South, notably Asia and Africa; and to emphasize applications in areas of societal concern. Availability of funding also has its impacts, and ITC has weathered, with some success, a reduction in excess of 20% in its core funding over the past three years. In addition, a further 10% reduction is possible in only two years time. Funding is perceived as more readily available for applied research in these areas of societal concern, than for fundamental research in remote sensing and GIS. As a result, the research groups have been more successful at attracting funding through contract research and support for PhD students, than from international funders such as ERC and from the basic-research programs of NWO.

In reviewing each of the six research groups, we consistently probed for statements of vision that could provide each member of that group with strategic direction. In every case we found a lack of such a vision, and instead a sense of opportunism. In the current funding climate every group felt compelled to pursue nearly every funding opportunity, and to make hiring decisions based on maximizing these opportunities, for example by staffing in new areas of research that appeared to be well funded. In many cases the group's sense of its own domain seemed impossibly broad, with little strategic sense of long-term direction. We found ourselves first, noting the urgent need for a clear and credible vision of where each group wanted to be in say five years time and second, making the same practical recommendations: to identify an area of research lying within the current domain of the group, that would allow the group to focus its activities and build a world-class reputation in that area. This will be challenging, as some groups were still trying to achieve stability and direction following the mergers that resulted from the previous review in 2010.

We were disappointed to find that ITC as a whole does not have a shared and credible vision of where it wishes to be in the future and as a result, no plan to get there. However, we were reassured to find that the Dean is developing a vision and ITC does have a view of both what it is doing now (its mission) and its overall intellectual structure. It sees its mission as "Space for global development", a succinct linkage between its geospatial methods (remote sensing and GIS) and its application domains. Its departmental structure has appealing simplicity: two methods-oriented groups (EOS and GIP) underpinning four application-oriented groups: WRS ("water space"), NRS ("green space"), PGM ("urban space"), and ESA ("geo space").

“Jointly, these spatial domains cover the most relevant societal domains of GIS and Earth observation in developing countries”.

In this new environment it is almost inevitable that groups will overlap in interests, driven by the desire to pursue every feasible source of funding. The two methods groups will seek application domains where funding can support their core interests, and the four application-domain groups will seek to leverage the strong expertise in methods that each has to varying degree. We heard repeatedly that, in this competitive environment, the collaboration between groups is not as strong as it might be, and that collaboration outside ITC can give proposals an edge with funding agencies that collaboration within ITC does not. Requiring each group to develop its own distinctive vision will help in several ways. It will emphasize complementarity of expertise within ITC, encourage groups to augment their own expertise, not by adding staff but by seeking collaboration, and allow each group to emerge as world-class experts in well-defined but manageable areas of strength.

Several research group specialities are undoubtedly at the cutting edge. Interest is being pursued in new methods of data acquisition: crowdsourcing, UAVs, and LiDAR. The PGM group is pursuing novel approaches to land registration. More important, perhaps, is the opportunity to find applications of high societal impact in the developing countries that have always been important to ITC and where ITC has a unique advantage.

Importantly, we are not recommending that these research groups be reorganized but would anticipate that they would evolve to meet the needs of an ITC vision and subsequent strategic plan.

We were impressed by the dedication, tactical abilities and quality of the ITC leadership. They have achieved much since the merger with the University of Twente in 2010, not least, as we were informed, ‘survival’. There is now an opportunity to step back and think where ITC could credibly be a few years from now and then plan how best to get there. However, in a week of reviews that first focused on the six research groups and then on ITC as a whole it was difficult for us to see how bottom-up and top-down were balanced in decision-making and direction-setting. Our recommendation for the development of strategic vision is intended to clarify and facilitate leadership in both senses: leadership from ITC management to motivate and direct, and leadership from each group to ensure that the six vision statements and their emerging strategic plans all have the full support of the entire research staff.

In summary, ITC has made great strides, and is to be congratulated on weathering well the various storms that it has had to confront in the review period. It is very much a work in progress, given the difficulties of achieving such a major reorientation in the space of only a few years. The next few years present significant challenges: first, to develop a culture of strategic planning; second, to continue the ongoing reorientation of ITC; third, to build stronger collaborations within ITC, with the University of Twente; and fourth, to weather whatever further budget cutting is required. At the same time there are many exciting opportunities: to champion the ‘spatial dimension’, to make the most of the University of Twente environment, to continue to play a major role in the nation’s foreign-aid efforts, to take advantage of continuous technical innovation, and to aid in the solution of humanity’s pressing societal problems.

2. Research quality

ITC is known around the world for its training programs and for the research of several of its internationally prominent staff. Indeed, it is unusual to attend any remote sensing or GIS conference in the developing world without encountering at least one member of ITC staff and several ITC *alumni*. This reputation has been built over many decades, and represents a very substantial asset. On the other hand ITC is much less well known in the Netherlands, and its relationship to its new parent institution, the University of Twente, is still, after only four years, a work in progress. Other organizations within the Netherlands challenge ITC for leadership in the remote sensing and GIS fields, and may well be better known nationally and within Europe. Of these, Geodan is perhaps the best known, though unlike ITC it is largely invisible outside Europe.

The publication rates of ITC are generally very satisfactory. In our recommendations for individual groups we frequently suggested a strategy of moving where feasible, the *balance* of publishing to the domain science journals and away from the remote sensing and GIS journals, on the grounds that the former tend to have higher impact factors and to be more widely read. But overall we have little concern for the quality of ITC research as reflected in bibliometrics.

Research infrastructure appears to be excellent in certain areas, including spectroscopy, soil chemistry, and related areas. Of more general concern, however, is the state of the IT infrastructure. Great strides have been made internationally in recent years in advancing IT infrastructure as it relates to the distribution and sharing of large geospatial databases. Esri is investing in real-time access to imagery from platforms as convenient as the smartphone, while GEOSS has developed very effective methods for archiving and dissemination, and the US Geospatial One-Stop is able to harvest metadata robotically from distributed servers. Yet ITC appears to be falling behind these developments. As a leading center for remote sensing and GIS one would expect a substantial investment in data science: in curation, interoperability, metadata, provenance, visualization, mining, and all of the other concerns of the rapidly emerging world of 'Big Data'. Instead, ITC's current technology in data management reminded us of the 1990s (e.g., the Alexandria Digital Library of 1993), with its emphasis on acquired and locally stored data, and access via the sensor rather than geographically. We asked several groups how the observational data they acquired was managed, and were told that every researcher essentially managed his or her data; a very unsatisfactory approach given the growing importance of data, and data science, in world-class research. More broadly, we missed the kind of strategic planning that is necessary today in the rapidly evolving world of IT, and essential for any group that wishes to hold onto an international reputation. It would be good if such strategic planning could be made in the context of the pending move to the University of Twente campus, and could take advantage of the logistical, financial, and economy-of-scale opportunities such a move offers. Finally, the actual inaccessibility of ITC's data to outside users seemed at odds with its expressed "open data" policy.

3. Societal relevance

ITC has an excellent record of relevance in its traditional role of training students from the developing world in remote sensing and GIS. Countless projects in the developing world owe their success and impact at least in part to ITC. Its ILWIS package, now distributed through 52 North, is an excellent asset that could be doing more to promote the ITC brand internationally. ITC has branched out into the four application domains represented by four of

the six research groups, and built a record of strong, socially relevant research in each area.

ITC is hampered however, in achieving the same societal relevance in the developed world, and in the Netherlands. It is unable to recruit Dutch students into its PhD program, though we understand efforts are under way to change this regulation. ITC's relevance could be enhanced by a program of development of strategic partnerships with highly regarded centers, both nationally and internationally, and by exploiting the new intellectual opportunities offered by merger into the University of Twente. The social sciences, for example, are often the key to increasing the societal relevance of projects in the environmental sciences, but are an area where ITC is weak. However, there are new opportunities on the main campus of the university, where ITC will be moving in a few years. It would be helpful to conduct a strategic search at both the University of Twente (e.g., within the Academy of Technology, Liberal Arts and Sciences) and other centers in the Netherlands and more broadly in Europe, in order to identify suitable groups and departments, rather than leaving such networking to individuals.

4. PhD policy

ITC has a large and impressive community of graduate students. We were very impressed with our interactions with them, and with the posters and presentations they had prepared. ITC students have a long tradition of rich cultural interaction, and benefit enormously from the maturity and diversity of the group. On the other hand we heard some frustration that they are generally not able to experience and learn about the Dutch culture, in part because of the lack of Dutch students.

We sensed that the PhD students could take a larger role in organizing intellectual activities. A student-organized conference can often be very rewarding, giving students an opportunity for peer-to-peer interaction that is often difficult in a structured program. Students might enjoy organizing sessions of 'lightning talks', or organizing seminars on topics of interest. SENSE offers many services to assist PhD students, including a Web service to identify requirements and monitor progress, and the A1 course. We understand that all ITC students take the A1 course, but sometimes and for various reasons not early enough in their programs. We also heard some variation in the degree to which students feel part of SENSE, and take advantage of what it has to offer.

In our meetings with students several concerns were expressed about the student-support services offered by ITC, including issues over IT and in particular, housing. In a short visit we were not able to probe deeply, or to determine whether consensus exists on any of these issues. While we noted a general sense of student satisfaction, in our view it would be desirable if ITC's strategies and policies with respect to student life, and its mechanisms for listening, monitoring, and responding to student views were reviewed.

It has always been difficult to establish uniform standards of quality for the PhD, given its advanced nature. Peer review through the appointment of external examiners is far from foolproof, but has perhaps been the most important instrument for maintaining uniform minimum standards. Recently, however, there has been a tendency to emphasize published papers, and to see the PhD as a collection of some specified number of papers. Peer review is involved, of course, because publication is in refereed journals. At the same time placing the emphasis on a count of published papers has its own dangers, in encouraging unduly early publication and a culture of "least publishable unit". Moreover, we heard wide variation across SENSE in the number of papers required by a supervisor (promoter), before thesis

submission was possible, and also in whether a standard minimum count existed. Quoted counts from ITC alone ranged from zero, to three in press, to seven published. (It is impossible also to ignore the effect that such policies have on “reviewer burnout”, since publishing seven papers must involve at least 21 invited reviewers!). We do not have a position to recommend. However, a large proportion of ITC graduate students fail to submit within five years of study (average is over five years). This would suggest that ITC work with the University of Twente (who award the degree) to clarify its policy on the minimum level of peer review required for thesis submission approval by a supervisor.

5. SWOT

In its own SWOT analysis ITC proposed several strategies to address perceived weaknesses and threats, and to build on strengths and opportunities. The following comments refer directly to the analysis, on p10 of ITC’s self-assessment.

Weakness: limited experience with entrepreneurial activities, and the current trend towards more collaboration with private partners.

ITC is ideally situated for collaboration with the private sector, especially in developing countries. Given the University of Twente’s acknowledged strength in enterprise activities we strongly endorse its proposed strategy: “Start our own research-based start-up companies (both in the Netherlands and in target countries)”. ITC currently is a partner in 52 North, but could do more to build partnerships with existing remote sensing and GIS companies in the Netherlands and Europe more widely. We were told that the adopted strategy of “open-source, open data” precluded benefiting financially from ITC’s research through patents, royalties, etc., which seemed to us a rather narrow interpretation.

Threat: base funding insecurity and Dutch political developments.

Weakness: gaps in expertise (e.g., engineering and health) and ineffective communication of policy-relevant outcomes.

Threat: development policy is too much focused on Ploumen themes, and GEO-ICT is considered ICT only.

As suggested earlier, we believe that vision-led strategic planning and the focusing of research group interests will help to raise the visibility of ITC, and encourage collaboration with complementary groups elsewhere. Collaboration of this kind seems to us the best strategy for dealing with base-funding insecurity. By way of contrast, the filling of gaps in expertise within ITC is likely to be an expensive and ultimately ineffective approach.

We were not able during our short visit to probe the strength and effectiveness of ITC’s arrangements for public communication. Just as an organization of this nature requires an IT strategy that provides up-to-date infrastructure, similarly it is necessary to work strategically to enhance the organization’s communication and public-affairs capabilities. An important element of this will be the careful positioning of the ITC brand (international focus, world-wide reputation, narrow in scope) in relation to that of the University of Twente (national focus, strong reputation in the Netherlands, broadly based) for the benefit of both. However, we did explore the visibility of ITC publications within the academic community and more widely. We were informed that for many years the research group name and then the ITC name appeared after the author’s name on a research publication. Currently, however, we were informed that the research group, ITC in brackets, and then the University of Twente appear after the author’s name. Given that research publication is probably the most powerful mechanism at ITC’s disposal for raising its national and international profile it is suggested that thought be given to placing only ITC and the University of Twente after the author’s name, omitting the research group.

We did wonder to what extent ITC and its spatial expertise were understood in the University of Twente and more widely. The notion that “GEO-ICT” is just ICT is of course naïve, but very appealing to those needing to cut costs and to funding agencies. To fight it requires a constant commitment, and the ability to marshal convincing arguments. Efforts to build support for “spatial thinking” and “geographic information science” stem from exactly this problem, and have been under way now for two decades. Following the example of Harvard or UC Santa Barbara, one might convene a committee of senior academics from across the University of Twente to explore these issues and identify programs that can illuminate the cross-cutting nature of spatial thinking. It might also be strategic to consider the same kind of activity between institutions, perhaps across the Netherlands or within SENSE.

We were most impressed by the esprit de corps of ITC and the genuine pride shown by staff and students in their organization. This pride is the product of many influences; these include (among others): successful history, strong social mission, international scientific and technical reputation, cultural and social diversity, flat management structure, sense of identity, purpose-built and architecturally interesting building, common social and dining space, close proximity of reasonably priced student accommodation, and an easy working style. We were surprised by two things: first, that this significant strength of ITC was not noted in the documentation and second, that a potential risk to this strength, the imminent relocation to the University of Twente, was also not noted. While it is clear that joining a larger academic community would bring many advantages we would suggest that ITC focus on the cultural/social as well as the physical/financial implications of the move in order to mitigate the risk to this significant but intangible ITC strength.

6. Recommendations / suggestions on improvement

- Develop a strategic plan for ITC around a common and shared vision: to become by, say, 2020 the leading research entity in Europe, in a well-defined area or areas that fall within ITC’s current domain. Define the steps that will be needed to achieve that vision, through recruitment of students and academic staff, development of research infrastructure, and development of links with complementary and similarly ambitious groups.
- Develop vision-led strategic plans for each research group that feed into the development of the strategic plan for ITC as a whole. As recommended in our research group reports there is a need to choose a research focus, within the current domain of each group. This focus should guide future recruitment, help to identify the specific strengths of each group, and provide a basis for complementary collaboration with other groups within ITC and elsewhere.
- In conjunction with (2), conduct systematic reviews of the potential for collaboration with groups within the University of Twente and within other Dutch institutions. Special emphasis should be placed on groups that can provide expertise in social science. Ideally this work needs to be completed prior to the relocation of ITC to the main University of Twente campus.
- Initiate a process of strategic planning of ITC’s IT infrastructure, with a view to (i) identifying generic areas that need to be sector leading and generic areas that could be sector average and (ii) bringing IT to the level expected of a leading center of remote sensing and GIS. Develop a data policy that addresses all aspects of (big) data science, with institution-level management of ITC’s data resources.

- Work with the PhD student body to improve opportunities to discover Dutch culture, perhaps taking advantage of the opportunities offered by the pending move to the main University of Twente campus.
- Encourage the PhD student body to initiate and organize student-led activities that enhance the intellectual and scientific aspects of student life.
- Clarify ITC's policy on the minimum level of publications required for thesis submission, in consultation with the University of Twente and SENSE.
- Initiate a process of strategic planning of ITC's public-affairs and communications activities, with the aim of improving national and international public perception of ITC and in particular, ITC's societal relevance.
- Convene a committee/working group of senior academic staff within the University of Twente to explore the interdisciplinary opportunities of spatial thinking and GIScience.
- Plan carefully the cultural/social alongside the physical/financial implications of the move of ITC to the main University of Twente campus.

Programme 3:	Earth Observation Science	
Programme leaders:	Prof. G. Vosselman; Prof. A. Stein	
Research input 2013:	tenured staff:	2.3 fte
	total staff:	13.9 fte
Assessment scores:	Scientific quality	4.5
	Productivity	5
	Societal impact	4
	Viability	4

Scientific quality

The scientific quality was internationally excellent with some areas world leading. The two Professors in the group are both undertaking research that is at the cutting-edge of their fields. The past few years have seen the impact of this research rise from 'above world average' to 'very good world impact'.

There is potential to publish in higher-impact journals if undertaken in partnership with others – in general, the top journals in the application domains tend to have higher impact than the specialist journals in remote sensing and GIS.

The potential for the future is excellent, given the focus on topical areas such as low cost sensors, 3D terrain simulations, UAV and SLAM.

Productivity

The productivity of the group is world leading and increasingly focused on publications in refereed journals. The majority of these are in the geo-informatics journals and as noted above, there is an opportunity in the future for more joint publishing in higher impact discipline wide journals (e.g. health, planning).

Research income and PhD student numbers are both high and increasing. The international profile of this group is greatly enhanced by journal editorships and the willingness of its members to contribute to issues of global relevance.

The research of this group is relevant to the other five research groups at ITC and the potential for greater within-ITC partnership is substantial.

Societal relevance

The research is applied in several, clearly documented, societally relevant areas with a growing strength in health. The impact of this research, both in terms of the interaction with stakeholders and effect on society, is of international standards of excellence.

Research in developing countries (e.g., Ghana) is a clear strength. Also notable are the group's contributions to practice in laser scanning, specifications for digital elevation models, and 3D data capture.

Issues of data quality are often difficult to present to a broad audience. Much of the research in this area is highly mathematical and thus inaccessible to many communities, despite their evident need for such information. The research might be made more accessible through easy-to-use tools, offered perhaps through the ILWIS platform, plus online tutorials,

examples of best practice, and methods of visualization that might be developed in partnership with the GIP group.

Vitality and feasibility (viability)

The group is small (8 faculty, 2.31FTE), well managed and has the vitality and feasibility one would expect from an internationally excellent group in this field. The group is clearly a stable pillar of ITC, with a carefully managed balance between fundamental research and the more easily funded applied research. They have gained more coherence and focus since the last review and this was welcomed.

The group presented a very clear explanation of where they are *now* (2014). The challenge for the next stage of the group's development is to identify a clear and compelling view of *where they wish to be* by the time of the next review (2021?). This will enable the group to identify clear strategies to get there.

This move from 'good to great' is in the grasp of this group if they choose to focus on a future vision. They could, for example, be Europe's leading centre for research on the quality of geo-information.

Recommendations

- Develop a strategic plan around a common vision: to become within, say, five years the leading research group in Europe, in a well-defined area that falls within the group's current domain. Define the steps that will be needed to achieve that vision, through recruitment of students and academic staff, development of research infrastructure, and development of links with complementary and similarly ambitious groups.
- Develop further the opportunities for within-ITC partnership for the benefit of both ITC and EOS.
- Seek opportunities to publish in higher impact journals in partnership with others.

Programme 4:	Earth Systems Analysis	
Programme leaders:	Prof. F. van der Meer; Prof. V. Jetten	
Research input 2013:	tenured staff:	3.8 fte
	total staff:	22.3 fte
Assessment scores:	Scientific quality	4
	Productivity	4.5
	Societal impact	4.5
	Viability	3.5

Scientific quality

The group resulted from the merger of two groups in 2010, one focused on geothermal energy and the other on natural hazards and is now performing at international levels of excellence. The merger is still clearly a work in progress; as the self-assessment notes, the group is “on its way to integrate these themes”. The self-assessment presented a diagram of this integration, with geothermal energy at the base, ascending through geodynamics and mineral and soil predictions, to urban disaster risk management, rural hazards, and food security, to climate change and extreme weather at the top. This gives the group a very broad domain, and within that domain it has achieved remarkable success in the quantitative metrics of scientific accomplishment: publications, research funding, and growth in the PhD program.

This breadth of interest is eminently suitable to training, but at the same time it acts as an impediment to the establishment of a world-class reputation for research. Instead, the group is known for its individual research contributions, rather than for an outstanding reputation in any one area. Future planning in this environment is difficult, since the lack of a clear vision makes it impossible to strategise or to make decisions on long-term issues such as the recruitment of academic staff. Some areas of interest clearly overlap those of other groups: PGM, for example, is also proposing to hire a specialist in climate change, and has expertise in land management; while food security also shows up in the interests of NRS.

There is potential to publish higher impact journals if undertaken in partnership with others. The environment is a complex system and its problems are consequently complex and difficult, requiring collaboration between many disciplines. No one group can hope to include all of the interests needed to solve even the simplest problems; instead, environmental science is characterized by a rapidly changing network of collaborations between groups, each of which is eminent in its own chosen domain. ITC offers the opportunity for a rich set of collaborations, between groups, with other groups in UT, and internationally. It was good to read in the self-assessment that ESA is “just starting” to exploit the potential of collaboration within UT; the proposed move to the main campus should make this easier than in the past. In its self-assessment the group noted that the “network in the Netherlands is not used to its full potential”, seeing this as a threat. Collaboration with the social sciences is critical, as the human dimensions of the Earth system become more and more important. It is clear that the greatest potential for effective collaboration on social issues lies outside ITC.

In short, the group is producing internationally excellent research in certain domains. Its lack of a clear vision and focus will be an impediment, however, if it is to continue to improve its scientific quality in the future.

Productivity

The productivity of the group ranges from internationally excellent to world leading. The bibliometrics are generally excellent for the group. The rate of PhD graduation is satisfactory relative to the size of the current group, which has remained stable through the review period.

As the group develops one would expect the total number of papers in refereed journals to stabilise or decrease as the number in high impact journals increases.

Societal impact

The research makes a societal contribution that is internationally excellent. In addition there are some areas that make a world leading societal contribution. The group's work is eminently suited to a strong impact, especially in hazards, and to significant impacts in the areas of the Global South that are identified by the Dutch Government as of special interest. At the same time the methods of outreach that are available to a group of this size are limited, so it is important that the group strategize about the best methods given its resources. For example, is the group making the most out of the potential of its *alumni*, who are in many cases in positions of growing influence?

Care will be needed not to build the future of the group on the availability of some excellent PhD students to generate a wide range of geographically based case studies. Such studies can so easily replicate many of the scientific methods without generating the new principles and concepts that will lead to a higher research profile. There would be benefit in linking these studies link to local stakeholders and so deepen their impact.

Vitality and feasibility (viability)

As reviewers we were concerned about long-term viability of the groups ambitious research programme, given the issues identified earlier. Particular concern was expressed about the level of contract grants that resulted in applied, in-place applied work and also the long-term stability of overseas funding via PhD studentships. We think the group will need to work hard on strategic planning in the next few months, if it is to make the most of its potential, both internally within the group, and externally within ITC, UT, and the broader scientific community. The current aspiration, expressed in the self-assessment report, is overly ambitious given current realities and reasonable expectations about the future. Similarly, the senior ITC administration's vision of this group's role, as providing the institutional cover for an important component of "geo-space", is also overly ambitious. Parts of this current aspiration are not sustainable, and other parts need to be complemented by proactively established linkages. Moreover, it is important that these linkages be with groups that have established reputations for high-quality research.

Recommendations

- Develop a strategic plan around a common vision: to become within, say, five years the leading research group in Europe, in a well-defined area that falls within the group's current domain. Define the steps that will be needed to achieve that vision, through

recruitment of students and academic staff, development of research infrastructure, and development of links with complementary and similarly ambitious groups.

- Consider the benefits to ESA and ITC more widely, of a different organisational structure that does not divide what is a world leading strength in remote sensing.
- Seek opportunities to publish in higher impact journals in partnership with others.

Programme 5:	Geo-information Processing	
Programme leaders:	Prof. M-J. Kraak	
Research input 2013:	tenured staff:	2.2 fte
	total staff:	14.1 fte
Assessment scores:	Scientific quality	4.5
	Productivity	4.5
	Societal impact	4
	Viability	4

Scientific quality

The group resulted from the merger of two groups in 2010, a merger which “required re-orientation of research”. Today the group is integrated around a simple model that combines five interests: modelling, analytics, geo-visualization, data organization, and the intriguingly named “cloud and crowd” covering user-generated content and computing in the cloud. The group has an international reputation, approaching a world-leading reputation, in several of its areas, most notably geo-visualization, which it is able to sustain despite its very limited size. However it would be naïve to think that it can achieve or sustain such a reputation in all five areas, so we probed to see if the group had a clear vision of a sustainable future. Moreover, as it perceives itself as under increasing pressure to find funding in application domains, and as competition for the kinds of funding that ERC and NWO directs at fundamental research becomes increasingly intense, it is essential that the group not attempt to add expertise in new areas, but to cultivate a reputation as the “go-to” collaborators in certain well-defined areas. For example, many of the projects for which the group might compete for funding will require expertise in the social sciences, in human-subjects evaluations of geo-visualization techniques. But it makes much more sense to seek this kind of expertise through collaboration rather than by adding it to an already stretched academic staff complement.

The group has identified spatio-temporal analytics as a major focus. There is much world-class research to be done here, especially in the context of geo-visualization and crowdsourcing, and an abundance of fertile areas of application. We were surprised to see “Spatio-temporal domain becomes mainstream which leads to more competition” as a threat. Greater confidence in the group’s own strength would be appropriate, especially if it aspires to continental or global leadership.

There is potential to publish in higher-impact journals if undertaken in partnership with others—generally, the top journals in application domains have higher impact than the specialist journals in remote sensing and GIS.

Besides fundamental research, the group also sees the development of tools as part of its contribution to high-quality scientific activity. The ILWIS GIS, which has been developed at ITC over many years, is now maintained and distributed as an open-source package through the company 52 North, in which ITC is a major collaborator. We wondered how effectively ITC is able to leverage its investment in ILWIS, and noted that the front page of the ILWIS Web site makes no mention of ITC. Given the statistics on ILWIS distribution it seems ITC is missing a major opportunity here to strengthen its reputation in geospatial technology. At the

same time, we were impressed by the team's ability to justify software development as a contribution to science. Similarly, the group feels that it is necessary in today's climate to commit to projects with little scientific content, and acknowledges that this is a potential weakness.

In summary, the group's research is world-leading in certain areas and internationally excellent in much of the remainder, but focus will be needed if the next review is to rate the totality of its research as world-leading and assign the highest possible grade.

Productivity

The productivity of the group ranges from internationally excellent to world leading. The bibliometrics are generally excellent for the group. The rate of PhD graduation is low relative to the size of the current group, but can be explained by the earlier ramping up of student numbers that has yet to work its way through into the graduation rate. Given the nature of the group's work one might have expected a stronger record of patent application, and we were unclear as to whether the group has been responsible for any spin-off companies (a comment that can be made about ITC in general).

Societal impact

The group are achieving internationally excellent levels of impact. Given the group's focus on fundamental research and on tool development it is likely that its impact on society will be indirect rather than direct. However there are several excellent examples of direct impact: the requests for work by the International Court of Justice (mapping border conflicts), World Bank and the UN Cartographic Unit and local governments and ministries (e.g., in Georgia), as well as practical contribution in development of sensor Web standards via the Open Geospatial Consortium, are all examples of direct contribution. ILWIS has had major impact, so it is important that ITC's role in its development be given greater emphasis. The group's model of its "geoinformation production chain" is an excellent basis for applied and domain-specific research, but as noted earlier it is essential that this be achieved through collaboration, rather than through limitless stretching of the group's limited expertise. We heard that many funding sources emphasize collaboration outside ITC, and that collaboration within ITC is less attractive in this context. Nevertheless the group is one of the two that is more defined by methods than by application domains, and this surely makes the group an essential collaborator in many ITC projects. In that sense it was surprising to see "insufficient internal (faculty) cooperation" listed as a threat.

Vitality and feasibility (viability)

The group are very well equipped for the future. We were impressed with the group's achievement in merging two of the 2010 groups into a harmonious and homogeneous whole in the space of four years. Nevertheless, its long-term viability depends on how well it is able to balance the need for external funding, with its associated opportunism and "mission creep", with the need to achieve a world-class reputation for a well-defined line of research.

The group did not have a clear view of where they would like to be in the future and so an evaluation of their route was problematic.

The self-assessment listed “Lack of collaborative publication policy” as a weakness, and we understand that this stems from concerns within the group. But we wonder if it makes sense for a group of this size to be indulging in introspective policy formulation.

Recommendations

- Develop a strategic plan around a common vision: to become within, say, five years the leading research group in Europe, in a well-defined area that falls within the group’s current domain. Define the steps that will be needed to achieve that vision, through recruitment of students and academic staff, development of research infrastructure, and development of links with complementary and similarly ambitious groups.
- Take steps to ensure that ILWIS is strongly associated with the ITC brand, and that ITC reaps appropriate returns for its decades-long investment in this toolset, and for any future investments in tools. When investments are made in tools, ensure that besides supporting scientific research, such developments also contribute to the body of scientific knowledge (for example, by reporting research discoveries on the user experience or on software architecture).
- Seek opportunities to publish in higher-impact journals in partnership with others.

Programme 6: Natural Resources

Programme leader: Prof. A. Skidmore

Research input 2013: tenured staff: 3.9 fte
 total staff: 23.2 fte

Assessment scores: Scientific quality 4
 Productivity 5
 Societal impact 4.5
 Viability 4

Scientific quality

The group produces generally very high quality science of international levels of excellence, indicated by a very good, though slightly declining, world average impact. The *h*-index scores of many individuals in the group are very impressive and increasing (e.g., two over 30). It was noted that the group had produced some highly cited papers during the review period but also that the contribution was very variable across the group's members. There is potential to publish higher impact journals if undertaken in partnership with others, since impact scores of journals in the specialist remote sensing and GIS fields tend to be lower than those in the top journals in applied domains.

The large number of visitors from home and abroad attests to the group's international reputation.

The group had a large and stable number of PhD students, coupled to equally stable research income. A future challenge will be to decide what mix of funding to seek (i.e., exceptionally competitive NWO and ERC funding vs international project funding). The choice will be dependent on the development of a long-term vision of the group.

The group's emphasis is on vegetation and they develop and use a range of remote sensing techniques. It was clear that the group has excellent skills, tools and experience to support this. Because vegetation is in some ways the driver of the entire environmental system, the group is potentially able to tackle an enormous range of projects. In Chapter 1 of the report there is mention of "wildlife and livestock behaviour", "food security through crop production", "forest biomass", "biodiversity", "land cover change and landscape modelling". This kind of breadth makes sense in an environment in which research groups need to pursue funding opportunities as they arise, and also in an institution oriented to training, but it is unlikely to give the group an international reputation as the go-to experts for collaborative ventures. "Sustainable landscape" is another uniting theme of this methodologically strong group that opens funding doors but in the long run may be too broad to be distinctive. This kind of opportunistic breadth also has uncontrollable effects on the workload of academic staff as it encourages a culture of saying "yes" to everything.

Productivity

Productivity across a very wide range of research activities is at a world leading level of excellence. Publication in refereed journals has increased markedly and although the overall

level of funding is not increasing, it remains high. The group benefits from several members who have developed innovative methods in remote sensing and quantitative modelling and an exceptionally productive leader with a world-leading reputation for the quality and relevance of his research.

The majority of the publications are in remote sensing or allied journals and there is an opportunity for more joint publishing in higher-impact discipline-specific or major science journals. The choice between, for example, a *Nature* paper vs an environmentally relevant contribution to sustainable development in a developing country, will be dependent on the long-term vision of the group.

The international profile of this group is greatly enhanced by journal editorships and the willingness of its members to contribute to issues of global relevance.

Societal impact

Remote sensing of vegetation is applied in several, clearly documented, societally relevant areas with a long-term strength in the spatial distribution of biodiversity in general (flora and fauna). The impact of this research, in terms of the interaction with stakeholders and effect on society, is generally of international standards of excellence but with some examples of world-leading excellence.

Research in developing countries, notably in Africa, is a clear strength (e.g., wildlife) and the increasing focus on issues of concern to Europe was noted. The training of large numbers of young scientists from all over the world, and notably developing countries, is a main characteristic of the group and an important part of its societal impact. Like other ITC groups, the tradition of a developing-area focus is increasingly challenged, and effort needs to be made to make the group's work more relevant to the problems of Europe and the Global North.

Vitality and feasibility (viability)

In the long term, we are concerned that such a broad distribution of strengths will not lead to the kind of unique and distinctive reputation that will be needed if the group is to achieve sustainable viability as a world-leading operation and if it is to compete for the most prestigious kinds of research funding. It is unlikely that its size will increase by more than a few positions in the next few years, so its viability will have to be achieved with a small group, something that can only be done if the group shares a common vision of purpose that is built around a well-defined and focused area of strength. As it stands, we feel that the areas of strength recognized by the group – remote sensing of vegetation and landscape sustainability – are too large and diffuse for this to be achieved without even greater levels of collaboration. Moreover the complexity of environmental problems is such that no group, however large, can succeed without strong and overtly strategic collaboration. In this environment, if expertise is needed in some new area, such as social science, it is almost always better to find it through collaboration than by adding more diversity to an already highly diverse group.

Recommendations

- Develop a strategic plan around a common vision: to become within, say, five years the leading research group in Europe, in a well-defined area that falls within the group's current domain. Define the steps that will be needed to achieve that vision, through recruitment of students and academic staff, development of research infrastructure, and development of strong and overtly strategic links with complementary and similarly ambitious groups.
- As part of that strategic plan, identify the steps that need to be taken to transform the traditional focus on developing areas into a truly global focus.
- Seek opportunities to publish in higher-impact journals in partnership with others.

Programme 7: Urban and Regional Planning and Geo-Information Management

Programme leader: Prof. M. van Maarseveen

Research input 2013:	tenured staff:	4.7 fte
	total staff:	40.5 fte

Assessment scores:	Scientific quality	4
	Productivity	4.5
	Societal impact	5
	Viability	4

Scientific quality

Since the establishment of the new and stable leadership, the group has made great strides in defining and advancing their research agenda and complementing the strength in capacity building. The interdisciplinary science mission related to social and geo-information science / technology, with an ambition to incorporate the perspectives and concepts from humanities, is commendable. The group's intention to accomplish this goal through collaborations with scientists from UT and other institutions in The Netherlands and worldwide is realistic, as it would be difficult to provide such a broad and diverse expertise internally.

While not necessarily new as an idea, the interdisciplinarity and the socio-technical approach have not been effectively achieved and mainstreamed in the discipline, and the group is well positioned to fill this gap. This, however, would be difficult to pursue in an environment which praises such endeavours, but to a large extent operates through established disciplines and channels. Under these circumstances, the group is encouraged but also will be challenged to assert their uniqueness and contributions to a broader community of peers. This community could be both disciplinary and cross-disciplinary, and it would be useful if the unit decided who the most relevant peer group would be.

The group has maintained the core staff research capacity (even with some small decrease and turnover) and has significantly increased the number of PhD students and visitors (along with related funding), contributing to overall doubling in FTE available for research. The group is doing well in ensuring the balance between the capacity building mission and increasingly research-oriented activities, but is also stretched with the increasing demands in both areas of operations and given the extensive disciplinary portfolio.

The group is well embedded and successful in obtaining funding nationally and internationally and connecting to institutions at all levels and various scope – north and south – based on complementarity of interests. In addition to SENSE, the graduate programme is part of UT graduate school. The supervision of students, quality control and monitoring has been enhanced in the process of changing funding environment and publishing expectations from PhD students. Staff are recognised with awards and keynote invitations and journal editorship, membership in national, European and global societies and networks.

Productivity

The group has made an excellent increase and diversification of output and impact since 2007. The staff continue to pursue conference papers and publishing of PhD theses, while the publications and reports intended for a general public readership, which are an important outlet to ensure the societal impact, have been maintained with some fluctuation. Social

science output is the key strength; the publications, however, are across the disciplines – as expected from the inter-disciplinary agenda of the group. PGM has achieved this level of productivity by strategically redefining their research program, and employing a new strategy to leverage research support for increased productivity from post-doctoral researchers and Ph.D. students.

The PGM has also made notable progress in generating external funding. Over the review period the research funding has increased by nearly 200% and the funding from contract research has increased by nearly 300%. Overall, the PGM has achieved a high level of productivity and appears to be on a trajectory to continue to improve and stabilise the achievement as measured by the relative impact, with expected additions of new faculty members this year and next.

Societal relevance

The unit's general aim is well established -- contribution to the global development agenda by focusing on urban poor and data poor environments by developing methodologies for improving local collaboration and communication in understanding, problem-solving and decision-making. The group has a strong emphasis on societal issues which guide their engagement in both research and capacity building. The foci which bridge the research and capacity building include: strengthening of land governance in the global south; informing policy on urban development; and promoting stakeholder involvement in urban decision-making. These foci are highly relevant to contemporary issues and challenges, especially in developing countries seeking to achieve sustainability in the context of poverty and rapid urbanization and could be more focused in order to reinforce the methodological element and the group's interest in developing pragmatic socio-technical solutions. The PGM pursues its work in collaborations with national and international partners, including professional organisations (FIG, EADI, NAERUS, UN Habitat, World Bank, UNEP, FAO; Dutch Cadastre) and local agencies and groups (governmental and non-for profit). From the program's self-assessment, it appears that stakeholder involvement is a genuine and routine aspect of their activities, which asserts the group's social relevance. Among the international projects, PGM's involvement in development of ISO 19152 Land Administration Domain Model stands out. PGM uses creative knowledge dissemination methods, including education, media and software tools (in addition to publications for general public / non-academic).

Vitality and feasibility (viability)

The PGM appears to be a vital and healthy department poised for continued productivity and international recognition. Restructuring and adaptation to the new environment (UT) and developing a joint mission has laid the foundations for the unit's success. The group is becoming stable and coherent, has diversified its resource base, and is very active in their engagements (possibly overstretched). There appears to be a recognised tight staffing situation and no support staff. The expected growth in tenured staff with strategic selection of expertise should contribute the needed additional energy and expertise. While the age profile of the faculty includes a majority of senior faculty, the program will benefit from the approval to recruit three additional faculty members.

The unit is well aware of its context and issues, with continued attention to further development and performance. The PGM has a proven ability to attract research funding, through governmental support and contract research funding. The self-evaluation report notes a threat of funding instability. Based on recent advances in research funding and

publications, and an entrepreneurial culture, it appears that the PGM is likely to endure temporary uncertainties in funding, while seeking funding from a diverse pool of sponsors.

Recommendations

This is a diverse but complementary and cohesive group with an ambitious interdisciplinary agenda, viable capture of research funding and high productivity. It is commended and encouraged on its current interdisciplinary path and assertion of its uniqueness and value. Given the already substantial breadth of applications, the group is correct to express the need for selectivity and in fact careful framing of its research foci to ensure continued success with funding, publications, and achieving a clear overarching mission. The new hires should be selected carefully to ensure the coherency of the group's work and it is not obvious that the specific topic in climate change would do so. The capacity building work and contract work remain an important part of the group's portfolio and are well aligned with the strategic research foci. The group is connected and well-known internationally for its capacity building and educational activities, and is on a clear path to an excellent reputation in interdisciplinary endeavours and socio-technical approach to the fields of geo-information, land management and urban development. However, given the extensive and interdisciplinary nature of the three fields which could lead to many possible applications, the balance between the breadth and depth would be important to keep in check. The PGM is therefore advised to:

- a) continue efforts to integrate the three existing fields and research foci with an overarching focus which will ensure the greatest synergy, unique expertise and increased potential for externally funded research;
- b) pursue the inter-disciplinary and socio-technical approach by carving and maintaining a unique expertise and contribution, by complementing the internal strengths through collaborative engagements with social sciences and humanities, rather than attempting to develop the social science and humanities expertise internally; and
- c) use the approved future positions and hiring process to strengthen the Department in the selected synergy of the three existing fields (and in this regards, adding climate change domain and expertise is not an encouraged option).

To ensure its advancement and continued success, the PGM unit would need to develop a strategic plan around a common vision: to become within, say, five years the leading research group in Europe, in a well-defined area that falls within the group's current domain. Further, the group would define the steps that will be needed to achieve that vision, through recruitment of students and academic staff, development of research infrastructure, and development of links with complementary and similarly ambitious groups.

Programme 8:	Water Resources	
Programme leaders:	Prof. Z. Su; Prof. W. Verhoef	
Research input 2013:	tenured staff:	3.0 fte
	total staff:	28.0 fte
Assessment scores:	Scientific quality	4
	Productivity	4.5
	Societal impact	4
	Viability	4

Scientific quality

The group produces science at international levels of quality, as indicated by an above world average impact. It was noted that (i) the level of contribution was very variable across the group's members and (ii) the *h*-index score of the researchers was below ten with the leaders recording around twenty.

There is potential to publish in higher impact journals if undertaken in partnership with others.

The group indicated that they had a unique position in the domain of hydrological remote sensing with effectively no peers for comparison. This warrants further investigation.

The group had focused their efforts on advancing process understanding in Earth observation of land surface processes and their interactions with the atmosphere. The self-identified goal of the group was to create and transfer knowledge generated by remote sensing techniques to help support improved water management. The evidence presented to the reviewers supported clear and international level of strength in remote sensing along with a capability (rather than a similar high level of strength) in the actual 'transfer of knowledge to manage water' -- this despite attempts to respond to a similar comment in the 2010 review. The development of hydrological remote sensing expertise in developing countries (e.g., 'training the trainers') and the maintenance of long term monitoring sites were evidence of this well-established capability and were welcomed. The group are encouraged to further develop the transfer of knowledge gained with the aid of remote sensing to water management.

The group had a large and increasing number of PhD students, coupled to a research income that was also increasing, albeit less rapidly. A future challenge will be to decide what mix of funding to seek (i.e., exceptionally competitive national grant funding vs international project funding). The choice will influence future scientific quality and is dependent on the development of a long-term vision for the group.

Productivity

Productivity across a very wide range of research activities is at international and world-leading levels of excellence. Publication in refereed journals has increased markedly, as has the overall level of funding. The productivity on an FTE basis is impressive. Growth has been mainly through contract research and it is suspected that the numbers underestimate

the proportion of funding from this source. This may have hampered the group's ability to develop a long-term vision and associated research strategy.

The key publications indicate the level of research leadership with many first-author papers. The majority of the publications are in remote sensing or allied journals and there is an opportunity for more joint publishing in higher impact discipline specific or major science journals.

Considerable attention was given to the mismatch between the impressive number (30) of PhD students and the graduation rate of 2-3 per year. Three of the issues were generic to ITC (1) a time-lag lag between a recent increase in PhD numbers and graduation, (2) the challenge facing sandwich students from developing countries and (3) variable student quality. These issues are well understood and are, we understand, being addressed.

WRS added a fourth issue, the requirement for each student to have *published* between three and five ISI journal articles prior to submission, on the grounds that this was the minimum standard required to produce an 'independent researcher'. The University of Twente require 'an extensive amount of work, which deserves to be published in national and or international literature'. Other groups within ITC aspire for each student to have three ISI journal articles in press or published and in practice, one such paper may suffice.

A different submission standard for the same degree represents a potential risk for the University as it leaves ITC and thereby the University open to student complaint. Moreover, the unduly high level of publication required in the WRS research group would appear to be a significant barrier to timely thesis submission.

There was also discussion of the self-evaluation of joint projects, open source software, modelling tools and joint projects discussed within section 8; however, these did not directly articulate the social benefits of the work.

Societal relevance

The group gains its strongest social impact through the training of scientists from the developing world and the role that these professionals play in their home countries once graduated. Given the fact that many of the ITC students are mid-career professionals or academics with PhD study sites in their home countries and that the vast majority return to their home country, this impact is very high. This in turn helps to support the Dutch international development assistance agenda.

There is good number of popular articles, but it is not clear where these are published. Despite an earnest attempt to respond to a prior review recommendation that the work be placed more soundly into the climate sciences, there was little action otherwise toward ensuring the societal relevancy of the many technical capabilities of the team. For example, the group's leadership in aspects of large international initiatives such as TIGER and DRAGON are beneficial and relevant and the support of GEONETCAST facilities at institutions in developing countries is very useful for the supply of remotely sensing data. However, these products and the benefits they provide appeared to the reviewers to be disconnected from the research activities of the group. Further information provided by the group confirmed that there were connections between services and research activity. However, more thought needs to be given to maximising the benefit of the link between these services and research. At a minimum, some partnering should be considered.

Vitality and feasibility (viability)

While there was some consideration of previous review and tactical placement for the future, including good opportunities for progression of junior staff in team, the review team were surprised to find that here was no vision or strategic plan for the future of the group. The WRS group's response to the prior review (to better link to climate science) was clearly successful (e.g., EU FP7 CORE-CLIMAX), however, the group did not take from that critique the broader message that they needed to better self-define additional strategies for research viability. The link to the GEO-10 plan, while praiseworthy, was an apparent earlier response to the SWOT, and this strategy does carry some risk, given the challenge of any highly contested funding round. The team also found the SWOT responses by the group tactical in nature (e.g., installing ground instrumentation, solving computing storage issues, cloud computing) when compared to the more strategic responses from the earlier external survey (e.g., improve social relevance, balance national and international agenda, involve itself with global-scale water issues). The group have done well to create a vital research environment but now is the time to think more strategically.

A strategic vulnerability is the high degree to which the group's longer term research ambitions are dependent upon contract work. Such research is opportunistic and *ad hoc*, plausibly interfering with the formulation of the team's vision. (However, we note that some of these projects have 5-10 year funding time frames, which do provide longevity to the research and should be strategically targeted). The focus on contract work represents in the view of the reviewers, a potential handicap to the development of world-leading science and may interfere with otherwise good opportunities to leverage the groups base funding.

Recommendations

- Develop a strategic plan around a common vision: to become within, say, five years the leading research group in Europe, in a well-defined area that falls within the group's current domain. Define the steps that will be needed to achieve that vision, through recruitment of students and academic staff, development of research infrastructure, and development of links with complementary and similarly ambitious groups.
- Develop a plan to move the standard for PhD submission to the norm for ITC.
- Seek opportunities to publish in higher impact journals in partnership with others.

Water Management Group, University of Twente

Programme 9:	Water Management	
Programme leader:	Prof. A. Hoekstra	
Research input 2013:	tenured staff:	1.9 fte
	total staff:	7.9 fte
Assessment scores:	Scientific quality	4.5
	Productivity	4.5
	Societal impact	5
	Viability	4

Scientific quality

This group indicates that its focus is on two themes: water scarcity/footprinting and integrated water modelling/assessment. The Water Footprint concept is a key outcome. Despite criticism regarding its fundamental contribution to the science of water, the group has succeeded in driving the development of a useful global concept. Without doubt, the water footprint work has been exceptional, and clearly the group is a world leader. The group, for instance, published three papers in the list of 265 most influential studies in the field of environmental and ecological economics and to a large measure this has been a reflection of their work on water footprinting. However, the second theme on integrated modeling reported on in their documentation was poorly developed (or at least reported upon poorly & hardly stressed within the self-evaluation). This self-declared research agenda made for an unbalanced situation, which was in turn reflected in its overall scientific merit in which the first theme dominated greatly over the second. The academic reputation and stature of the Chair is high while other members of the group are arguably of less stature overall. The human resources supporting this group appeared to be modest and, as the team itself recognized, to be more-or-less stable. Another interpretation is that the group has not sufficiently grown. In fact, the team's own SWOT analysis stated it to be with "relatively low number of staff covering a wide research area" and therefore stretched thinly. Under training, it is noted that there has been a relatively low number of PhD students associated with this group.

Productivity

The productivity of this team appears to be high, however, one might suspect that this is associated mainly with the water footprint activity and less so on the integrated assessment work. Further, the degree to which this is driven by the programme leader himself remains to be seen. Again, the issue here is one of balance. Overall, the group produced on average ~1.2 refereed article per staff each year, and about 3.3 refereed articles per fte each year. In the period of review, the group had 14 publications in the top-10% of ISI journals in the category of 'water resources', as well as 7 papers in the top-5% of journals in the category 'environmental sciences'. Two articles were published in PNAS, and several articles have been cited highly. At the same time, among the key publications declared on the eight mini CV's, the review team enumerated 5 cases where the team member reports 0 or only 1

paper with him/herself as primary author. In section 4.3, the group cites a variety of statistics including that it is #1 ranked among SENSE groups working on water. Whilst some of the statistics can be traced to the bibliographic analysis, the assertion should have been backed-up by providing a specific origin for this statement. In addition, on some publication measures, undoubtedly other SENSE research teams would argue that they top the UT-WMG team in the rankings. It is noted that the variability in annual publications is high and on average showing a small overall, downward trajectory. PhD throughput appeared to be low relative to staff numbers and few students complete within expected 4-year period. At the same time the team indicated that they teach advanced courses that are quite relevant to the research of the PhD students.

Societal impact

The group has played an important role in (1) raising general awareness of water scarcity among professionals in the public and private sectors and the public at large; (2) providing tools and scientific understanding to support water policies and corporate water stewardship, and (3) helping capacity building in water footprint assessment. The water footprint and affiliated analyses are at the core of this team's social impacts. In fact, this element of the work is quite impressive. There was excellent impact for society and in particular business. The group claimed a degree of government-level impact, but little evidence of this was given in the written documentation and awaited the formal interview process. What the impact of the Integrated Modelling & Assessment for Water Management group component remains an open question.

Vitality and feasibility (viability)

Despite the impressive adoption of some of the ideas of this group, in particular the water footprint work, this did not apparently stimulate much growth in the number of researchers, PhD students or the team's total funding. The reviewers saw no real strategic plan and the SWOT analysis reveals a more or less comfortable acceptance of the status quo. The review team sees the group's expectation that the water footprint work will continue, as a given, to represent a significant and apparently unrecognized vulnerability. In this context, the self-assessment even states that "The group does not actively pursue contract research..." Why not? The idea of hosting guest researchers to help in the viability of the effort was noted and noteworthy. The Water Footprint Network (WFN) and associated initiatives provide a future opportunity, provided the concept grows beyond its current level. A risk noted is that the network and interest could shrink. The intention to link research plans of Water Scarcity & Water Footprint Assessment and Integrated Modelling & Assessment for Water Management group appears to be sensible, but little description of the details of this have been shared, in both the written documentation and interview.

Recommendations

- Worldwide, more and more research teams have been working on water footprint research. It is expected that the Water Management Group of the University of Twente can play an important coordinating role in working together among different groups.
- Key vulnerabilities for long-term viability of the team seem to be not considered and these should be. This was true both in terms of the self-assessment report and during the

interview process. When asked what weaknesses or vulnerabilities might the future bring, the group answered in a very tactical manner: focusing on the distance of their institute to “central Netherlands”. When pressed on the issue of vulnerability, the WMG team indicated that a few years back, they created the Twente Water Center, a very strategic move in order to survive, reflecting a strategy to ensure survival by becoming bigger. To what degree is this sensible in an era of shrinking funding. They also made a strong link to education (esp. Civil Engineering) with the aim of becoming “essential” to the University. This was a good indication of past, proactive behaviour. However, the review committee during the interview was surprised to hear the equivalent of the words “no real vulnerabilities” according to the team leader. Much more strategic thinking should be done including an analysis and response to increased funding competitiveness as well as the loss of key personnel, however unintended or unexpected (e.g. Hoekstra as leader). In this context, they group is encouraged to more concretely present a plan for taking the Water Footprint concept into the domain of solutions.

- In answer to the breadth and depth required of a strong program in the future, the group was unable to clearly articulate their depths in terms of disciplinary space. It seems sensible to include bona fide experts in crop-water relations and environmental economics, in addition to other areas, which apparently were picked-up ad hoc by the team.
- Finally, the self-assessment showed 2 groups, with one overshadowing the other, but unclear if this was to be one or two facets of the overall strategic plan for this team. The review team recommends that the group develop plans to better co-balance the stature of the less well-known team. They should also consider the question of where they will be in 5 years, with a much fuller analysis of risks.

UNESCO-IHE, Institute for Water Education, Delft

1. Mission, vision and policy

For its mission the UNESCO-IHE Institute for Water Education envisions a world in which water is managed sustainably and equitably and in which all members of the society — particularly the poor — can enjoy the benefits of basic water services. The United Nations has given the Institute the mandate to play a global role in educating and training a new generation of water professionals, facilitating the development of capable organizations, providing an enabling environment for well-informed decision-making and improving integrated water management practices. The Evaluation Committee fully supports this mission since it directly connects to the needs of developing countries and countries in transition where global and regional changes are most pressing and where the capacity to effectively guide these changes should be improved significantly. UNESCO-IHE is in a unique position to perform this mission most effectively.

At the outset, it is noted that this is the first time that UNESCO-IHE has been part of the SENSE consortium. The Institute underwent a separate internal review in 2009 by the SENSE leadership and has since made several adjustments recommended in the previous review. These included a major strategic decision for UNESCO-IHE to evolve from a leading international education institute into an institute that places equal importance on both education and research. In line with this strategic change, the Institute has created the new position of Vice-Rector. New Academic Departments and Research groups were organized under new scientific leadership to harmonize research activities across the Institute. This reorganization has been guided by the introduction of six research themes, all about water, but all demanding multi-disciplinary input and all linked to international programmes (e.g., IWA, EU, and Panta Rhei).

It is also noted that a new Human Resources - Performance & Development Management System was developed and implemented that strengthened academic leadership and set specific academic and outreach targets for every staff member. Promotions are now clearly based on achieving high academic outputs, as well as professional involvement in the scientific community and with generating outreach/societal impact. The regulations of the PhD Program have been revised which has led to a streamlined program with improved supervision and professional skill development.

These changes have already contributed to a significant growth of the overall research program. In addition to the PhD programme, UNESCO-IHE has also employed up to 20 post-docs and more than 220 MSc researchers annually, who together form a thriving graduate research community. The great majority of the graduate students are from developing countries and countries in transition and typically work on research that is focussed on their own home countries. In parallel with the growth in the PhD program and the increased emphasis on research, the Institute's productivity in terms of the number of publications has more than doubled and the impact in terms of citations and societal impact has grown significantly.

The members of the Evaluation Committee were impressed by the leadership of the institute as a whole and on how well the Institute has fulfilled its mission by carrying out three main

activities: (i) Education at the MSc and PhD levels and non-degree programs (ii) Research to increase the knowledge base concerning the water environment (iii) Capacity development by strengthening water sector organizations and, knowledge networks. The Committee suggests that in addition to these three activities, the experimental research on basic hydrological processes in the field should be emphasized and consideration should be given to add this as the No 4 activity. The strategy to operate under the UNESCO flag is applauded and considered very effective in terms of worldwide impact by the Committee. Finally, the policy emphasize water governance and social science, in addition to hydrologic science and engineering, as a way to expose the students to a T-shaped education and training environment is ingenious

As for any institution that evolves in such a short time, some parts of IHE have grown at a rate different from others. Yet as most other institutes, common means (space, finances) are distributed according to algorithms which usually are reflective of the existing situation. The IHE management should be prepared to institute a flexible and dynamic division of common resources that mirrors how well the groups contribute to the mission of the institute

2. Research quality

The quality of the research in the institute is world class considering the following:

academic reputation (recognition and visibility): The academic reputation of UNESCO-IHE with regard to its work in developing countries is excellent mainly because the high quality of the graduates that are currently in educational, technical and governmental leading giving positions in their country

In the standard numeric evaluation, the institute performs well with impact index of 1.5 in the bibliometric analysis

Human resources of IHE are excellent. Financial resources are partly based on the ability of the Institute to obtain outside funding. Although it might be difficult to realize in the research funding system in the Netherlands, newly appointed professors would benefit from significant initial monetary support to do research and to write grant proposals

Organisation and internal processes would be aided by the development and implementation of a cross boundary research group collaboration matrix. This exercise should be initiated by the management but assure that cooperation occurs where it is needed but it also should help to make the different research groups improve their core activities.

3. Societal relevance

The mission of UNESCO-IHE dictates that partnerships be established with academic institutions, regional entities, United Nations Institutes, NGO's, banks etc. The list of achievements presented in this regard in the self-assessment report in which knowledge is transferred towards third world countries is very impressive. The crucial factor of the success achieved is the trans-disciplinary research design in which outreach (demonstration sites, policy briefs) is directly combined with research of the PhD students. Furthermore, the overall networking with alumni, integrating them into the education activities and encouraging their participation in the publications with IHE staff are very laudable.

4. PhD policy

Presently, the PhD program is carried out in collaboration with Dutch universities and with other international partners as joint degrees. The number of PhD fellows has increased from less than 70 in 2007 to more than 140 in 2013. Research output has also almost doubled in the last 7 years – the average citations per paper are far above world average and 20% of the papers are in the top 10% of the journals; several important awards have been received (IWA, Women in Science, Tison etc.)

The PhD program is adequately handled by the Office of Student Affairs and the Education Bureau providing significant personal attention to the students. A PhD guideline has been established to delineate clearly a set of rules proper for the IHE. It is a starting point to negotiate partnerships with other institutions. Indeed besides the Dutch universities, other partnerships with European and Asian institutes are now being pursued. This is very good.

The great majority of students were very satisfied about the courses offered, the facilities they have, and their accessibility to their teachers. There were, however, some issues about the amount of funds allocated to them for their housing, particularly in the case they have to take care of family members. They claimed that other students in traditional university settings received more funds.

The students offered a series of poster presentations and the members of the Evaluation Committee were greatly impressed by their eloquence, their scientific depth and their openness. It was greatly encouraging to see how well these students from all over the world presented themselves as such a cohesive way. The faculty and staff of IHE can be proud of such an achievement.

Finally, the concern of IHE on a heavy emphasis of the scores of their publications is justified since it is not necessarily the most appropriate metric of their unique quality. IHE works primarily in developing countries, publishes in open access journals in a field which has 'not so hot' journals. Since UNESCO IHE has published 45% of their papers in these top three water journals, the research quality of this institute is exemplary and better than their Relative Impact score of 1.5 indicates. The Assessment Committee notes that the fact that IHE spends so many words on their presentation on the numeric score indicates that they still are under pressure in defining the real nature of their intrinsic quality. The fact that matters is their quality in training and the quality of the achievements in the field in the third world and on both issues there can be no shred of doubt.

5. SWOT

The overall vision for the future is that the problems in the developing world will still grow and hence the mission of the IHE concomitantly will gain importance. The IHE faces the difficulty of having to operate in developing countries and at the same time to increase its 'academic level'. The current financial means need to be expanded in the years to come. The current direction of transiting to an international graduate school on water and development associated with existing Universities worldwide is valuable and encouraged.

6. Recommendations / suggestions on improvement

The Evaluation Committee considered the research and education accomplishments of UNESCO-IHE especially as they relate to developing countries as highly effective and comparable or better than other such efforts in world. To maintain this high level in the future the Committee has the following recommendations:

- The teaching and research of the masters can be continued at the level of the research groups; yet some research groups are too small and too busy with the MSc program and already cooperate effectively with other research groups in carrying out their research tasks. This structure should be formalized within IHE. We believe that there is merit to organizing the research at the level of the departments. This enables the research to exploit the synergies that can be generated through collaboration between research groups. Any future assessment of the strength of the research at the level of departments is likely to be highly positive. This will avoid the problem that has been encountered in assessing small research groups when any such cooperation is seen as diluting the performance of individual research groups. At the Institute level this type of cooperation is highly effective and is the reason that evaluation of the Institute is much more positive than most the Research groups.
- Highlight the unique leadership of IHE in the field of water science for developing countries worldwide; find ways to represent this better in the formal reports, including through numerical scores where possible.
- Explore possibilities to associate more strongly with the Universities worldwide in order to cope better with the demands of the developing countries in the domain of water science for the future.
- Maintain the UNESCO label, as this greatly helps the mission of IHE in connecting with their peers in the UNESCO system and gives the faculty access to the country leaders. In addition, the recognition of the students' degrees in their home country is greatly facilitated by the UNESCO label.
- Start a dialogue with the graduate students on the financial aspects and the means to alleviate some of the burdens of the high costs of accommodation.

Programme 10:	Aquatic Ecosystems	
Programme leader:	Prof. K. Irvine (since Oct. 2011)	
Research input 2013:	tenured staff:	2.1 fte
	total staff:	8.8 fte
Assessment scores:	Scientific quality	3
	Productivity	3
	Societal impact	3
	Viability	3

Introduction

The assessment of this group is based on the total six year review period that ended in 2012. The new and excellent leadership of Professor Kenneth Irvine who started at the end of 2011 is acknowledged by the reviewers but is only marginally represented in the current scores and narrative. The evaluation committee believes that under the leadership of Professor Irvine the scores can greatly improve.

Scientific quality

The assessment was hampered because the main scientific advances of the group since 2007 were not well articulated. While they are currently building synergistic collaborations with other IHE groups and external groups (since the arrival of K. Irvine in 2011), the actual form of the scientific collaborations needs to be clearly defined.

Ecosystem-scale, process-based research (N, P cycles) of sub-Saharan wetlands is a cornerstone of the program. Nevertheless, the activities being conducted appear to be routine, in that research of this type has been extensively conducted in other tropical systems. While the group's research may lead to significant new understandings about wetlands, it needs to be articulated as to how this research avenue may yield new insights. How is the research unique from that being conducted elsewhere?

The academic reputations of key staff with the exception of Professor Irvine, as judged from memberships on editorial boards, other professional activities and research program leadership (e.g., only ECOLIVE), are limited.

One of the problems that this relatively small group faces was the supervision and scientific coordination of the 116 MSc theses over a short period. The fact that the research results of the MSc thesis have not appeared in professional publications or scientific advancements is of concern and appears to be missing a wonderful opportunity. The review team believes that when the MSc theses with acceptable quality are managed creatively by the faculty, it could significantly contribute to additional scientific synthesis efforts.

Productivity

The group consisted in 2013 of 7 staff and 9 PhD candidates but only 12 articles appeared in peer reviewed publications. In addition, the key outputs listed are in journals with relatively low impact factors. Only K Irvine has a reasonable Hirsch Index. The group is involved in several collaborative projects but their specific responsibilities are not identified and it is not clear how much of the scientific leadership they are shouldering in these collaborations.

Mentoring and graduating doctoral students is a significant factor in determining productivity. The group has not graduated a PhD student since 2007; fortunately there are news ones in the current program. The MSc program could provide the opportunity to screen for potential PhD students, as well as support the research activities of ongoing PhD students

Overall, the scientific productivity has considerable scope for improvement.

Societal relevance

The general societal relevance of having sustainable and useful wetlands is without question. Further, wetlands are a natural way to form “communities of practice” since their use and management affect so many people – and the group is making use of this ecosystem feature. This is a strong point in the program’s favour since the group is involved in local capacity building, a vital component of sustainable use. Nevertheless, the group has not articulated how key results are passed on to local stakeholders or decision-makers (or how stakeholders help shape the research agenda). Is there a strategy in place to do this beyond participating on professional committees? One suggestion would be to make better use of the emerging forms of communication (e.g., websites, Facebook, Twitter, and so forth).

Vitality and feasibility (viability)

Two key issues are of major concern. First, no mention is made of capacity building of junior staff within the research group. Second, the Strategy, as articulated, does not chart new directions or offer mechanisms for addressing the weaknesses or threats identified by the SWOT analysis. The group is small and has not been especially productive since 2007. Although the new leadership has made strides to improve the weaknesses, it was not evident in the strategy presented in the Self Study

The future viability of the program rests clearly on the ability of Prof. Irvine to provide vision and leadership, and he is certainly capable of doing this. He is “forward” thinking and has identified the program challenges to be overcome in the next few years.

Recommendations

- The group’s focus in the past has been very narrow. It would be prudent for the new leadership to consider setting near-term research goals for the group. The current scores are contingent (and could improve) upon meeting these goals within three years. It is advisable that the Group’s progress be reviewed annually.

- The group is deeply focused on wetlands and their management, especially in sub-Saharan Africa. As such, IHE should either consider either changing the group's name to better reflect the narrow focus or expanding its research portfolio.
- The Group's research should be consolidated with one or more other IHE research groups in order to increase their critical mass and trans-disciplinarity. The Land and Water Development group seems to be the most obvious to join forces with. There are already joint projects and joint supervision etc. between these two groups, and the research impact of both groups could be significantly enhanced through the establishment of a larger group that combines their expertise to work toward common problems. It could also alleviate the high administrative burden associated with academic leadership of a Research group. The MSc program should stand by itself for the time being.
- The Group should aim to graduate 2-3 PhD students per year, with the chapters of the dissertations published in well-regarded professional journals.
- The Group should aim to demonstrate how the MSc theses are contributing to scientific advances, especially the broad understanding and management of aquatic ecosystems.
- The Group, especially the faculty, must aim to publish synthesis articles on wetlands (or another appropriate aquatic ecosystem topic) in high profile professional journals (e.g., *Ambio*, *Science*, *Frontiers*, *Biological Reviews*). For example, these could be timely reviews of contemporary aquatic issues (e.g., proliferation and consequences of chemicals, invasive species and the management of hybrid ecosystems) based on a synthesis of several of their research results.

Programme 11: Coastal Science & Engineering and Port Development Group

Programme leader: Prof. J. Roelvink

Research input 2013: tenured staff: 0.8 fte
 total staff: 11.5 fte

Assessment scores: Scientific quality 4
 Productivity 4
 Societal impact 4
 Viability 3.5

Introduction

The group is heavily focused on modelling, and the application of models to address problems of coastal erosion, in the context of climate change. The group has played an important role in understanding and modelling the behaviour of estuaries and coasts around the world through international collaborations. The group has developed a unique expertise in long-term, process-based modelling that has contributed to the understanding of channel-shoal patterns, quasi-equilibrium morphologies, etc. To the Netherlands also this area of activity is highly relevant. The group contributes to the maintenance of the long-standing reputation of Dutch civil engineers in this important area. Links with TU Delft and Deltares put them in a very good position to benefit from the resources available there.

Scientific quality

The work in many areas is achieving world class status, particularly in the contributions to the development of the DFlow-FM Code. An article on an open-source storm impact model XBeach has ranked top 1 most cited publication since 2008 in Coastal Engineering journal. The work of this group is very competitive at the International level. One of the staff members, Prof. Ranasinghe, has been awarded the AXA Chair in Climate change impacts and coastal risk in 2013, which is a testament to the excellent reputation of the group.

Both the number of PhD candidates and the successful PhD completions have increased. This makes their contribution to the SENSE postgraduate community very considerable. The atmosphere of the postgraduate academy at UNESCO-IHE seems to be highly stimulating to the students and the formal link with Delft Technical University aids in maintaining the high standards.

Despite the excellent quality of the research, the group may find it difficult to compete with larger international groupings due to its relatively small size. While the group has the opportunity to study the many estuaries) around the world, more fundamental scientific pursuit that arises from these has not been given adequate attention in the group's current plans.

Productivity

CSEPD's productivity is excellent. The group produces on average 7 peer-reviewed articles in journals covered by the Web of Science per year. The number of publications produced by this group has increased since 2007, with a slight dip being evident in 2010. The relative impact of the CSEPD publications is 2.27 which is twice the world average in this sector. This is reflected by the fact that 44% of the publications belong to the top 10% of publications in their field and 2% (1 publication) belongs to the top percentile. This is primarily influenced by the evident focus on the Engineering sector in terms of high impact journals. Furthermore, the scientific production of the PhD students is good as well, thanks to a very efficient cooperation with MSc students and staff. The group produced on average ~1.9 refereed article per staff each year, and about 3.1 refereed articles per fte each year. There is a significant increasing trend of higher publications in 2012 and 2013. About 50% of papers were published in top 10% cited journals. Serious international collaborations are evident. In 2013, a paper was published in Nature Climate Change, which showed that the effects of coastline erosion as a result of rising sea-level in the vicinity of inlets which have until now been dramatically underestimated.

Societal relevance

Coastal protection and restoration are extremely relevant topics. The vulnerability of the coastline in the presence of human impacts and climate change is a topical issue in many countries and the related scientific challenges are exciting. The research achievements of WSE-CSEPD provided a good contribution to the above topics. Furthermore, the attention that is placed on students from developing countries makes the activity of CSEPD particularly noteworthy in terms of societal relevance.

The group has played a key role in developing knowledge and tools that is accessible to the developing world through capacity building, research and advisory projects. It has maintained close collaborations with developed as well as developing countries. The group has an excellent international reputation. As a result it is part of the research consortiums that give advice to governments and international agencies on the world's largest estuaries (Yangtze, Mekong etc.)

Vitality and feasibility (Viability)

This group has grown steadily from 4 in 2007 to 7 members in 2013, and the group's scientific output has substantially increased. The new Coastal Engineering Professor has been awarded a prestigious AXA endowed chair in Coastal Risk and Climate Change. All of these signs point to the increasing vitality of the group.

However, to be viable in the long-term, the group must grow in size to neutralize the volatility of funding and staff turn-over. Even though the group is on a fast developing track, a strategic plan is needed to adjust its PhD and MSc programmes and to look for more post-docs and staff members.

As with all IHE Groups, the developing country focus (and the time required for education and capacity building) impacts on the time available for generating publications, developing

and implementing uptake strategies as well as for 'curiosity driven research' that is often the nucleus for new developments and the uptake of new ideas. Continued viability and success at the international level depends on the group managing these twin objectives.

Recommendations

- The productivity and quality of the CSEPD group is excellent. In addition the number of staff members in this group has increased in the review period. Despite this its efforts are limited by its relative size. Therefore, in order to maintain its leading research position, efforts should be undertaken to increase the size of the group, including through the appointments of post-docs.
- The review panel was under the impression that the focus of the research of the CSEPD Group was on the application of sophisticated models to solve problems in various parts of the world, including developing countries. The apparent focus on model applications (which may be inadvertent) should be balanced by an increased effort towards more "curiosity driven" research. The potential for novel findings exists, both in performing detailed research on key processes that must be captured well in the models, and through synthesis efforts based on the differences and similarities between places highlighted through the application of the models, taking into account the underlying climatic (including ocean climate), land use and socio-economic factors. This will add value to the current research of the group, even while keeping the focus on developing countries.
- The appointment of the AXA Chair represents an opportunity to clearly articulate a new vision for the group, including defining the boundaries and synergies between the different parts of the group. This will aid the group in capitalizing on both scientific challenges and funding opportunities, in collaboration with other IHE Groups, including, among others the HERBD Group.

Programme 12:	Hydroinformatics Group	
Programme leader:	Prof. D. Solomatine	
Research input 2013:	tenured staff:	3.5 fte
	total staff:	12.5 fte
Assessment scores:	Scientific quality	3.5
	Productivity	4
	Societal impact	3.5
	Viability	4

Introduction

The objective of the group is to conduct state-of-the-art research in Hydro informatics, including data-driven and hybrid modelling, process modelling, uncertainty analysis, model-based optimization and decision making, surge forecasting methods, and data assimilation. This is a high profile group who, over the years, have made a significant contribution to the development of Hydro-informatics.

Scientific quality

The work of this group is competitive at the international level, and serious international collaborations are evident. The number of successful PhD graduations has increased, as has the number of PhD candidates. The contribution to the SENSE postgraduate community is therefore quite considerable. The quality of the postgraduate cohort is high and the formal link with TU Delft helps to maintain high standards.

The group is also very good in terms of the level of contribution to scientific organisation and community service, through service in Editorial Boards and scientific committees. It is also very good in terms of the standard of international recognition through scientific awards. The group chair and some of the group members are internationally recognized leaders in the field.

The review panel feels that current research efforts are still somewhat constrained by the legacy of the past, and the score for science quality partly reflects this. For example, the research areas listed in the Self-Evaluation Report are individually fine, but together they did not articulate a clear and coherent vision for the future. This is disappointing for a group that aims to (and probably claims to) lead the world in the area of Hydro-Informatics.

Productivity

The group produced on average 1.15 peer reviewed articles per staff, and 1.9 refereed articles per fte each year. The productivity became significantly greater after 2012. There were 10% of total peer reviewed articles published in top 10% journals, and 2% in top 1% journals. The prestige of the journals where these contributions were published is very good, with some being in top journals. The publication list highlights a good internal organisation of the group, given that the contributions cover complementary subjects. The output is fully

consistent with the mission of the group and the overall mission to address societal challenges. Some of the publications are in emerging fields of research, such as the interaction and feedbacks between humans and environment.

The group has contributed to the best of its ability given the large teaching/course load that it seems to carry. The focus has been very strongly towards developing countries and this seems to mitigate slightly against achieving an excellent world class rating. Also, even while publication output is increasing, a large amount of effort is still directed to conferences. The review panel feels that this is a relatively large group that could have been more productive.

As with all IHE Groups, the developing country focus and having to spend much time on education and capacity building, impacts upon the time available for generating publications, developing and implementing uptake strategies as well as for doing 'curiosity driven research' that is often the nucleus for new developments. Continued viability and success at the international level depends on the group managing these twin objectives.

Societal relevance

The societal relevance of the topics studied by the group is very good, but could have been better. Attention is being given to emerging societal challenges and education, with a focus on developing countries. In spite of this, due to the nature of the work they do (e.g., development and application of informatics methods) the societal relevance is difficult to measure for this group. Much of the work comes across as being of a theoretical nature, which makes it a challenge to demonstrate societal relevance in the short term.

In spite of this limitation, as mentioned in the self-assessment, the group has done quite a lot of work in developing and testing computer technologies and models, teaching students, and bringing these techniques to end users. Since many tools are used not only in the Netherlands but also in many other countries, the societal relevance could be judged as "good".

The way this group is organized, societal relevance is brought out only when proper alignment of the group's work is made to the more scientific or water resources management oriented programmes within IHE. An example is the work the group has done in collaboration with the HERBD group. The group should aim to achieve similar results in collaboration with hydrology and water resources management groups within the IHE.

Vitality and feasibility (Viability)

We believe that the group has a lot of vitality and has very good prospects for the future. This group has maintained itself at about 20 members and is therefore large by IHE standards. The amount of funding that the group has raised is very good and the final outcome from research projects is noteworthy. The reviewers are of the opinion that the group was capable of applying new philosophies and approaches in education and research, by producing original and new results related to the interaction between humans, water and natural hazards. There is so much the group can do to utilize new technologies widely available in the developing world (e.g. cell phones) and combine these with analysis tools that will make the work of water professionals more effective.

The underlying philosophy of the group is promising. The research portfolio of the staff is full and the group regularly acquires funding for projects that makes it possible to hire new staff. The Hydroinformatics Laboratory, created in 2012, has the potential to support advanced and new forms of research. The attention of the group to addressing emerging research fields, with the ambition to play a leadership role at the international level, is particularly promising. The group lacks support of IT experts and infrastructure that would allow “translation” of the developed research ideas into software. Finally, the several rounds of rebuilding of key staff of the group together with the considerable teaching load in developing countries, may have limited the group’s full potential in research.

Nevertheless, it is important to maintain the group’s leading role in education for the developing world in Hydroinformatics. The key for success is balancing the basic and applied aspects of the research, and improving productivity by adjusting strategic plans. However, the leading role of the group may be threatened because more research organizations are moving into Hydroinformatics. There is a great potential for this group in the new “information” age – provided data-mining and data-based learning are brought out as key aspects in the strategic plans for the future.

Recommendations

- The review panel feels that current research efforts are still constrained by a legacy of the past. What is the vision for the future in Hydro-informatics at IHE? Where does this group wants to be? The group will benefit from clear definition and rationale for Hydro-informatics, looking to the future in the emerging “information age”. A vision statement and/or a strategic plan that is updated regularly will aid in setting the course for the future.
- The nature of the interactions of Hydro-informatics with other IHE groups is not well-defined. The role or purpose (i.e., support or independent research) of Hydro-informatics should be established and its relationship to the other research groups must be clarified. There is still a close cooperation with the HERBD Group, which again is a legacy of the past. The vision statement should elucidate, in addition, its plans for the future, and the nature of its relationship to all groups within IHE.
- The organization of the group impacts its societal relevance. We recommend that the group make a realistic effort at marketing its tools and conducting educational training programmes aimed at water professionals (including in developing countries), independently of its joint efforts with other IHE Groups.

Programme 13: Hydrology and Water Resources Group

Programme leaders: Prof. Dr. M.E. McClain (since 2013)
Prof. Dr. S. Uhlenbrook (until 2013)

Research input 2013:	tenured staff:	3.5 fte
	total staff:	9.8 fte

Assessment scores:	Scientific quality	4
	Productivity	4
	Societal impact	4
	Viability	4.5

Introduction

The mission of the Hydrology and Water Resources Research group is to contribute to a better understanding of hydrological processes from hillslope to basin scales, to improve techniques for data monitoring and handling, to improve modelling of processes within the hydrological cycle, and to interpret and present results for implementation of water resources management. The research activities of the group focused in three areas: hydrological processes near the earth's surface, ecohydrology, and basin hydrology and global changes. In general the committee found that this group has done well over the past 5 years and has the potential to achieve even more under Professor Michael McClain who recently became the chair of the group. We were impressed both by their ability to obtain outside research funding and by the social relevance of the research, but at the same time they have not made use of their research findings in diverse settings to publish synthesis papers in high profile journals. The latter should not be taken as a critique, because the emphasis of this group is on educating students from developing countries that are and will become leaders in their countries either in educational institutions or in government, but we believe that the potential exists to make even more of an impact on the global hydrology scene than they have done in the past, and this should not be under-estimated.

Scientific quality

Prof. Stefan Uhlenbrook has been a good leader. He took over as head of the group in 2005, when the research part of the program was essentially non-existent. By 2007 the group had grown to include 7 PhD fellows and published about 15 peer-reviewed papers per year. By 2013 the group nearly doubled in size through the addition of PhD candidates.

In 2013 the group had 3.5 FTE in research and an amazing 36 refereed journal articles of good quality. On the average there were 10 refereed journals per faculty FTE which is a good average especially for an institution that has a heavy teaching load. Some of these articles were in high impact factor journals such as *Ambio* and *Nature Climate change*.

The faculty and PhD students are well-respected as evidenced by their awards, senior service roles, membership of editorial boards, and invitations to speak at conferences. The active alumni network is also a good sign that the IHE experience is a good one. Finally, while the group is engaged in numerous research activities throughout a wide research network, the major research advances were not well articulated. With the heavy

teaching load, low investment of IHE in funding research and the heavy emphasis on outside funding, this is understandable.

Productivity

The research foci (i.e., hydrological processes, ecohydrology, and global change) are of broad interest and the group has organized several interesting conferences and produced many relevant publications in well-respected journals. The number of refereed publications has dramatically increased since 2007. The articles address holistic hydrologic issues relevant to different geographic regions (e.g., southern Africa, Ethiopia) rather than focusing on particular hydrologic process and yet they are of broader international interest. There is a laudable trend of having students publish as first authors which is in agreement with the mission of the Institute

The number of PhD students of around twenty is good for the number of staff. The graduation rate with approximately six PhD students during the previous years and approximately the same number graduating next year show good productivity. The duration of six years acceptable in the European system is a long time for faculty or staff from developing countries to be away from their respective work situations.

The Hirsch Indexes of Professors McClain and Uhlenbrook are good but are low for most of the remaining faculty. It is not clear how much internal capacity building is done to develop professional skills of junior staff. The appointment of McClain in 2013 as Head of the Group is seen a positive step since Professor Uhlenbrook has taken on the position of Vice Rector.

Societal relevance

With respect to critical water issues, the group has a long history of research cooperation with local water authorities, development organizations and private sector partners. In all cases, specific research activities are co-designed and co-developed with key stakeholders. The impact of the group, therefore, on the social relevance was the most significant .

In addition, the faculty members, along with mentor students from developing countries conduct specialized classes in which the research outputs are incorporated into the educational and capacity building activities of the group in the form of case studies. In addition the group conducts specialized classes, organize field “lessons” to educate local authorities, and embed themselves in ongoing water development activities. The importance of the group’s activities is essential for the sustainable management of water in many developing countries, and several are described in the self-evaluation report.

Finally group members interact with local media in the regions where they work and contribute to the communication strategy of the institution.

Vitality and feasibility (Viability)

The Hydrology and Water Resources Group has in cooperation with the laboratory staff the analytical capacities to accommodate tracer studies using stable isotopes and synthetic DNA. The group was involved in obtaining high performance computational capacity. While the strategy for maintaining long-term viability is good, we remain concerned about the weaknesses and threats identified in their SWOT analysis as well as the drop-off in incoming MSc students. The decline is likely caused by greater interest in irrigation in developing

countries (supported by the fact that enrolment in “irrigation related groups is increasing). A realignment of the program structure to deal with the increase in the amount of water needed for irrigation during the dry phase of the monsoon could be an option.

Recommendations

- The academic staff in this group is experienced and well qualified. However, for continuity it is important that when a possibility exists, appointing a young and brilliant faculty member should be given high priority.
- The group’s main emphasis on raising research funds to increase the number of PhD students has obtained good results. This requires an open mind and a broad research portfolio. In addition to the excellent progress made by the group in the recent past, it is desirable in order to continue the trend forward, to formulate a research plan for the next five years with specific goals that address the group’s mission and ways to fund the envisioned activities.
- The review team is of the opinion that the HWR Group, in view of the work they do in many parts of the developing (and developed) world, across gradients of climate and socio-economic status, have a great opportunity to carry out synthesis efforts that bring out the similarities and differences between the various research locations and frame these in terms of the underlying controls. They should take it upon themselves to publish review and synthesis papers in high profile journals (such as, for example *Ambio*, *PNAS*) and even in regular hydrology journals. This recommendation does not apply only to this group but to all IHE Research groups.

Programme 14:	Land and Water Development	
Programme leaders:	Prof. Dr. Ir. Ch. de Fraiture (since April 2012) Prof. B. Schultz (until April 2012)	
Research input 2013:	tenured staff:	1.0 fte
	total staff:	10.7 fte
Assessment scores:	Scientific quality	3.0
	Productivity	3.0
	Societal impact	3.0
	Viability	3.0

Introduction

The assessment of this group is based on the total six year review period that ended in 2012. The new and excellent leadership of Professor de Fraiture who started in 2012 is acknowledged by the reviewers but is not represented in the current scores and narrative. The evaluation committee believes that with the new leadership the group is in a good position to achieve substantial progress.

Scientific quality

The group has a long history of research that has been narrowly focussed on irrigation and drainage. As such, the scope of research undertaken has been limited and the journals in which they have published have been focussed on technologies with limited impact beyond this focus.

There has, however, been a clear progression since the appointment of Prof de Fraiture. The reviewers believe that this is a good appointment and that there is already an upward trajectory in terms of the quality of research being produced. This is also seen in the increasing number of publications and the journals now being targeted. However, the Academic Reputation of the group remains below average as judged by professional awards, editorships, and speaking invitations and it is also clear that over much of the past 6 years there has been limited output that would be considered high quality.

PhD output has been steady at around 1 graduating PhD student per year, but it is difficult to assess the quality of these, as there is no evidence of journal articles arising from them. The Chair noted that PhD theses as monographs have been preferred until now and that the "sandwich programme" model limits truly original research.

The previous 2008 assessment and the low scores achieved then are noted. There seems to have been a progression since 2012, but little seems to have changed in the years 2008-2012.

Productivity

Productivity since 2008 has been low with only a single journal article published in 2010. There has been an increase since then, but productivity over the review period is generally below expectation. There have been a number of “non-refereed” articles produced. These are important, but seem to have been the focus and in the case of conference proceedings have not been converted to journal articles.

The group has steadily produced 1 PhD graduate per year. There is now an increase in the number of PhD students and the review group notes the opportunity for new PhD’s through the increasing number of MSc students attracted to this field of study.

Overall, the scientific productivity of the group has considerable scope for improvement.

Societal relevance

The societal relevance of the research, particularly in the developing world is clear and the group has done a good job ensuring that their research has an impact. The research that is taking place (in collaboration with other IHE groups) is well embedded in local communities and seems to have opportunities to provide important benefits to people “on the ground”. In addition, products such as the FAO level guidelines highlight the broader relevance of this group’s research beyond single field sites. It is important to maintain links to international groups such as IWMI and the high profile of Prof de Fraiture is significant in this regard.

However, the moderate score awarded reflects that the appointment of the Chair is a recent development and the reality of the extent of the impact that a small group can make.

Vitality and feasibility (Viability)

This is an area of major concern. Despite the appointment of a new staff member (to start later in 2014) and the recent appointment of a dynamic Chair with a strong vision for the future, the reviewers are concerned that the small staff complement are not in a position to take advantage of opportunities offered by the increasing student numbers in the associated MSc programme and the strong development focus (including irrigation) in the IHE target countries.

The group has raised concerns about their ability to attract “research” rather than “development” funding and that their applied research focus limits their ability to publish in high impact journals. However, this should rather be seen as an opportunity, not a limitation, especially given the group’s stated intention to “leverage” their existing resources to ensure stronger research quality and productivity in the future. This should also be seen in the context of suggestions below regarding the broader research strategy and opportunities where the group could be consolidated with other groups at IHE (see recommendations below). The challenges will be substantial if additional support is not forthcoming soon.

The staffing complement is low and several members have low productivity. There is no mention of how this aspect will be addressed, nor on any recruitment plan to cover staff that will retire within the next 6 years and how this will link to the group’s future vitality and feasibility.

Recommendations

- It would be prudent to consider setting near-term goals for the group, with the current numerical scores being contingent upon meeting these goals within three years, and the condition that the Group's progress be reviewed annually.
- The group's focus is very narrowly on irrigation rather than the broader themes of "land and water" or "food security". Given their small size, a meaningful contribution to these two broad themes is unlikely. The group should consider developing the "ecological irrigation" theme more fully and make this an area of focus. There are clear opportunities in a theme of this nature to incorporate the rapid way in which traditional/ smallholder systems are changing with the rapid uptake of new and newly available technology such as cell phones, cheap motorized irrigation pipes etc.
- The Group's research should be consolidated with one or more other IHE research groups in order to increase their critical mass and trans-disciplinarity, while the MSc program can stand by itself for the time being. The Aquatic Ecosystems group appears to be the most obvious to join forces with. Although there are already joint projects, joint supervision etc. between the two groups, the review group believes that the research impact of both groups could be significantly enhanced through the establishment a larger group focused on the need to produce more food without compromising the ability of natural system to provide other services. This provides an opportunity to bring irrigation engineers and ecologists together at IHE – in line with the larger vision articulated by the Chair. It could also alleviate the high administrative burden associated with academic leadership of a Research group.
- The Group should graduate 2-3 PhD students, and the dissertations published in well-regarded professional journals.
- The Group should clearly demonstrates how the MSc theses are contributing scientific advances, especially the broad understanding and management of "ecological irrigation" and/or "water for food".
- The Group, especially the faculty, must aim to publish synthesis articles on these new themes (or other appropriate topics) in high profile professional journals (e.g., PNAS). For example, these could be timely reviews of contemporary issues relating to land and water management (e.g., water for food, water-food-energy nexus, balancing the needs of humans and the environment etc.) rather than based (and building) on focused or localized research results.
- The group, and IHE as a whole, should consider how they use Post Docs in their research. The intention that Post Docs remain in their home countries is laudable, but in programmes where Post Docs are utilised, they seem to be utilised as field workers who facilitate the research rather than scientists generating publications.

Programme 15: Pollution prevention and resource recovery

Programme leader: Prof. P. Lens

Research input 2013: tenured staff: 1.7 fte
 total staff: 27 fte

Assessment scores: Scientific quality 4
 Productivity 4
 Societal impact 3.5
 Viability 3.5

Scientific quality

The Group has developed joint MS and PhD degrees with international institutions, which is a special achievement and is giving the Group good visibility. If the Group and the partner institute provide equal support and rigour, this approach can be a successful way of increasing the international impact of the Group. It is very important to have good quality control mechanisms in place in case one side significantly decreases support and the quality of the program on that side decreases significantly.

The group has developed a process for bio-precipitation and recovery of metals applicable to industrial areas of developing countries that can mitigate local pollution. The group should look for other processes / eco-technologies which fit the concept of resource recovery and can expand the portfolio of useful technologies.

Productivity

The generation rate of 25 papers in refereed journals per year by 4.4 FTE is good; about 20% of these are in the top 10% of journals ranked according to quality, which is quite an achievement. Three senior faculty have recently left the group so the new members of the Group will have to compensate for this.

There has been a strong increase in the number of PhD candidates during the reporting period, for which the Group is to be commended. However, the teaching load appears to be high and it is suggested that the Group assess the relative amount of effort placed on teaching compared to research.

The Group has made good contributions to the development of their profession. The Group Chair is editor of the Reviews of Environmental Science and Biotechnology Journal that has an Impact Factor of 2.3. They also contributes to policy briefs for several learned societies; it has 2 online courses and finally its output of PhDs is higher than average (20 in the last 7 years).

Societal relevance

The group is very interconnected to the social media through the use of You Tube, blogs, and special programmes, which serve to raise awareness of pollution prevention and resource recovery issues in the general public. However, care must be taken to prevent such activity from consuming too much time.

The outstanding societal relevance of the Group's main research areas (cleaner production, resource recovery, and development of eco-technologies) is constantly rising with a growing world population. It is appreciated that the Group is careful to select organisations to collaborate with based on clear criteria, such as the potential of establishing joint degrees, the availability of reliable research facilities, and geographical location, in order to make best use of their time.

The links maintained with their alumni, particularly by stimulating them to contribute to the journal edited by the Group Chair, are warmly welcomed.

Vitality and feasibility (viability)

The seniority distribution and the scientific profile have improved via recent recruitments of younger staff members. However, the scientific staff is exclusively male, and a better gender balance will provide female role-models that are important for the Group.

The Group has demonstrated its ability to function in a large number of areas and demonstrates its ability to adapt to new problems

Recommendation

Due to historical reasons, there is some overlap in research areas between this group and the SE group. The PPRR Group should explore areas not directly related to sanitation, such as industries where the topics of cleaner production, resource recovery, and eco-technology development have great potential. For the areas that are in the purview of both the SE and PPRR Groups, close collaboration is highly desirable.

Programme 16: Hydraulic Engineering and River Basin Development

Programme leaders: Prof. A. Mynett (since 2009)
Prof N. Wright (until August 2007)

Research faculty 2013: tenured staff: 1.6 fte
total staff: 15.9 fte

Assessment scores: Scientific quality 3.5
Productivity 4
Societal impact 4
Viability 3.5

Introduction

This Group deals with a very important area within UNESCO-IHE. The preliminary assessment of the scientific interests and production of the Group gives the feeling that the research activity covers a large spectrum of topics that may appear on first glance fragmented. The self-evaluation report lists 4 major research themes that do not look intimately connected. This situation seems to be the result of the historical legacy of the Group, which experienced a recent change of the Chair and is still adjusting to changes in the research environment.

Scientific quality

The group has a steadily increasing scientific productivity that in topics that have a long history, in view of the societal relevance of the related research challenges. The number of published items per full-time-equivalent is good. The Group produced significant contributions on the subject, spanning a wide range of problems related to river hydraulics, bridge safety, inundation modelling and Hydroinformatics. The academic reputation of the Group members is high and is increasing. Group members regularly attend international conferences and workshops and their contributions are generally well respected. Some of the Group members are leading scientists in their field. The presence of group members in governing boards is also significant. The quality of the PhD trainees is good/very good and their number is increasing. It is clear that Group members feel deeply committed to Education, which is in accordance with one of the primary missions of UNESCO-IHE. They supervise a large number of Masters and Ph.D. students.

During the face-to-face discussion the enthusiasm and motivation of the Group members clearly emerged. They came across as a very unified team, enthusiastic, with good ideas and a clear vision. The Chair has a very good perspective on the Group's activity and showed good leadership, but he is close to retirement. However, the leadership capabilities of other members are also impressive, something to build on for the future.

Productivity

The group produced on average 1.78 refereed articles per fte each year, and in particular the productivity increased to 2.4-3.1 in 2012 and 2013. There were 8 papers (about 12% of total

peer reviewed articles) in top 10%, and 0 in top 1% journals. The prestige of the journals where contributions were published is therefore appropriate and the publication list highlights a good internal organisation of the Group, given that the contributions cover complementary subjects. Furthermore, the output is fully consistent with the mission of the Group. The publication list still includes a large number of non-refereed contributions, therefore highlighting room for potential improvement. It is also relevant to note a steady number of publications directed to the general public.

In general the productivity of the Group in terms of scientific papers is not outstanding. Also, the visibility of the scientific production is not outstanding, but this might be related to the narrowly focused subject matter of their contributions. In fact, several articles are published in high profile journals, but the research questions are very specific or narrow. The Committee had the impression that high priority is given to teaching activities therefore limiting the scientific output. On the other hand, the Group appears to be highly productive in serving national agencies and foreign education programmes. It is also noteworthy that the Group members regularly attend international meetings and are in the process of organizing a very important and large-size international scientific conference. It is also relevant to mention a strong focus on developing regions of the world.

Finally, the group is very productive in securing funding. Group members are very active and leading scientists within EU projects, with a special focus on the mitigation of natural hazards.

Societal impact

The topics studied by the group have much societal relevance, as they are related to natural hazards assessment and mitigation. The group has a strategy to help solve real world problems and strengthening capacity in the developing countries. It is also important to note that the visibility of this group in the EU context is dominant.

The Committee is convinced that the effort to solve scientific challenges related to hydraulic engineering and river hydraulics should be further stimulated, as these topics are today less popular than in the past, yet their relevance for the public is high. The societal relevance of the research carried out by the HERBD group is also proved by the amount of funding that the group has been able to secure, which is noteworthy if compared with the average level of funding of the discipline and the number of full time equivalents in the Group. The Group is heavily involved in teaching and capacity leading in developing regions of the world and therefore the societal relevance of their research and educational efforts is indeed very significant.

Vitality and feasibility (Viability)

The Committee shared concerns about staffing levels and turn-over. The Chair of the Group is close to retirement and some important Group members are about to leave. The steady increase of the capacity of the group since 2011 and success in the start of several new research projects clearly indicate that the group is motivated and well organised. However, the turn-over is indeed a potential threat. The Committee noticed that there are opportunities that could be exploited in terms of growing capacity of the some of the current members. However, it is clear that new human resources are needed and it is also clear that the group would need to gain more full time equivalents. The human resources of the group appear

rather limited if compared with the efforts that might be required to reach the target of a broader perspective.

Recommendations

- The Committee recommends that the Group makes an effort to develop a consistent recruitment plan, which should be laid down well before the retirement of the Chair, in order to manage the situation in a proactive way. Staff replacement is an opportunity if it is efficiently managed.
- The Committee feels that the Group needs to make an effort to better brand itself. A more structured and integrated vision is needed in order to overcome possible fragmentation. The Committee is convinced that the Group has the potential to improve its visibility by focusing on more general and relevant research questions.
- Furthermore the Committee is convinced that higher priority should be given to research as the Group members appear to be over-committed to their education mission.

Programme 17: Sanitary Engineering

Programme leader: Prof. D. Brdjanovic

Research input 2013: tenured staff: 2.8 fte
 total staff: 12.9 fte

Assessment scores: Scientific quality 3
 Productivity 4
 Societal impact 4
 Viability 4

Introduction

Prof. Gary Amy, professor of Water Treatment Technology in the Urban Water and Sanitation Department, was also responsible for the Sanitary Engineering field in the period 2007-2008. In 2009 a separate Research group Sanitary Engineering was installed with the appointment of Dr. Damir Brdjanovic as Research group leader and Professor in Sanitary Engineering.

Scientific quality

The Group has published in high quality journals such as *Water Research*, and *Science* has just accepted one of its articles. The Group has also helped to start a journal for developing countries (*Journal of Water Sanitation and Hydrology for Developing Countries*). It has contributed to a set of important IWA textbooks in its domain. The Group also has a wide range of novel experimental programs in various developing countries.

This Group is just getting started after being formed by a re-organization of Institute activities in about 2009. The average publication rate is 8 articles per year, with 12 and 13 for each of the last 2 years, so the rate is increasing. The publications have above world average impact.

Productivity

The number of students has risen to full load of the available facilities. In the past five years the Group has established an impressive network of contacts in developing countries. They installed a series of novel pilot plants in developing countries and they have the potential to become a leading hub in the world in the field of sanitary engineering. They have the foresight to focus on long term cooperation and client bonding.

The Group has produced 73 publications in 2013, only 18 of which have been in refereed journals. The quality of output of the group would be enhanced by a higher rate of publishing in internationally competitive peer-reviewed publications.

The Group is very active in capacity development in developing countries; their impact on the research in these countries has been magnified through the thousands of individuals that have been trained by them in these countries, especially in Iran and in the Mediterranean.

Societal relevance

The Group deals very directly with the quality of life in developing countries, for example by predicting flooding events and removing sources of fecal contamination via improved waste treatment methods. They are not afraid to deal with the very basics of sanitation. They deal effectively with stakeholders such as the EU, financial institutions, and foundations that are interested to invest in sanitary projects for countries in need of new, low cost technologies.

Vitality and feasibility (viability)

The new sanitary engineering laboratory developed at UNESCO-IHE is a nice achievement and will be important in the Group's future education and research activities. The Group has a good proportion of tenured staff and a very large amount of third party funding. They are ready to take risks in terms of investing in a replacement and a new faculty position; and are now looking for individuals in the areas of urban water systems, urban drainage and sewerage.

They have the vitality to expand their activities, driven by societal needs as they arise in the developing world.

In view of the great importance of sanitation to society, and taking into account the unique role that IHE can play world-wide, the SE Group is in a very good position to make important advances in the solution of this major environmental problem.

Programme 18:	Water Management Group	
Programme leader:	Prof. P. van der Zaag	
Research input 2013:	tenured staff:	4.2
	total staff:	13.6
Assessment scores:	Scientific quality	4.5
	Productivity	4.0
	Societal impact	4.5
	Viability	4.5

Introduction

The group has articulated a clear mission, which is to contribute to developing and managing water systems that are socially, economically and environmentally sustainable. In their oral presentation they demonstrated clear and high ambition to be the leading group in the world in the area of water management, which we applaud. They are not there, but have the potential and our scores reflect this.

Scientific quality

The Committee was greatly impressed with the scientific quality of the group's research which we believe is approaching world standards and has great societal relevance. Overall, this is very strong, dynamic group undertaking innovative and meaningful research.

The group members have an excellent international standing and have produced an impressive number of publications in high-quality journals. In addition, they provide service through membership of Editorial Boards and participation in the governance of scientific associations. The group has a steadily increasing production in very relevant topics and with a wide and forward-looking vision. The bibliographic indices of the group members are outstanding, confirming their excellent international reputation. It has an excellent teaching and research network within the Netherlands and all over the world. In addition, the group plays a leading role in capacity building for integrated water resources management, in particular in developing countries

Productivity

The group produced on average 0.93 peer reviewed articles per staff, and 2.1 refereed articles per fte each year. The productivity became higher after 2011. There were 25 papers (17% of total peer reviewed articles) in top 10%, and 2 in top 1% journals. The productivity is very good, in spite of many challenges faced in converting societally relevant research to articles in peer-reviewed international journals. The citations received by the contributions were also very numerous, therefore confirming the societal relevance of the research output. The contributions covered a broad range of topics related to water management and much attention was devoted to developing countries. The effort of the group to produce

publications for the general public and professional publications is noteworthy. This kind of output is extremely important for developing countries.

Societal impact

The group undertakes directly societally relevant research in Asia and in Africa predominantly. It is clear that contributing to the knowledge and development of instruments for sustainable development is the main target of this group. The group is very efficient in seeking relevance of the scientific output and development impact. One excellent strategy is to conduct research jointly with local partner institutions and knowledge partners, as well as the relevant stakeholders and potential end-users. A lot of research is jointly carried out with local partner institutions. The dialogue with stakeholders is a key step in the activity of the group. This has enabled the knowledge gained from the group to be applied in the real world very effectively. It is also relevant that a significant part of the research output is directed to practitioners and potential users of the knowledge generated. Indeed, the achievements of the group in terms of capacity building for addressing relevant problems related to water security, with particular emphasis on developing regions, are very substantial. The group also played an important role in shaping water policies and creating platforms for research and training.

Vitality and feasibility (Viability)

The Committee believes that the group has very good prospects for the future. The underlying philosophy is promising. The fund raising capacity of the group is substantial, the internal organisation is very solid and efficient and the current composition of the group is promising, with the presence of numerous young members. The excellent international standard of the group members provides enormous opportunities in terms of international links. It is a key to maintaining the group's leading role in education and research for the developing world.

Recommendations

- The group chair and some of the group members are internationally recognized leaders in the field of water management. The Committee recommends that the group aim even higher and become true global leaders in this field. The aim of providing a unifying leadership to global water management efforts is ambitious, but is feasible.
- The group performs excellent research together with local stakeholders on the ground, specifically in Africa. It will be very valuable to prepare high level synthesis papers from the accumulation of their research outputs and publish them in high-profile journals.
- The research activities of the group were heavily focused on Africa. It may be helpful to expand research activities to Asia and other regions to further enhance the visibility of the group. The water accounting project supported by FAO provides such an opportunity to link the group to more countries, including China and India.

Programme 19:	Water Supply Engineering	
Programme leaders:	Prof. M. Kennedy (since 2010) Prof. G. Amy (until 2009)	
Research input 2013:	tenured staff:	3.2 fte
	total staff:	11.5 fte
Assessment scores:	Scientific quality	3.5
	Productivity	4
	Societal impact	4
	Viability	4

Scientific quality

We agree with the Group that its top achievement is its 14 PhD graduates, together with the MSc students who do research related to PhD dissertation topics and the publications that result from this research. Another very important Group achievement is the process for arsenic removal by waste iron coated sand that has been applied full scale in developing countries. The research group gets good international visibility from its research that is published in leading international journals. The senior staff members are regularly invited to give speeches at international conferences, and junior members and students have received several best paper awards.

Since 3 top faculty have left, the good junior faculty that have recently been hired are expected to develop in ways that will keep the Group strong.

Productivity

The Group is very active in capacity development in developing countries. We consider it likely that the individuals that have been trained in these programs have significantly improved the quality of water produced in these countries, and that the Groups' research has been magnified through the individuals that have been trained (e.g. more than 1000 people over the 5 year period). In addition, they installed pilot plants which led to the building of full scale plants in refugee camps. Water quality control processes that they have developed are now gaining general acceptance.

Societal relevance

The Group's primary focus on technology development for the supply of sufficient, good quality water in developing countries is highly societally relevant. The implementation of technological advancements is achieved via a strong network with Dutch drinking water industry and related industries (i.e. technology suppliers) but is always geared towards the real stakeholders such as water utilities, refugee camps and universities in the developing world. The group's contributions to the development of full scale drinking water installations for iron, arsenic and chromium removal have considerable, measurable impact in various countries, some of which are quite difficult to operate in.

The group keeps track of its alumni, which is important because these individuals serve as door to their country and to new projects. A special aspect is that indeed most of the MSc graduates and a majority of the PhD graduates return to their home country to implement the science and technology they acquired at UNESCO-IHE.

Vitality and feasibility (viability)

The group has an excellent strategy to select future faculty members when openings develop: they go for individuals that are strong in science, willing to work in developing countries, and willing to acquire hands on experience in the different topics they teach. They gradually develop new domains of expertise via their master students, e.g. indicators for biostability in distribution systems.

Recommendation

The group would greatly benefit from a chair in 'Water transport and distribution in developing countries'. This individual should be an expert in topics such as water quality, leakage control, system design, distribution system maintenance, corrosion control and distribution system rehabilitation. Indeed, in developing countries there is often a major problem with the above mentioned issues and to the best of our knowledge, no chair of that nature exists worldwide.

Copernicus Institute for Sustainable Development and Innovation, Utrecht University
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1. Mission, vision and policy

The Copernicus Institute investigates and develops processes and strategies for innovative change toward sustainability. It is aligned with one of the key strategic themes of Utrecht University, and as such it is in a strong position to secure the institutional support and to make an impact. University support is assured through 2 BSc programs and 5 MSc programs, all apparently well attended and several strategically created since the last review. The four groups constituting the Copernicus Institute are all highly relevant for the overall mission of the Institute and collectively make for an intellectually highly coherent research enterprise. The Institute strongly encourages inter-group collaboration and interdisciplinary research. The Committee observed many indications that this strategy is implemented, in particular through the Institute's research and teaching.

At the time of the 2007 review the Copernicus institute was quite young and its goals were ambitious relative to its stated mission and resources. Since then, the Institute has made excellent progress towards achieving its mission and goals: it has increased in size from 50 to 71 FTE research positions, has produced a very substantial body of research on innovations toward sustainability, and it has secured substantial amounts of external research funding. Its management structure is relatively simple, governed by a small board which is elected by the faculty. The Committee commends the Institute for this efficient and apparently effective management structure.

The Institute's financial structure, whereby some of the overhead from external funding that individual groups obtain is pooled, fosters collaboration and collective action by the four groups. That, as well as the physical location of all research groups in the same building and in the same Faculty of Geosciences, are important factors in fostering cohesion among the groups and in de-emphasizing internal to the Institute competition for funding. The Committee noted that communication among the leaders of the four groups appeared to be very easy and efficient.

The subject areas covered by the four research groups include several of the key elements of understanding the human impact on the Earth's life supporting systems and its transition to sustainability. In theory, the Copernicus Institute could benefit from including or strengthening some additional areas, such as cultural and sociological perspectives on social change toward sustainability, or macroeconomic modelling of sustainability, but the Committee recognizes that one institute cannot reply to all research questions at the same time (this is addressed further in the recommendations section).

Overall, the leadership of the four constituent groups demonstrated extraordinary clarity of purpose, a strong sense of collective identity and a clearly articulated sense of future direction.

2. Research quality

The Copernicus Institute is well recognized, nationally and internationally, and its leaders are very active within the national international research communities (reflective of the strategies of the individual groups). The name is associated with high quality research and education in the area of sustainability. The Committee strongly supports the apparent recent decision not to change its name. Although the Committee was not able, during the short site visit, to fully evaluate the research facilities and infrastructure – especially the scientific laboratories -- it

appeared that there was adequate and comfortable working space for all research staff as well as facilities for informal conversations and encounters (as much as permitted by the somewhat outdated architecture of the building). The latter is essential in interdisciplinary innovative research.

The value of relative impact of publications from the individual groups, although somewhat varying, is generally at very high, as is testified through our individual group evaluations. Research productivity and the quality of the publications by the Institute has been very high, and has shown a significant upward trend since the 2007 review. Generally, the institute appears to have been on an upward trajectory in reaching its goal of high academic standing. A general problem in interdisciplinary research is the conflict between prestigious high-quality research and interdisciplinary relevance. This leads to a conflict between funding from basic science sources and more contract types of support. It is important that the institute tackles this in a strategic way. Interdisciplinary research generally benefits from “meta-level” research (findings and conclusions based on comparisons between results from different groups or aspects in the institute), etc. and a research strategy in support of this could be developed further. The leadership of the Institute is keenly aware of this challenge. The Committee suggests that high attention is continued to be given to these questions.

3. Societal relevance

The societal relevance of the Copernicus research areas is very high. It deals with some of the crucial concerns for our civilization, seen in a long-term perspective. The institute has a very good international reputation and its leaders are very active at a high quality level in international organisations, NGOs, national bodies, etc. Together, this reflects high societal relevance. The senior personnel of the institute is deeply engaged with policy makers and several key economic sectors, such as energy, agriculture, or health. These connections are essential in creating opportunities for diffusion of the research outputs, in inspiring relevant questions for future innovative interdisciplinary research, and in obtaining funds, and in. The Committee commends the Institute for its societal relevance.

Societal relevance is also enhanced through the doctoral research policies. After all, the young generation will need to deal with the challenge of sustainability transition. This is especially true for the graduates of the Copernicus institute, a large proportion of whom go to non-academic jobs where they have influence on industrial and government policies. The Committee did not see sufficient attention to that aspect of societal relevance. We discuss that in the next section, and offer some food for thought and suggestions.

4. PhD policy

The committee met a number of very competent students at various stages in their PhD programme. We received the impression that supervision of students was generally good or even excellent. The knowledge among students of the “big picture” of sustainability science varies; perhaps more debate at the level of the institute about these matters could be helpful. This debate could focus on key drivers and mechanisms of unsustainability, for example. There was a clear impression that the introductory SENSE course was too short and too basic in order to fulfil this objective. The committee therefore suggests additional courses during or near the end of the PhD period.

5. SWOT

Strengths:

- Quality and quantity of scientific output
- Good relation between PhD supervision and scientific production
- Strong ability to raise funds for scientific research
- High international visibility and reputation

Weaknesses:

- No significant weaknesses

Opportunities:

- Greater level of exposure for PhD students to major sustainability issues
- Additional cooperation

Threats:

- Possible reduction of (public) funds for research and training
- Increased time having to be spent on acquisition of research funds

6. Recommendations

- We recommend that the Institute strengthens further its research capabilities in the sociological / cultural / economic perspectives on technological innovation, energy transitions, governance, and resources management. This could occur either through strategic appointments in the future or through external collaborations.
- We recommend to upgrade significantly the introduction for PhD students about the definition, multiple aspects and meaning of sustainability, and how sustainability thinking relates to the research activities throughout the Copernicus institute. The “big picture” seems to be missing for many students. We recommend a PhD course at an early stage of PhD projects, which goes far beyond the introduction in SENSE and also one at the end of the studies (see also below).
- Although the societal relevance of work at the Copernicus institute is very high, we recommend that this relevance as well as the sustainability aspects are made more apparent throughout the whole work of a PhD thesis, so that each student can put his/her work in a broader perspective.
- The cooperation and interdisciplinary culture between the groups within the institute is very good. However, we believe that there is a potential to even improve cooperation on a “meta” level, i. e. to use results from individual groups and put them into a broader perspective by applying technical, system, social, etc aspects on different future development routes. While some of this done partly already today, significant new knowledge could be generated by strengthening this perspective.
- The topical system boundaries of the institute are important. We recommend the institute not to broaden its spectrum in the direction of more technological research but instead continue to cooperate closely with internationally recognised technology-oriented research groups. Likewise (as discussed above) the institute will benefit from finding good ways to cooperate with macro-level and societal level research groups.

- We recommend that the Copernicus institute reinforces its development of a visible and visionary strategy for enhancement and broadening of its societal impact and public engagement.
- The name of the institute has earlier been discussed internally. We recommend that it is kept as it is. Copernicus is such a well-known name and high-value “brand” that it should be kept as it is.

Programme 20:	Energy & Resources	
Programme leader:	Prof. E. Worrell	
Research input 2013:	tenured staff:	4.3 fte
	total staff:	28.7 fte
Assessment scores:	Scientific quality	5
	Productivity	5
	Societal impact	5
	Viability	4

Introduction and overview

This group is pursuing work on sustainable energy and resource systems efficient use of energy and resources with renewable energy supply solutions, at various scales. They develop “methods and tools for system analysis to assist in the development of transition pathways and technologies for a more sustainable energy and resource system, by combining strong technology knowledge with a deep understanding of the broader system”.

Scientific quality

The relative impact value of the work published by this group is very high, 2.9 as an average and 3.5 2012. The areas included are broad and important and the group has managed to get a very good value of top10 (45%) and top1 (grown to 13 %) lists as well as on the quartiles of journals for their publications. At the same time the output has increased (see next part). For a multidisciplinary group and only based on Web of Science, that is a very good achievement.

The good ranking applies to all the five areas of the group, Bio-energy, Resources, Energy Efficiency, Smart Cities, Georesources, in spite of the relative diversity of these areas. The review group identified a scope for improved integration and collaboration, also in terms of organisation, between the sub-groups.

One reason for the high quality is the ability in the group to cooperate with other expert and scientific groups internationally, ranging from those working at the systems level to those conducting more basic research. This enables them to use technological developments made by other groups as a foundation for its own systems oriented research directed at real recognised problems.

The approach to multidisciplinary research in the group is highly recognised internationally. In fact, the review team is of the opinion that this research group has contributed substantially to defining multi-disciplinarity in this area and to the recognition of its scientific status.

The review team considers this group to be a leading group internationally in its areas of research.

Productivity

The total number of publications is high for the size of the staff. The review team identified a decrease in the number of conference papers in proceedings but, on the other hand, a slight increase in peer-reviewed publications. The research group considers this level to be sustainable and has as an aim to maintain this level. The type of research conducted is relevant in evaluating the group's publication record. This group pursues systems-oriented, inter- or multi-disciplinary research, in many cases in collaboration with other groups internationally or with industry. This type of research tends to take more time for publication in peer-reviewed journals compared to conventional disciplinary research.

Completion rates for PhD students have been improved considerably lately. At the review meeting, the group explained the earlier lower track record for this completion as resulting from financing difficulties for some students (due to lack of financing for the whole PhD period) rather than from inefficient or small supervising resources. The improvement in recent years is due to a better and long-term funding situation.

Societal relevance

Quality: This group, currently the largest core group in the Copernicus institute, deals with some of the crucial areas for our civilization, seen in a long-term perspective. The societal relevance of the group's research is therefore very high. It has a high reputation nationally and internationally and its leaders and staff members are prominent and respected in international research and policy circles (e.g., IPCC), confirming its societal relevance. It is evidently planned that the group's research will continue to focus in the same areas for the foreseeable future.

Impact: One particularly notable impact is the group's work on ex-ante evaluation of new technologies/systems. This gives good indications to society about which possible future development routes are sustainable and which are to be avoided. The group is heavily involved in the IPCC work, is active in the US Fortune 500 companies, and is leader of IEA, Bioenergy Task 40. It has also close cooperation with many industrial companies (including external PhD projects). The group's leaders are active and highly visible in public debate.

Validation: As discussed above, validation of different development routes is an integral part of the work in the group. It is suggested that a future research strategy could include a "meta" level approach, in which the kinds of benefits for society possible for different routes can be evaluated and, most significantly, compared, quantified and presented to society in an even more instructive way.

Vitality and feasibility (viability)

As mentioned, the number of PhDs has increased and the number of abandoned PhD studies has decreased. This is further confirmation of a more vital and stable situation. The group has a good potential to deliver and even develop further in its research areas. The financing is increasing, although the contract part has grown at the expense of research grants. There is therefore a risk of having a situation with more short-term, applied, projects and a decreasing number of more long-term, scientifically-based ones. Some key researchers have left in recent years, one of them most recently in April 2014. E. Worrell is the programme leader for the moment. It is essential that a strategy be devised for strengthening the senior staff including hiring a new leader and increasing the number of

endowed professors. However, the total number of tenured staff has already increased and further new staff are to be appointed soon. As a result of the changes in staff, the group is going through a generation shift, to which it must adjust. Networking between PhDs and between staff members seems to be very good and strategically managed. This is a good sign of a vital organisation.

A main strategy for the research group is to maintain the level of resources, to consolidate and develop an approach to a closer cooperation and organisation between the subgroups. The review team found this strategy sound and appropriate. Links between subgroups and the organisation of the whole group show some cause for concern and must be improved if a risk of not maintaining the cohesion in the group is to be avoided.

There is a strong need for one more leader, as the research group itself has identified. This inevitably leaves some uncertainty about the future development, as this person and, indeed, his/her ambitions are unknown.

The high and increasing share of contract research was discussed at the review session. With such a preponderance of contract research there is a risk of becoming dependent on the source of finance so that the research could become too applied and short-term, although the group has so far avoided this pitfall. The research group representatives, however, assured the review team that the majority of the contract research is long-term based on funding from Dutch governmental organisations and EU as well as long-term cooperation with industry (e.g. in consortia).

Recommendations

Based on the discussion above, the review team has identified the following recommendations:

- Due to the quality and importance of this group, the university is highly recommended to support it to the fullest extent possible, so that it can develop further in accordance with its aims and strategy.

The group is recommended to:

- be careful in order not to lose its cohesion
- keep to its core areas
- not go in the direction of technological research per se but keep on cooperating closely with internationally recognised technologically oriented research groups
- try to have a more balanced funding in the future in order not to be too dependent on contract research (which is easy to say....)
- develop a strategy for even further enhancement and broadening of its societal impact and public engagement

Programme 21: Environmental Sciences

Programme leader: Prof. M. Wassen

Research input 2013: tenured staff: 1.5 fte
 total staff: 10.4 fte

Assessment scores: Scientific quality 4.5
 Productivity 5
 Societal impact 4.5
 Viability 4

Introduction and overview

The research of this group focuses on the interactions between global change and ecosystem processes on multiple scales, ranging from local landscapes to the entire globe.

Scientific quality

The overall scientific quality of this research group is outstanding, which is indicated, in part, by several publications in high-level journals such as Nature as well as in a number of mainstream journals in ecology and climate change. It is worth noting that the scientific quality of this group has improved from very good to outstanding during the past 5 years. The high citation rates of their publications (4.54 times the world average) attest to the extremely high quality of the journal papers.

The group as a whole is particularly strong in spatial ecology, landscape ecology, and modelling the interactions between climate change and ecosystem processes across spatial scales, as well as in resilience research involving critical transitions and tipping points. Their interdisciplinary and multi-scale approach is appropriate and effective. Their combination of theoretical and empirical methods is innovative and productive. While their overall scientific vision and the interrelationship among research areas could be still better articulated in terms of coherence and clarity, the research done by this group is of very high quality, making the key members of the group world leaders in their fields. Several senior and younger researchers in the group are well recognized internationally; the group as a whole has been quite successful in obtaining external funding; the organization and governance within the group seem to function well; and there is little doubt that they will continue to produce high-quality scientific outcome in the next several years.

Productivity

This is an extremely productive research group. From 2007 to 2013, the number of researchers (particularly doctoral students and postdoctoral fellows) and the total amount of funding both have increased substantially. Scientific productivity, in terms of peer-reviewed journal articles and project reports, has increased at a rate that exceeds the growth in staff members.

Hence the productivity of the group as a whole is very high by all standards and the impact of the publications is quite impressive. That said, there is significant variability in productivity

among the members of the group. It is quite positive that the group has both exceptionally productive senior and younger scientists.

Societal relevance

The research is of high relevance as illustrated with extensive international, national and local policy-oriented reports and collaborative efforts. The group sees in its self-assessment the societal relevance primarily in the scientific underpinning of environmental policy, i.e. effective strategies for sustainable use, management and planning of land, water, nutrients and biodiversity in order to restore and conserve ecosystem functioning and services. Their second objective regarding social relevance is to transfer research results to professionals and the general public. The possible down-side of this two-pronged strategy is that it is assumed that the societal relevance would emerge through “work on environmental issues” only – at face value, there does not seem to be a deeper concern with societal processes.

As mentioned, the most important stakeholders the Group targets are public policy makers at national, provincial, and water board level, as well as in the EU and UN, IPCC and GEA, in addition to many other scientific assessments and efforts. Other stakeholders benefiting from the research results are NGOs and industry, and the MSc and PhD students.

Vitality and feasibility (viability)

The self-assessment highlights three pillars as the basis for the viability of the group: 1. Highest scientific quality; 2. Responding to societal needs for scientific knowledge on sustainability issues (global change and ecosystems); and 3. Expanding the research portfolio to fields for which there is a social demand, but only if this would lead to scientific advance through peer-reviewed papers. This three-pronged statement is both a sign of strength and weakness regarding the long-term viability of the group.

The clear strength is that the group appears to be viable because of the highest quality and relevance of its research and because it appears poised to take challenges ahead. They have been successful in strengthening viability by the actions implemented since the last review including the doubling of research staff (from 8 to 16) and of PhD candidates (from 5 to 10). In addition, the quality of the research staff has been improved (2 new Associate Professors, 1 Full Professor, 4 endowed Professors). Publications in Nature and Science rose from 5 to 6 associated with a great increase in peer-reviewed publications (from 103 to 386) resulting in a very high impact factor increase (RI from 2.30 to 4.54).

Another strength is the balanced age structure, with a mix of young promising and senior experienced staff members. A weakness, however, is the significant gender bias towards men with very few women in senior positions.

Viability is strengthened because the three main research themes of the group are now more prominently embedded in the faculty and the university (strategic theme sustainability, sub-theme water, climate and ecosystems). Financially, the group shows viability by being able to acquire about two thirds of the research budget through competitive project funding.

The main weaknesses include the apparent lack of coherence among the three pillars of the research event though one of the focal areas includes integrated assessment. The pertinent question is whether a more limited focus on a number of key issues would be more viable. Given the impressive scientific impact of numerous publications, the question must be asked whether the group members are spread too thin across the three rather separate research areas. Another potential weakness is whether the contribution of the part-time members of

the group is sustainable in the long run and what synergies within the group are possible in the future.

One strategy for a more coherent research agenda in the future appears to be the development of a “bridge” between integrated assessment models (namely, IMAGE) and the Earth and climate systems models (e.g. the NCAR model). The viability of this particular strategy will depend on very much whether the group will be able to nurture and attract younger colleagues who would build the interfaces and be able to further develop such integrated modelling framework. The recommendation would be to attract full-time rather than part-time human resources to undertake this development work and thereby increase the thematic coherence of the whole group.

Finally, the statement that the research portfolio would be expanded to fields for which there is a social demand, but only if this would lead to scientific advance through peer-reviewed papers, appears to be quite contradictory especially with respect to social relevance. Peer-reviewed papers are a weak assurance of social relevance.

Recommendations

Given the high quality of the work by this group, the main recommendation must be to build on its successes from the past. It will be important to maintain credibility through high-level publications, as it will be essential to use that to increase the future contributions of the group in the science-policy interfacing processes of the IPCC and other bodies.

In addition to building on the past successes, the group needs to overcome the apparent lack of coherence among the three pillars of the research event though one of the focal areas includes integrated assessment. We recognise that one strategy for a more coherent research agenda in the future appears to be the development of a “bridge” between integrated assessment models (namely, IMAGE) and the Earth and climate systems models (e.g. the NCAR model). As mentioned above, the viability of this particular strategy will depend on very much whether the group will be able to nurture and attract younger colleagues who would build the interfaces and be able to further develop such integrated modelling framework. The strong recommendation is to attract full-time rather than part-time senior researcher to undertake this development work with younger (also full-time) colleagues and thereby increase the thematic coherence of the whole group as well as achieve “endogenous” capacity to maintain and further develop the integrated research pillar as the thematic focus of the group.

Programme 22:	Environmental Governance	
Programme leaders:	Prof. P. Driessen (since 2008) Prof. P. Glasbergen (until 2008)	
Research input 2013:	tenured staff:	2.0 fte
	total staff:	11.5 fte
Assessment scores:	Scientific quality	4.5
	Productivity	5
	Societal impact	5
	Viability	4.5

Introduction

This is a relatively small group consisting of five tenured staff, one active professor emeritus, and about 18 doctoral students. The leadership of the group has changed since the last evaluation from Prof. Glasbergen (who retired but continues his close involvement with the group) to Prof. Pieter Driessen.

Scientific quality

The 2007 evaluation of this group was rather negative. The main criticism from the evaluators was directed at the theoretical basis of the research, characterizing it as “axiomatic rather than analytical”, the publication record in second tier journals, and at the societal significance of the research. With respect to the latter, the evaluators did not think that the group was actively involved in the policy making process and with its key actors. Furthermore, the evaluators found that the strong focus of the group on Dutch context, while being “solid and competitive on the national level”, was a barrier to gaining international recognition and high standing within the international community of scholars.

Over the past six years the group has responded to these criticisms, achieving an impressive turnaround with regard to research quality, productivity, and societal relevance. The size of the staff (tenured and untenured) has significantly increased (from 4.5 to 9.1; 1.75 to 4.53 FTE). The number of doctoral students has also increased, partly owing to some “second career” students who hold other jobs while pursuing the degree. The group also has four postdoctoral researchers.

The group’s stated mission now is “to make a relevant and significant contribution to the scholarly and political debate by analysing, explaining and evaluating modes of governance and by making recommendations about interventions...”. The research within the group is underpinned by a typology of modes of governance that has been presented in a 2012 high impact article co-authored by all five current tenured staff members of the group (not including Prof. emeritus Glasbergen). This is notable, as it reflects the intellectual coherence of this research group, something our team also observed in various subtle ways during the interview. This conceptual framework is well articulated in the self –assessment document. Clearly, this is an intellectually well-integrated team, accustomed to thinking and writing together. There is of course a concern that with such a high level of agreement among the staff regarding the guiding conceptual framework, students may be discouraged from choosing topics that fall outside that framework, or from challenging it.

Our team addressed this question directly during the review process, and we are confident that the group does not suffer from this potential problem. To the contrary, the guiding

framework is used as a typology that, through accumulation of empirical data, is intended to evolve into a more robust theory (or theories) of governance, as the understanding grows of what kinds of modes of governance “work where and when and why” (to quote the authors). Furthermore, the typology is so broad that there is plenty of room for individual students to take pieces of it and explore them in any number of conceptual ways through research. Another response to the 2007 evaluation was to improve the quality of the publications, and to broaden the research program to include more international work. The results have been dramatic: the relative impact score went from 1.3 to 2.1, and 31% of the articles have been published in top 10% ranking journals.

The group’s research strategy is to further elaborate the evaluative and explanatory dimensions of the guiding framework by conducting more comparative studies of governance across various topical domains and policy levels, and to include more international work in their to-date mostly domestic focus. This seems like a good strategy but it may also create a certain tension (hopefully a creative one) between, on the one hand, maintaining the niche that this group has developed over the years – of creating knowledge that can have applications for better sustainability governance in the Netherlands – and on the other, creating more breath in their research portfolio. In reality, this will most likely happen naturally, through the influx of international students into the group (a trend visible in all SENSE programs) as well as through the expectations of the EU-funded projects such as the recently secured STARFLOOD project.

In summary, despite the negative evaluation of their viability in 2007, the Environmental Governance group has not only survived but actually evolved in a very positive direction. It has an intellectually coherent, well focussed and conceptually solid foundation, as well as a sense of direction. The quality of its output is strong.

The committee also notes that these visible improvements, as well as others noted in the sections below, have been relatively recent (since approximately 2010) and still need a test of time.

Productivity

Productivity, measured in the number of articles per person per year, has more than doubled since the 2007. It is solid and consistent with the high expectations made of research groups by the University.

Societal relevance

The Committee was impressed with the active involvement of the staff with Dutch municipalities and other governing bodies. Prof. Glasbergen’s well-regarded work on multi-stakeholder partnerships also brings an important direct interface with the civil society sector. Our advice is that the group continues and deepens this involvement. The Committee also welcomed the increasing activities at the international (European as well as global) level on a range of topics and systems.

Vitality and feasibility (viability)

The group’s financing strategy of relying primarily on large contract-based research projects as well as on direct university support, with only a small relative contribution from a variety of research grants, seems to be working well for them. Prof. Driessen’s prestigious professional

connections no doubt are helpful in this success. The group is intellectually vibrant and has a reasonable balance between the staff and the graduate student body.

Recommendations

The Committee commends the group for their achievements since the 2007 review and recommends that it stays the course, including maintaining its small size, even though smallness increases vulnerability. The small size allows the group to stay focused and to nurture its particular niche of producing research that can inform and improve Dutch sustainability policy at different levels and in different topical domains. At the same time, the accumulating empirical data, structured around the typology of governance modes, promises to advance the theoretical frontiers of knowledge that would be relevant to the international scholarly community. At the same time, it is our opinion that the group's resources are spread somewhat thin, and that the group would do very well with another staff member.

Programme 23:	Innovation Studies	
Programme leader:	Prof. M. Hekkert	
Research input 2013:	tenured staff:	5.1 fte
	total staff:	15.2 fte
Assessment scores:	Scientific quality	4.5
	Productivity	5
	Societal impact	5
	Viability	5

Introduction and overview

The innovation studies group was very young at the time of the last assessment. It is now a more mature research group that has achieved an optimal size in terms of staff and student body. The staff members are quite young, all in their 30s and 40s. The group strives to advance the knowledge and understanding of the process of technological innovation and diffusion, and to make this knowledge useful to society: policy makers, innovators, and other societal groups. Its focus is on emerging technologies in their early stages.

The group sees its primary role as a knowledge producer with regard to technological innovation and diffusion, with a mission to apply that knowledge to the current grand societal challenges. To the extent that ecological sustainability, food production, providing for and protecting public health, energy sources, and others, are such challenges, the group focuses its research on the technologies relevant to these topics. Its location within the Copernicus Institute connects them intellectually with the sustainability community and provides openings and legitimacy in their active efforts for societal relevance (see below).

The group has three well-articulated foci: its best known dynamics of technological innovation systems (so called TIS framework); the governance for responsible innovation; and the most recently developed production of knowledge. There are clear intellectual connections among the three, which enhances the intellectual coherence of the group. Its strategy for the next several years includes further elaboration of the TIS framework on both the macro and micro levels; expanding the research topics within its “responsible innovation” theme, and venturing to some new areas, such as socio-technical transitions, with a goal of enriching each conceptual framework by the other. The newly hired professor Frenken will enable this broadening of the research agenda. It is a logical and well justified plan.

Scientific quality

The quality of the research, measured through a bibliographic analysis has greatly improved since the 2007 review, and is now very high, with the relative impact of 2.29 (compared with the earlier 1.37) and with 30% and 3% of publications in the top 10% and 1% most cited articles, respectively. This group has a substantial international reputation and its work is at the forefront of innovation research.

Productivity

Productivity, measured in the number of articles per person per year, has increased by approximately 50% since 2007. It is high and consistent with the high expectations made of research groups by the University.

Societal relevance

The Group actively seeks to facilitate the diffusion of their research findings into public policy, the business sector, and the civil society. On that count, it has had considerable success over the past several years. Examples include the uptake by the national legislative body of their research findings on animal testing by the pharmaceutical industry, the adoption of the function innovation framework by the national authorities and the private sector to design the Dutch Innovation Agenda. Professors Hekkert and Moors are actively involved in frequent interactions with the representatives of these sectors. There are indications that the TIS framework may be similarly adopted in several Scandinavian countries. The Committee was impressed with the societal impact the Group has made.

Vitality and feasibility (viability)

The financial status of the Group is healthy. It balances its income stream quite evenly between the three sources and the prospects for the next several years are good. The completion rate of doctoral dissertations is high, and the two well-attended M.Sc programs bring a steady income stream. Under the able and inspired leadership of Prof. Hekkert, it is an intellectually vibrant youthful team with a clearly visible strong team spirit and high ambitions (“to be ‘the place’ for research in technologic innovation”). Its members represent a wide range of theoretical and methodological expertise and disciplinary depth, while each being committed to conducting interdisciplinary research. The committee finds it highly commendable. The recent addition of Prof. Frenken and (part time) professor Truffer nicely widens the available expertise within the group. With a strong support from the University, and two growing Master’s programs, this group is highly viable for the foreseeable future.

Recommendations

This is a lively, creative and ambitious group that would do well with less pressure from the university to meet productivity quotas, as measured in the standard numerical indices.

IVM – Institute for Environmental Studies, VU University of Amsterdam

1. Mission, vision and policy

We found that the overall mission and goals of the institute/research programme are well chosen and phrased in view of the actual developments in the relevant research field(s), and that the institute has excellently achieved its mission and the goals formulated for the period under review by becoming one of the trend-setting, internationally recognized sustainability-directed research and education centers in the world. Under at times difficult external circumstances (reorganizations; financial constraints, this has been achieved by appointing and maintaining an excellent management team.

However, the various research groups at IVM have thought about their longer-term future (vision, mission and policies) to a highly variable extent. Generally, in the groups there is a clear and shared sense of their current mission, but their vision of the future ("What will the world look like in twenty or thirty years, and how can the Institute (team) maintain its leading role in that changed world?") is less clearly articulated. Unless the Institute as such takes the lead in preparing such a vision, and does so in close collaboration and consultation with its research groups and the other SENSE institutes, there is the possibility that the research groups will, little by little, follow divergent paths. It will be necessary, and should be possible, to design a vision and a roadmap that fits the overall future mission of the SENSE doctoral education program, which can then be implemented by the different Institutes and teams for their own research domains. In designing such a future for IVM, the graduate students should play an important role, as it is - after all - their future sustainability and sustainability science that are concerned.

2. Research quality

Overall, the research quality of the Institute is extraordinary, as measured by all the yardsticks that are common in the academic world. The Institute has managed, over the last six years, to greatly improve its contribution to the worldwide academic discussion in its domains, as is testified by the very important increase in the number of papers published in paramount refereed journals, the large number of papers in these top journals (and the high ranking of many of them among these journals' papers), as well as the high citation index scores.

Similarly, the very large proportion of external research funding of the research groups testifies to their competitiveness in their field and financial context. Many grants are from the EU's research program; fewer from NWO but among these are some of that organization's most prestigious grants. All this has been achieved while also improving and increasing teaching, mainly by reducing the quantity of consultancy, rationalizing the organization of the research groups and shifting a very important part of the research load to the PhD students. All this has clearly required good leadership and an important effort on the part of everyone. There are, however, some risks attached to the current financial situation. These are mainly the great dependency of many groups on EU funding (which may, for political reasons, shift in theme and subject), and on teaching (the only source of internal funding, for most teams 20-30% of total income). Creation of some research-directed core funding for pump-priming is highly recommended, as well as, where possible, anticipation of changes in research trends and spreading of sources of research funding. Similarly, for long-term sustainability, it

will be important to be aware of the human limits to productivity and engagement, and not to stretch these durably beyond reason.

The current facilities are in one word excellent - the building is pleasant, the offices are sufficient, and the instrumentation is currently at the cutting edge. But this also means that these aspects of the functioning of the Institute need to be maintained if the IVM's international position is not to be eroded. The instrumentation of the C+B group deserves particular attention in this respect.

A core aspect of IVM that is one of the pillars of its position nationally and internationally is the trans-disciplinary organization of its research and PhD training. It has enabled the Institute in a relatively short time to become one of the worldwide leaders in sustainability studies, as is clear from the heavy involvement of its scientists in global projects, the honors bestowed on its faculty, the fact that it is invited to address audiences such as the General Assembly of the UN, etc.

The research domain of IVM concerns challenges caused by three centuries of unbridled interactions between people, groups, societies and their natural environments from the regional to the global. Global environmental change and the threat to sustainability are caused by the interaction between social and natural dynamics. Hence the only way to study them and to do something about the threats is by the integrated study of these phenomena, and that involves a wide range of disciplines. Many research institutes in this domain have not (yet) sufficiently implemented such trans-disciplinary research, and it is one of the great advantages of IVM that it has indeed done so from the beginning. To maintain that integration does without doubt place extra burdens on its finances, organization, intellectual and social climate, and personnel, but it is essential for the continuing success of the Institute.

3. Societal relevance

As to the societal relevance of the work done in IVM, this is in full development. Depending on the specific missions of the different research groups, there is direct engagement with industry to solve practical problems (C+B; toxicology), engagement with policy setting at different levels from the regional to the national and the international (EPA; EE) and engagement with the actors of land use and land use change, such as owners, planners, etc. (SPACE), for example also in a number of developing countries. But, overall, it seems that this effort can be developed further, in particular by increasing the team's interactions with civil society. Internationally, there currently emerges an important bottom-up movement towards sustainability because the top-down effort is not really advancing very effectively. This bottom-up movement is often in need of the kind of leadership that the researchers and PhD students of IVM can contribute. In this context, attention can be paid to the study of the (role of) narratives that impact on people's decision-making.

4. PhD policy

Generally speaking, we were impressed and encouraged by the attitude, commitment, quality and work that the PhD students exhibited. Many of those we talked to, did mention the fact that they are very happy to be part of the program. They get considerable and timely attention from the faculty, and this also shows in their performance: relatively little time is lost in indecision and in hesitation about choosing ways to tackle problems encountered on the way to the PhD. The posters we saw testify to the integrated socio-environmental approach that is the hallmark of the current IVM. But maybe even more importantly, we were pleased to see that there is considerable interactivity among the PhD students in the Institute. This is

an essential barometer of the success of the program, and should be monitored as such by the faculty, possibly by regularly doing a network analysis of the community (faculty and students).

As far as the program itself is concerned, we are convinced that because of the selective nature of admissions and the very high quality of the students, the choice of enabling a wide range of topics (and appropriate courses) to be chosen is indeed correct. To achieve this, the Institute is to a substantial degree dependent on courses taught elsewhere, and we recommend that a bit more funding for the students to attend these would be very helpful. It would also help solidify the SENSE network by stimulating interactions between PhD students of the different institutes.

The regulations of SENSE, as applied by IVM, do require two published papers and two papers submitted for publication as criterion for the obtention of the PhD. However laudable that is as part of the Institute's effort to reach the highest academic status, it is to some extent constraining, and in particular it does not offer much space for entirely different kinds of performance, which may be linked to the not purely academic roles that institutes such as IVM are called upon, and will be called on even more intensively in the future as part of their role in society. We are not suggesting abolishing this criterion, but are thinking it needs to be applied flexibly.

The core element that ties the IVM students to the SENSE network is the introductory course that SENSE offers to all new entrants into the program. We were alerted to the fact that some of the faculty negatively impact attendance of that course either by ignoring it or advising their students not to take it. It seems to us that this undermines the purpose of the SENSE network, as these courses are also occasions for community building and the exchange of information. If possible, courses and other activities should be organized in such a way that all students can attend. Coupled with a central website that advertises all SENSE courses well ahead of time, this will also meet one of the student complaints - that they are insufficiently aware of courses taught in other institutes.

As far as the program was concerned, one last point that came up in our discussions was the wish to have some attention paid in the curriculum to the future role of the students as scientists and members of society - preparing for job interviews, grant-writing, but also ethical and social aspect of practicing their leadership roles. This seems indeed an important potential improvement.

One last remark might be relevant: would it be possible for the students to have a little more involvement with the management of the Institute? The Institute has recently instituted a PhD council, which in our opinion is an excellent starting point. However, it could be strengthened. On the one hand that gives the students experience, and on the other it strengthens their stake in the Institute's well-being.

On the whole, though, we were greatly impressed by all aspects of the IVM PhD program. In particular, it is clear that the faculty makes successful education its great priority and pays individual attention to the students and their needs. Congratulations!

5. SWOT

IVM is currently in an enviable position - internationally recognized, heavily funded through successful grantsmanship, with an excellent student and faculty population. That also implies a major responsibility for the coming six years: how to maintain and improve on that position in a world where competition can only become more severe, in particular for funding that comes from various governmental or quasi-governmental sources, and which is likely to intellectually change very rapidly and profoundly.

An important asset of IVM in its current position is the fact that it participates in agenda setting at the international level. Agenda setting is not only a sign of the importance of the

Institute, but also a tool to keep strengthening it because it helps the Institute to be aware very early of future developments, and thus to adapt to these, as well as to influence them towards its own areas of strength.

However, that requires that IVM develop a truly strategic vision for the future of sustainability studies, sustainability practice and the changing landscape of both the environmental and the societal challenges that will demand scientists' attention in future years. Once that is done, it can position itself and its peers in such a landscape and try to choose a set of potential paths through it. By way of example (and not necessarily one to be followed), the future of urbanization, its risks and challenges is one topic that is not systematically addressed, even though it has in the last few years emerged as a major challenge for our societies worldwide. In this effort, it is important that all research teams are involved, and faculty as well as students. It should be directed at designing for change, and learning from the past about the present and for the future. In doing this, IVM will effectively deal with what seemed to us its main weakness in vitality and feasibility, while at the same time enabling it to select the (inter)national partners with which it can achieve the greatest success.

Part of this strategic exercise should be a consideration of its funding strategy to date, which seems very highly dependent on very few institutions. We would encourage the Institute to begin searching for non-European and non-public sources of funding that will widen its network and therefore provide a better defense against the vagaries of any institutional funding policy.

In the intellectual domain, any future policy should take a couple of things into account that have thus far worked in IVM's favor but may not always do so. First of all, the unit should have a long-term appointment policy that takes the demographic buildup of the various teams into account, so that the mostly balanced age-pyramid that the Institute currently has, can be continued. But balanced against that should be the vision it develops about the intellectual future of sustainability science, so that strengths and weaknesses can also be adapted to this. A difficult exercise, no doubt, that merits considerable reflection.

6. Recommendations / suggestions on improvement

We have generally focused the above paragraphs and sections on recommendations, in keeping with our idea that the Institute is currently functioning very well indeed, achieving its goals of excellence, trans-disciplinarity and high-quality education. Hence, we will not repeat the recommendations made above but rather focus on the potential of further integration of SENSE. We are aware that the various institutions involved have very different levels of involvement in the network, and that there is much to be done here. We would like to point out, however, that the network is a highly important tool at the service of the survival and improvement of the partner institutes in a world where funding is scarce, and collaboration and resource sharing become more and more important. In the next decade, as sustainability becomes a more and more critical subject, larger and larger consortia are likely to emerge to deal with the very large scale of the issues concerned. Individual academic units cannot hope to survive in such a competitive battle. They need to join forces, and the resulting consortia will also include long-term partners from business and industry. In comparison to the USA, Europe has recognized this need very early on, through the EC's research policies. Often, one sees that the resulting consortia are easier to mount with faraway partners rather than with those closest by. Yet that is a mistake - partnerships should be judged on their intellectual and practical merits, not the proximity between institutions.

It is thus our considered opinion that, for example, the mooted collaboration between the VU and the UvA is a medium-term inevitability. Yet in order to realize it, cultures need to be given the necessary time to converge, and explicit and deliberate policies should be put in place to further such collaborations. We would therefore argue that every occasion should be

grasped to further this goal, whether bottom-up or top-down. In our opinion such a collaboration would allow VU and UofA to gain very relevant experience that will help them be ahead of the curve of many future (inter)national collaborations that will, one way or another, emerge out of necessity.

One last recommendation concerns the need to seriously look into on-line education. While we do not think it is a 'silver bullet', we do think it is a very important tool to help educate a much wider audience in the domain of sustainability, and we also believe that, if structured correctly, it can hugely contribute to the financial well-being of the institution. As IVM is a graduate teaching unit, we see its role primarily as a tool to pilot a huge increase the societal relevance of the institution. It might also help the Universities concerned by increasing enrolment, and therefore enable them to fund more academic personnel that would strengthen the research potential of the units concerned.

Programme 24: Chemistry & Biology

Programme leader: Prof. J. de Boer

Research input 2013: tenured staff: 2.3 fte
 total staff: 9.8 fte

Assessment scores: Scientific quality 5
 Productivity 4
 Societal impact 5
 Viability 4

Scientific quality

The Department of Chemistry and Biology has a broad research profile in contaminant science that covers the discovery of new pollutants, new analytical methods applied to environmental samples, effect-direct analysis and human and environmental toxicological studies. The group is internationally highly visible and at the forefront of research in environmental analytical chemistry, while almost the same applies to environmental toxicology. Their research is topical and significant, which is reflected in many invited lectures and awards for important papers. The impact of the research is also very good as shown by the bibliometric analysis: a relative impact of their papers of 2.19, more than twice the international average, and a high proportion of highly cited papers.

The programme director has an excellent international reputation and several other faculty have strong international profiles. The earning capacity of the organization is very high as documented by a long track record of external funding that covers 90% of total expenses. They have been particularly successful at attracting EU funding with a success rate in FP7 that was four times higher than the average, but are aware that the opportunities for such funding may change in the future. Their PhD graduates have also been very successful in getting good positions in the professional job market, which is further important evidence of the high quality of the work done by this department.

Productivity

The productivity of C&B is high. The number of peer reviewed papers, about 30 per year for 7 researchers/professors, is good but could be greater. It is complemented by an unusually large number of "other research output". The department heightens its visibility in the research community through a large number of presentations at scientific meetings. Encouraging is the increase in PhD students through the evaluation period, and in particular the big jump in 2014. The review panel appreciates that this is the result of a long-term effort by the department and hopes that PhD student enrolment stabilizes at a higher level.

Societal relevance

Clearly, C&B's work is highly relevant to society. This group is directly engaged in policy-setting activities concerning the health of people and our environment. They consciously direct their research towards new issues of societal relevance, and engagement for socially relevant issues is a criterion in recruiting research staff. For the size of the organization they

have strong and diverse links with stakeholders. The department offers excellent support and services at the national and international level (incl. developing countries). Their webpage gives important information and guidance about organic pollutants for the public, and their faculty have very good visibility in the media.

Vitality and feasibility (viability)

Like other groups at IVM, this one has a long and impressive record of supporting themselves financially. The long term viability of such a strategy depends on having the flexibility to engage in new research questions and access new funding markets. We view C&B's current intention to focus more on indoor exposure and health effect as positive in this regard. The department's strategy of recruiting flexible researchers with entrepreneurial skills contributes to the long term viability of this approach. A department leadership that is attentive to identifying new risks / opportunities and responding to them is also important, and ample evidence of this was presented.

Recommendations

- The strong dependence on external funding is a handicap, both for the productivity as well as for the long-term viability of the organization. The low level of base funding generates a strong need for contract work to cover the co-financing costs of the EU projects that constitute more than half of the department's funding. Currently, much of the contract work is frequently short term, which commonly comes with high scientific management costs and results in an unhealthy amount of the publication effort going to reports and proposal-writing. One approach to break this pattern is to ask higher prices for the unique services that the department is supplying in its contract activities. This could free up resources to allow C&B to devote more effort to publication in peer-reviewed journals.
- In addition, it is important that the department increases its base funding to reduce its financial vulnerability. One dimension of this is to increase the number of PhD graduates. The department is making progress here and we encourage them to continue expanding their PhD training. The second dimension is to increase the undergraduate teaching. The department has started excellent initiatives in this regard, but it is important that they go further. They should pursue opportunities to participate in the IVM Master's program. Furthermore, they should exploit the great synergistic potential in collaboration with the University of Amsterdam in the teaching of environmental science, be this organized at the university or the department level. In these efforts C&B will need the support of the leadership of its faculty.
- Finally, we note a need for C&B to balance its current opportunistic philosophy regarding research planning with a long term perspective. To play a leading role on an international scale, one needs a critical mass of resources and experience. Opening new areas of endeavour is important, but this must be compensated by closing down existing research areas. These transitions must be made in a conscious and strategic manner, otherwise the scientific competence may become so diluted that the organization is no longer viable.

Programme 25: Environmental Economics
Programme leader: Prof. R. Brouwer

Research input 2013: tenured staff: 1.7 fte
 total staff: 15.7 fte

Assessment scores: Scientific quality 5
 Productivity 5
 Societal impact 4.5
 Viability 4.5

Scientific quality

The scientific quality of the work is excellent in their identified key areas of applied economics research: biodiversity and ecosystem services, water resources management and climate change and energy. Within these domains they work on economic valuation, modelling and instruments. Their applications of environmental valuation methods, in particular, including the applications of stated preference methods to developing countries, and their climate risk insurance research are in the forefront internationally. The research group has documented real interdisciplinary research and research-based teaching (e.g. through publication of a textbook on ecosystem services, based on their own research), and have a close co-operation both with natural scientists of their own department and the VU economics department in research and teaching.

Productivity

The productivity, in terms of referred journal papers, number of Ph.D. students and teaching is excellent, especially when seen against the relative small size of the research group. They are able to produce applied research which can be published in e.g. books, and at the same time they manage to methodological advances which are publishable in high rank refereed international journals.

Societal impact

Their research is highly socially, economically and culturally relevant, and they have documented their involvement with stakeholders and that their recommendations with regards to instruments for curbing environmental pollution and insurance schemes e.g. for flooding have been followed; especially with regards to their applied work in developing countries. The members of the group are also active in advising governmental bodies at the national and international levels. Both in the planning, implementation and reporting phases of their applied work does the research group interact closely with stakeholders.

Vitality and feasibility (viability)

The group has an exceptionally high success rate with European projects, but then also depend on these EU-projects for their external funding, which makes up nearly ¾ of their current funding. However, they also show great awareness and capability of adjusting to

changes in the funding opportunities. Although their part-time professors and researchers are high profile and make significant contributions to the group, the majority of projects and publications come from the tenure track staff and their Ph.D. students. Thus, they are not particularly vulnerable to changes in these arrangements. Since nearly all of these associated members have worked at IVM before, they also have a close relationship to the institution which makes it less probable that they will end these arrangements (but the department is continuously evaluating the use and output from these affiliated professors and researchers). Overall, the research group seems very viable with an inspirational and very dedicated leader and very committed staff.

Recommendations

- The group should develop a vision of what their field will look like in twenty to thirty years, and prepare a roadmap that outlines how they might want to influence, and deal with, the changes that are on the horizon. Furthermore, the research group should continue its effort towards reducing their share of external funding through active participation in teaching across VU, and the development of new courses (e.g. the course in environmental valuation and other applied courses in environmental and resource economics for the economics department, which does not itself have expertise in this applied economics field). They should continue to be attractive for Ph.D.-students, and continue their interdisciplinary research and the way they are able to combine this with advanced applied economics research.
- However, they should try to prepare well for potential changes in staff and funding opportunities, especially with regards to increased competition for EU funds.

Programme 26: **Environmental Policy Analysis**
Programme leader: Prof. F. Biermann

Research input 2013: tenured staff: 2.1 fte
 total staff: 16.7 fte

Assessment scores: Scientific quality 5
 Productivity 5
 Societal impact 5
 Viability 4.5

Scientific quality

This is a relatively compact research group that now consists of the equivalent of five and a half full time tenured staff (with one full professor and six associate or assistant professors) and more than 20 PhD students. The staff complement has varied somewhat over the period of the evaluation, during which three full professors left the group: one to retirement and two to other universities. Overall the panel judged this to be a highly dynamic and productive research group, which enjoys a substantial international reputation, and which has made important contributions to knowledge development and diffusion over the review period.

The previous assessment (2006) rated this group 'excellent' for research quality and 'very good' for research productivity. Over the past six years the group has continued to generate world class research that has been at the forefront of international academic discussion about global governance of the environment and sustainable development. Because of its high international visibility, review panel members were already familiar with many of the research outputs of this group. And the detailed bibliographic analysis leaves no doubt about the depth, range and reach of the group's academic contributions.

With respect to the education of PhD students, this group has gradually expanded from 14 PhDs in 2007 to 22 in 2013. The self-assessment report provides ample evidence of a lively and critically informed research culture where students are presented with ample opportunities to develop intellectual and research skills. The SENSE research school, as well as international networks associated with the Earth System Governance research program, provide important opportunities for professional development, the cultivation of leadership qualities and network building related to sustainability science. In its discussion with the group the assessment panel pursued questions about supervision practices, the format for PhDs (articles, monographs), the role of co-authorship and the extent to which PhDs might be 'cast from a single mold'. The panel is well satisfied that the IVM-EPA group has put considerable effort into developing methodological training but also the intellectual autonomy of its PhD cohort.

Productivity

This is a highly productive research group. More than 600 research products were generated during the assessment period, including more than 200 articles, 180 book chapters and 25 books. Many of these were published in high profile journals such as *Global Environmental Politics, Science, Ecology and Society* and *Policy Sciences*. Edited volumes included many with top ranked academic publishers

such as MIT Press and Cambridge University Press. The expansion of the PhD program has enhanced outputs and productivity with the whole adding up to more than the sum of the parts. The panel has no hesitation to award a score of 5 for productivity.

Societal impact

This group has been involved in many high profile activities to advise international officials and organizations about policy issues surrounding environmental problems. Its members have provided advice at many levels, especially in relation to political and policy dimensions of sustainable development, climate change and business sustainability strategies.

The panel did raise the question of whether there was some sense in which societal relevance was mainly concentrated in elite international forums, involving liaison with official natural scientific bodies and with UN system organizations. Evidence was forthcoming from the group that societal involvement was in truth at multiple scales (from international to regional and local) and involved different sorts of social sectors (governmental-official, business, and civil society organizations) as well as being focused on concrete problem solving. Group members are closely linked to Netherlands government organizations such as PBL, and non-governmental groups such as the Global Reporting Initiative, WWF, Oxfam Netherlands and the Environmental Justice Foundation. The group was also involved in the call to create a World Environment Organisation in order to improve the coherence of global environmental governance.

In international political and policy circles this group is one of the highest profile academic research groups involved with sustainability governance from around the world.

Vitality and feasibility (viability)

This group has strong leadership, a very satisfactory age profile (relatively young), good financial position and a dynamic cohort of PhD students. Their home in IVM provides an excellent context for continuing to develop multi-disciplinary work on global environmental governance at the highest level of research achievement. The panel was somewhat concerned about the potential implications of the uncertainties related to the merger discussions between the two Amsterdam universities. Questions were also asked about the group's re-articulation of its research focus in terms of the earth system governance approach, and the definition of the particular niche for the IVM policy group within the evolving context of international earth system governance institutes. There was also the issue of the succession should one of more experienced researchers leave. Overall the panel was convinced that this is an effective group with considerable foresight and flexibility that should be able to navigate the more turbulent research environment expected in coming years.

Recommendations

In continuing its excellent work the group could:

- reflect more on how to define its distinctive contribution within the expanding international network associated with earth system governance;

- think a little more about the long term development of the group and its long term contribution as an international leader in this area;
- continue to actively explore collaboration and strategic alliance with teaching programs at the University of Amsterdam, which would provide potential for additional income as well as providing more teaching opportunities for faculty.

Programme 27:	Environmental Geography	
Programme leaders:	Prof. P. Verburg; Prof. J. Aerts	
Research input 2013:	tenured staff:	2.3 fte
	total staff:	12.9 fte
Assessment scores:	Scientific quality	5
	Productivity	5
	Societal impact	4.5
	Viability	4

Introduction

This research group has a well-integrated, dual research profile, characterized by the strong and innovative leadership of two outstanding, relatively young, scientists of international stature.

Scientific quality

The scientific quality of this team is above any doubt. It is internationally known, has many supportive partners in Europe and across the world, and publishes in very high-quality reviewed journals. The topics chosen are directly relevant to the challenges of the 21st century – as they are in several other groups undergoing the present evaluation, but this group has the added quality that its 'Land use' theme concerns the interface between the Earth's natural and societal dynamics in a particularly direct way. It is fair to say that the emerging field of "Land Science" is to a large degree crafted by this research group, and Peter Verburg is, as chair of the "Global Land Project" in an excellent position to do so. The risk-oriented work of Jeroen Aarts has a similar stature on the international scientific arena. Moreover, this group tackles the cross-scalar dynamics of the combined system, which is a crucial part of understanding that system. Its excellence is further confirmed by the demand for participation of this group in a wide range of European and international projects, where they usually contribute to the success of the consortium they join, and by the fact that several of its faculty have received major and extremely competitive individual grants (ERC, VENI, VICI).

Productivity

The productivity of this team has hugely increased over the last seven years, tripling the number of high-quality peer-reviewed publications and also increasing their impact factor in a major way (see graphs in the self-assessment report). Add to that the important increase in the number of PhD students that participate in the research, and it is clear that the productivity of this group has made a quantum jump over the review period.

Societal relevance

It is an interesting characteristic of this group that it substantively involves stakeholders at different levels in its research, including NGO's, government institutions and supra-

governmental agencies. This ensures that its societal relevance is not only defined in academic terms, but also in the terms of the society it is supposed to be relevant to. Partly, that is the result of the specific topics chosen – and in particular the land use theme, which focuses on the interaction, at different scales, between society and the environment in which it is embedded. Members of the group are involved in a substantive number of advisory bodies, etc., and thereby have a role in international agenda-setting.

Vitality and feasibility (viability)

The group has made an ambitious and highly successful transition from a consultancy oriented department based on tenured staff to an academic department with high-level scientific output and a large number of PhD students, and its strategy is to continue on that path. The average age of the group is relatively young. Financially, the group also seems viable, at least under the current funding regime.

The group leaders have an extremely clear view on the opportunities and constraints for the group's viability. They know very well that the current support from the EU and other public entities is volatile and they recognise the need to further diversify their acquisition of research funds. Despite their own relatively young age, they also recognise the need for high level career development of their colleagues (well-illustrated by their choice to bring a young and a mid-career colleague to the meeting with the evaluation committee).

A major concern related to the group's viability is whether the university is able to provide adequate opportunities for teaching of the senior staff members, as this factor currently seems to be one of the major obstacles for the acquisition of sufficient university core funding. Beyond that, the struggle for teaching opportunities will also hamper the possibilities of younger scientists to achieve necessary mid-career opportunities and reach suitable tenure-track status.

Recommendations

- A first set of recommendations is to keep the momentum towards the stated fundamental scientific objectives and towards innovation. It is noteworthy that “assessment” is considered not to be a final goal, and it is probably this intellectual freedom that allows the group to actually produce very high quality assessments as well as fundamental scientific breakthroughs.
- Momentum should also be maintained with respect to the international coordination of their research, despite the obvious costs of doing so. The highly significant contributions to programmes such as GLP in the past and now Future Earth provide benefits to the international community, but they also help Dutch land scientists and all international scientists passing through this research group to find opportunities for making major contributions to this field of science.
- It would also be very beneficial for the SPACE group to strongly work together with the Earth Science and Ecology groups in VU and in UvA on a collaborative vision for environmental research and education in Amsterdam.
- The final recommendation is to consider negotiating with university bodies for a better allocation of teaching opportunities. In the short term this will strengthen the viability of this research group and the opportunities of its scientists to have high international impact. In the longer term, the credibility of IVM as well as SENSE with respect to trans-disciplinary sustainability science will benefit from a solution of this problem.

**WIMEK – Wageningen Institute for Environment and Climate Research,
Wageningen University**

1. Mission, vision and policy

This is a very broad ranging network of 17 research groups on one campus. The research covers environmental sciences and management, eco-technology and applied systems analysis, policy assessments, and PhD training. There are over 300 PhD students enrolled in the programme each of whom is required to take training courses, to seek supervisors from across the network (including external campuses where relevant) and, as a broad objective (but not required) to complete four research papers, two of which have to be published and two formally submitted. All of this concentrated effort places a significant workload on the faculty – particularly the chair professors – and the general resources of WIMEK. There is a constant pressure between teaching and supervision commitments and the need to produce high quality research in high impact journals. In addition there is the usual “friction” of cross research group cooperation and coordination which is expected of a closely functioning network such as this.

We do not under-estimate these challenges, which are considerable. Yet we also feel that WIMEK has not clearly set out a vision for the coming research review period of some five to six years. This is an omission which we feel needs urgent attention. There are always issues of successional planning (the careful replacement of key researchers who may move away and the hiring and mentoring of both senior and junior research staff). And there is the changing agenda for funding and for cooperative research involving the private, public and civic sectors. Indeed there is no guarantee that in a period of continuing austerity there will be sources of funding from EU governments, including the Dutch government over the coming years. Horizon 2020 is exciting and richly funded, but the demands on its resources will be enormous. So any research and management vision also needs to consider successional funding.

The world of sustainability science is not currently well positioned. It is murky and often obscure to many in the higher education fraternity. WIMEK (and indeed SENSE generally) is in a unique position to pursue excellence in sustainability science in its forthcoming portfolio and we urge that it seeks to do so as an important part of its future mission and vision.

We admire the quality of WIMEK’s leadership and the highly committed effort that all of the researchers invest in the success of the overall research programme. This is indeed a dedicated team with huge personnel as well as corporate enthusiasm, and enviable intellectual prowess. Nevertheless, as noted above, there is still work to be done on strategy evolution and suitable management to ensure even greater integration with the social science and applied policy making with connected stakeholders off campus.

In the review period we feel the team have met their expected achievements with considerable merit. The PhD programme has blossomed, the research publication output has high performance levels, and non-academic publications have also boomed. There is still a need to assess the role of communication with policy makers and various “publics” including the schools, though we note with admiration the work on phrenology with the local

communities. For this past seven years, this is a commendable performance, but laurels are not designed to be rested upon!

2. Research quality

We salute the academic reputation of WIMEK. Both in the self-assessment report as well as the interviews and subsequent meetings with the PhD students we received a very felicitous impression of intellectual rigour, of joy in being in this active research community, and of overall excellence. We were particularly impressed by the postgraduate students who were obviously very enthusiastic and excited about their training in WIMEK, and who enjoyed the opportunities for interdisciplinarity. We offer more comment on this aspect below. The research facilities we toured were excellent with new infrastructure and state-of-the-art equipment and analytical instrumentation.

We feel the academic qualities of the programme, which are already powerful, nevertheless could be upgraded even more with attention to greater interdisciplinarity especially with regard to involvement with relevant stakeholders in civil society, in business (especially) and in the public sphere (beyond national government). And, given the demands of predicting outcomes of policy options in a very uncertain world, there is scope for more creative approaches to visioning and predicting as well as to weighing outcomes (in social justice terms) with regard to medium term (20 years) and longer term (over 50 years) consequences.

The financing and management arrangements for the review period are very fine. We have already commented on financing for the possibly more turbulent future and the management for greater involvement of the policy sciences and the humanities.

As for leadership, we recognise and respect the very considerable national and international commitments by senior researchers to activities on science boards, working groups, committees and conferences. We also note that the demands on senior researchers are growing as well as requiring even more absences, despite commendable efforts to make more use of Skype and other media. It is ironic in the modern scientific age that demands on travel and attendance can seriously conflict with “domestic” scientific requirements. This balance also needs more attention and judgement, but should be widened to the Dutch scientific community more generally than just to WIMEK.

3. Societal relevance

We are very impressed with the overall dissemination and general public outreach of WIMEK. Indeed overall this is one of the most impressive aspects of the team. There is a case for more involvement by PhD students here both to take off the pressure as well as to widen their research and communication experience.

As we remark above the role of WIMEK within the national and international scientific scene is exemplary but not without costs on faculty and travelling budgets. The conundrum of visibility and audibility in a world of greater noise and confusion on scientific endeavour and communication is not lost on us. We return to this in our recommendations below.

We read and admired the recent publication “Challenges and successes in interdisciplinary and transdisciplinary research and education”, which plays a strong role in the communication and outreach strategy of WIMEK. This makes a strong case for interdisciplinarity as well as transdisciplinarity and provides showcase examples of research from all over the world. This kind of document should be encouraged in the SENSE programme overall. It provides succour to researchers contemplating novelty, as well as offering to the paying public and to interested collaborators the merits of the research programme in its active disciplinary and methodological interfaces.

We also discussed gender balance and the very real difficulty of ensuring appropriate and adequate female representation in professoriate and in innovative research leadership. We became aware of the WU policy on gender balance and (in retrospect as we did not see this while we were visiting WIMEK) broadly support this initiative. Nevertheless even this commendable statement does not fill the recognition void facing top class female researchers. We trust that this matter will continue to receive the highest level of attention and will include appropriate representation from the PhD students.

4. PhD Policy

We are impressed by the productivity and quality of the PhD programme and by the intellectual excellence and enthusiasm of the young researchers in WIMEK. Indeed they provide huge scientific “energy” as well as forming the engine room of the evolving research effort.

The policy of requiring four publishable papers from each graduating PhD student is very commendable, and a goal that is feasible and assures research quality. It is also very demanding on students, on supervisors and on reviewers. There is clearly a plateau for PhD intake given the complement of current resources. We were pleased to hear that such a policy is now in place. But we also understand that the funding for the research programme overall is very much dependent on successfully completed PhDs. This presents a conundrum (one of many for WIMEK) over successful (and timely) completion rates and the time demands of interdisciplinarity and of policy related research with a component of outreach to external stakeholders. It is not easy to resolve these difficulties as they present a formidable challenge.

One possibility is to change the manner in which PhD students are evaluated so that their contribution to supporting their peers, and for informal teaching and research seminars, is given appropriate weighting. This suggestion would extend to mentoring “younger” (in entry) PhD students and to supporting research effort by “twinning” research students in some variation of “dual disciplinarity”. Another possibility (already in hand) is more formally to provide “sequencing” of research where a successor PhD follows on with the data from the earlier PhD but with a wider tack to the research effort.

We are impressed to hear of the various courses offered to incoming PhD students and the scope for providing a stimulus for the interdisciplinary aspects of the research programme. Again we look for even more attention to the introductory two day course (currently offered for SENSE overall (and hence including WIMEK) possibly by an extra day) to meet student expectations of meeting each other and of understanding the scope for taking courses in sister universities and research programmes.

From the discussions with the students we gathered a general view of overall satisfaction with the whole of the PhD programme. It was mentioned that there was some variability

(much greater in SENSE as a whole) in the understanding and levels of commitment to supervision by faculty. Here we see an even greater role for the very successful appointment of the PhD coordinator of the WIMEK programme, Monique Gulickx, whom we felt was undertaking her job with great competence and sensitivity. Indeed this position should be given more freedom to work with students on the twinning, sequencing, and mentoring aspects of their research contributions, as well as help to support students obtain the very best supervision available both within and across disciplines and research groups.

We certainly understand the demanding requirements for all researchers concerned in making these observations.

5. SWOT

We have offered comprehensive commentary above on the many SWOT aspects of the WIMEK programme. In summary, the strengths lie on the quality of the research effort, publications and outreach, and the opportunities lie in the exciting realms of sustainability science. The weaknesses appear in the lack of vision and a coherent research strategy for the new research era, and the threats may lurk in variable funding, research capability (without reform) and lack of clear succession planning.

Our main recommendation lies in the necessity of creating an innovation fund. There is an annual pot of resources which stems from successful PhD graduations. This could provide seed money for this fund which would be of the order of 250 000 Euros. Its purpose would be to stimulate new approaches to research, to encourage “risky” but exciting and potentially remunerative research, and to invest in fresh forms of supervision, work experience, apprenticeships, and mentoring. It would be handled by a mix of faculty and PhD students so the latter have buy-in to the future of their research. The fund could be fuelled by the fruits of successful research in the form of intellectual property rights, patents and consultancy money. It would also be available to fund a successful PhD student towards the end of their PhD career in the form of continuation support where the student is clearly productive, innovative and potentially developing lucrative results.

6. Recommendations / suggestions for improvement

- This is an excellent overall programme with high performing faculty and PhD students. It has a very commendable international and national reputation. It succeeds in its performance measures for the review period, and it more than succeeds in its outreach and community involvement.
- There is a need to re-evaluate the social sciences, policy supporting and creative elements of the overall research programme. This is especially the case for the attention which is now required for upgrading the effectiveness of policy making institutions in the fields of sustainability science. This covers both the architecture of such institutions as well as mindsets and accountability.
- Dealing with future impacts of current social behaviour and policy making with regard to both the social justice and the wellbeing of future generations requires more involvement and integration with the creative arts, notably storytelling, art, dance and video presentations.

- The PhD student should be enabled to provide more support for the whole research effort and be recognised in the overall performance review. There is a need for a fuller “account” of student role and activities including mentoring, organising seminars and discussion groups working outside campus in business or government generally or civil society, and in supporting supervisions and parallel or sequential research with others. In general the PhD student should be an integral part of decision making over research vision, management, strategy and collective evaluation. This may lead to a reassessment of the “four paper” requirement code for PhD success, but we regard this as a matter for our colleagues to consider.
- There should be provision for an innovation fund of some magnitude. This would not be tied to any given research element, let alone an individual research student or faculty. This would be a corporate fund run by a corporate research trust consisting of faculty and PhD students cooperating in concert. It would be funded by a combination of the “PhD student success” money, by the receipts from patents and intellectual property rights, but outreach programmes, by research based consultancies, and by stakeholders (including charitable foundations). Its role and purpose could include:
 - Supporting innovative research especially of a truly transdisciplinary nature
 - Various forms of work experience and ambassadorships by research students and faculty
 - New approaches to methodological training and to informal research group training
 - Improved outreach to local communities, to schools and to stakeholders
 - A wider communications and publications effort.
- We regard the introduction of an innovation fund as vital for the future viability of a highly successful research programme. It is also central to the future significance of the SENSE network overall. It should be designed to capitalise of the strengths and opportunities which we have identified above, and to overcome the weaknesses and threats which perpetually lurk in the shadows of the luminosities of any much praised research effort.

Programme 28: Aquatic Ecology & Water Quality Management

Programme leaders: Prof. M. Scheffer; Prof. A.A. Koelmans

Research input 2013: tenured staff: 3.2 fte
 total staff: 22.2 fte

Assessment scores: Scientific quality 5
 Productivity 5
 Societal impact 5
 Viability 5

Scientific quality

The group excels in all aspects of scientific quality: publications in high quality journals, impact of the research, international reputation and leadership, and graduation of well-educated Ph.D. students. The research group is addressing highly important scientific issues that have direct societal relevance. There is strong leadership from Prof. Scheffer, and he demonstrates the clear vision of the group on its research strategy as well as on training of early-career (Ph.D. and postdoc) researchers. The output is broad-based across the group and is being published in the most respected journals on a regular basis. There is a good link between ecology and water quality, and the group is tackling complex problems through interdisciplinary studies. There is a good combination of laboratory microcosm, mesocosm, and field research which helps to validate models.

Among the Ph.D. students, there is a strategy of quality over quantity of publications. The goal is to have at least 3 solid journal articles for the Ph.D. dissertation, but an additional 1-2 chapters can involve more adventurous studies to probe new areas and facets of the topic. The leadership in the group has the ability to formulate the right question(s) for each project.

The seven research staff have diverse capabilities, and there is flexibility among their responsibilities in terms of teaching, contributions to research, and professional service. The group is functioning well together and is taking advantage of the different professional skills and strengths.

Productivity

The group productivity is excellent. This is reflected not only in the number of publications but also the strong citation metrics (e.g., h-index, RI, top ranked papers), the extensive communication of their findings to their professional colleagues, the public and decision-makers, the number of professional awards, and the extensive scientific collaborations and information-sharing network. The group produces on average one journal paper per week. There is a clear statement of quality before quantity and a good track record with research funding. There is a large group of active Ph.D. students.

Societal relevance

The research program combines innovative and cutting-edge fundamental science with high societal relevance through addressing questions on ecosystem resilience, water quality management, climate change, but also branches out to other socially relevant themes such as mental health. There is excellent visibility of the research results in the popular media. The utility of the results is evident through collaboration with commercial partners and/or adoption of research results by policy makers.

The topics being addressed have far-reaching implications for environmental and societal sustainability and quality-of-life throughout the world. The group is working on some pressing contemporary issues—marine plastics, eutrophication, engineered nanomaterials, pharmaceuticals and personal care products, antibiotics, pesticides, cyanobacterial toxins, and managing rivers, lakes, and marine coral reefs—and this group is providing insights into their resolution.

Vitality and feasibility (viability)

A telling sign of a group's viability is how much effort is afforded to capacity building among younger colleagues within the group – and clearly this is a very high priority. Additionally, they have a well-considered strategy for guiding their future activities, they are expanding their research interests into relevant areas, and they are remaining focussed on issues of great scientific and societal importance. The group is strong and productive, so Prof. Scheffer can branch out and pursue new ideas while other members of the group work on their own to carry out current projects. The group has diverse funding, excellent facilities, and is able to attract good students.

The goal is to more or less maintain the current excellent trajectory and maintain the resiliency of the group. The current 2-3 Ph.D. students per research staff member is a stable operation. The plan is to hire at least one new tenure track staff to replace a pending retirement.

The culture in the department is a bottom up structure so that staff and students are all able to contribute to the success of the group. Much credit goes to Prof. Scheffer for his inspiration and attitude to foster creativity and good communication for the exchange of ideas. For example, the entire group gets together every two weeks over lunch to converse and share ideas. Alumni are invited back for an annual social gathering to share “lessons learned” and offer advice to current students.

The SWOT analysis reveals two relatively minor concerns for the group. The first is that the university has restructured their finances and now charges for lab space. Plans are underway to deal with this new financial policy that means that additional money needs to be raised for the group budget to be in balance. Second, the students require advanced mathematical modelling skills that have disappeared from the curriculum at WUR. This makes it difficult for the AEW students to obtain the skills through courses. The plan to correct this deficiency is to develop a course within the group that will provide the needed skills, especially to Masters students.

Recommendation

An exceptional group, such as this one, should be formally recognized (and rewarded) for their research excellence and leadership. We often do little to recognize good leaders in science and engineering. The AEW group could be a wonderful inspiration to other groups, not only in the SENSE system but in other countries. SENSE should acknowledge such an exceptional group and help transfer this model to other groups in the network.

Programme 29: **Earth System Science**
 Programme leaders: Prof. R. Leemans (since Feb. 2012)
 Prof. Dr P. Kabat (until Feb. 2012)

Research input 2013: tenured staff: 1.8 fte
 total staff: 24.1 fte

Assessment scores: Scientific quality 4.5
 Productivity 4
 Societal impact 4
 Viability 4.5

Scientific quality

This group has a strong research program, and the research quality is very good to excellent and with strong research impact in the areas of climate change with a focus on water. They have been expanding this to including climate change impacts at the interface of water, food and energy (interactions of the water and carbon cycles), and to explore how climate change adaptation can be included within integrated assessment models/studies. We believe that this research direction is at the cutting edge of their field, and this group can be an important leader internationally in developing quantitative methods for developing climate adaptation methodologies.

The impact of the work varies across the staff members, with many staff personally having excellent impact, and publishing in the good journals (e.g. *Nature Climate Change*, *PNAS*, etc.), which should be expected for this highly topical area of research.

The research strategy of using existing models through collaborations with outside groups has been explained as offering the necessary flexibility to apply the most appropriate methodology for the specific research problem, and not to lock the group into specific tools. We find that this strategy can be effective with appropriate collaborations with their developers, and research value can be added in integrating the different models together needed for their research.

Productivity

The number of peer reviewed publications per year has increased from 35 to 58 over the evaluation period. Given a group size of 19 researchers at post-doc level or higher, this corresponds to some 2.5 publications per person over the last three years. With the recent growth in the size of the group, the review committee expects this number to increase. There is also a large number of non-refereed publications, reflecting both the requirement from grant agencies for reports and the need for dissemination of results to non-academic organisations and government.

The external funding profile in general is excellent. They graduated 2 PhD in 2007, rising to 4 in 2013; and expect to increase this going forward. With 7 tenured faculty and ~24 PhD candidates, the chair should be able to sustain 4 to 5 PhD graduates per year, which the committee deems to be a very good level.

Societal relevance

The research topics being addressed by the group are of the highest possible societal relevance, and are likely to remain so for the near future. However, although the group makes some claims to multi-disciplinary research with social scientists, the majority of the publications, including the 5 keynotes, focus more strongly on the physical and biological components of climate impacts, where they feel their research can be most impactful and where the needs of the climate adaptation community is greatest.

The group sees their societal engagement being directed mainly at institutional and governmental levels, for example through dissemination of an climate change water atlas showing impacts that allows for dialogue with local and regional government stakeholders that gives the group feedback onto their research, through influencing the EU water framework directive and its policies, and through the IPCC reporting on adaptation.

The ESS group has attracted an increasing number of research grants at this institutional interface and is actively engaged in consultancy with various bodies nationally and internationally.

These forms of societal engagement seem appropriate to the research activities of the group.

Vitality and feasibility (viability)

The group has seen a substantial growth over the evaluation period and has managed to establish its place in a relatively young and thriving field, i.e. 'Earth System Science'. It aims at using 'the best available model' from the diverse sub-disciplines in order to obtain an integrated assessment of carbon and water cycles and their impact on potential developments due to climate change, land and water use, which are all highly relevant for society (and influenced by it at the same time). Clearly, its research strategy is based on the *natural science aspect* of the carbon and water cycles, seeing its own role in the exchange with social sciences (rather than adopting social science methodology themselves) in order to arrive at solutions for society. The ESS group plans to expand its portfolio into the direction of 'mitigation, adaptation and sustainability strategies', the former two key words being mostly used in relation to climate change. With this, and given the modeling strategy, the group's overall goal might be summarized as 'to make mitigation and adaptation more quantitative'. The review panel judges this to be very timely, up-to-date and relevant. The group appears to have a good potential to reach this goal, especially through the presence of a number of active and promising young scientists at the associate professor level.

Since the position of the group's chair (Prof. Kabat) is presently vacant, however, the chances to reach this goal are largely dependent on the success of adequately filling this position. The review panel recommends to searching for a top-level individual at highest international standards. Given the substantial international competition in the field, this seems necessary in order to assume a leading position in at least some of the areas that are especially relevant for The Netherlands. Hopefully the appointee should be in agreement with the research strategy and approaches being advocated by the current members of the chair, since the review team feels that there is potential for the team to make stronger, sustained impacts going forward.

Recommendations

- The review committee recommends that the vacant chair be filled at the earliest convenience, and that the research vision of the successful candidate be consistent with the current research thrusts and activities of the current group.
- We believe that the interim chair (Prof. Leemans) could remain as a mentor to the research group as the new chair settles in, as this would provide important continuity.
- While recognizing the quality of the research activities of the group, it is important for them to define the compelling science questions for their field as this is necessary for them to rise to the next level of international impact.

Programme 30: Environmental Economics and Natural Resources

Programme leader: Prof. E. van Ierland

Research input 2013: tenured staff: 2.4 fte
 total staff: 10.5 fte

Assessment scores: Scientific quality 4
 Productivity 4
 Societal impact 4
 Viability 4

Scientific quality

We were impressed by the team we interviewed. We are also impressed by their commitment to furthering the role and effectiveness of environmental economics to the study of environmental management issues especially in water management, climate change, biodiversity and ecological services valuation, and environmental risk management. On the criteria for our review we believe this research programme to be effective and of international recognition.

Nevertheless our reaction is that despite improvements in the post review period over the past five years, the team is retaining its primary focus on environmental economics rather than ecological economics. So there is good work on natural resources, on environmental risk and on climate change and adaptation. But the shift to more ecologically orientated economics of the kind being promoted by the International Platform on Biodiversity and Ecological Services is still in progress.

Such research is more and more interdisciplinary involving sociology and ethics. We recognise that the Group is working well in the arenas of interdisciplinarity. But we are also charged with offering guidance for the forthcoming review period. We feel that the team seem to be a little undecided about how to achieve this. In our view interdisciplinarity both as in research as well as in publication requires a broader treatment of the subject matter. It is not a threat nor is it a weakness. It is a glorious new hope. But it required nurturing and careful positioning of researchers and new appointees to the programme.

Productivity

The productivity of the whole Group is significantly improving and also widening in both publications and in research output. This is a very promising trend. But the need for a broader ecological and social economics is pressing on the team. It should also be looking for widening the publication locales. There is a subtle irony that the top line journals are also the least enthusiastic over interdisciplinarity. This is particularly the case in economics. Heading only for the best may reduce the breadth and excitement of the emerging research agenda.

We believe that the Group still needs to make progress in both the effectiveness of its publication strategy and output for the furtherance of sustainability science.

We are impressed by the care and attention it gives to its PhD students. It also seems to have found the balance between maintaining an effective number of PhDs as well as combining research with supervision.

Societal impact

We note the active involvement of many members of the Group in international and national commissions and review committees. This is very much to be applauded. We also note the sincere efforts by the Group in the realms of the economics of climate change and in water management (especially coastal change) as well as crucially in risk management over toxicity.

We recognise that part of societal impact lies in the training of PhD and Masters students in the economics of environmental policy instruments. This is particularly the case with respect to case studies. But we repeat our refrain that the effectiveness of this Group for future researchers and policy-makers would be further enhanced by the extension of their research and teaching into the interdisciplinary aspects of integrated natural/social capital assessments along with suitable case studies.

Vitality and feasibility (Viability)

For the reasons we have offered, we feel the Group is both moving forwards in the realms of existing work, but less effectively in the areas where economics now needs to pitch its tent. Here is where the exciting new research is focussing: broadly in the shape of valuing ecosystem functions, providing policy support for resilience in nature and in people, and developing the exciting field of social wellbeing.

It would be helpful if the Group looked to strengthening its PhD programme by incorporating these dimensions into both its research and teaching. This should be possible through even greater collaboration with other research groups in WIMEK, notably environmental policy analysis and environmental systems analysis. We recognise that such collaboration between students and supervisors already takes place.

There is also a world to be captured in the mixing of social judgements and nature creation, the opening up of “new nature” at the scale of the community and town. It would see appropriate that the Group make use of its interdisciplinary skills as well as its colleague in landscape design to explore this very interesting field for research and community learning.

Recommendations

- We urge the Group to explore the emerging world of sustainability science. This involves the closer integration of the natural and social sciences as well as the creative arts linked to the collaborative involvement of the public, private and civil society sectors. Such a move would connect the Group to the promotion of Future Earth as enable better cooperation with the policy and practitioner worlds.
- There is also a strong case for more direct connection to policy analysis in the areas where environmental and ecological economics apply to forms of land use, of adaptation

of planning and development to climate change, and of involving the community in greater self and collective awareness of behaviour change with regard to the use of energy, water, waste and food.

- A special aspect of sustainability science is awareness of future impacts of current policy measures. Here is where conventional economics is weak, for it tends to emphasise short term payoff and shareholder gains. The group could well implement a programme of more forensic assessment of new economic policy tools to deal with the longer term aspects of resource usage through assessments of discount rates and fresh forms of participatory engagement. Here is where there is particular need to bring in the institutions of market regulation and corporate management.
- We also urge the Group to capitalise on the proximity of the Landscape Design Group and the environmental systems group to promote new research and training in the high value of interlinking both design of coasts and landscapes (including urban landscapes) as well as the connections between climate change modelling and policy making and new approaches to long term social and economic assessments along the basis of both resilience and adaptability.

Programme 31:	Environmental Microbiology	
Programme leaders:	Prof. H. Smidt; Prof. F. Stams; Prof. W. de Vos	
Research input 2013:	tenured staff:	1.7 fte
	total staff:	16.4 fte
Assessment scores:	Scientific quality	5
	Productivity	5
	Societal impact	4.5
	Viability	5

Scientific quality

The microbiology group in Wageningen is clearly world leading in several areas associated with particularly anaerobic microbiology. The three full professors are renowned, which can be derived through the awards and keynote invitations listed. They are highly successful in obtaining top science funding such as NOW, ERC, Dutch GRAVITY funding and so on. The group publishes in high outlet journals such as *Nature Reviews* and *Science* besides the qualitative outlets such as AEM, EM... They work together with about 10 other PIs on the WUR campus showing good connection with other fields of study or engineering applications.

Productivity

Within SENSE the group produces about 30 peer reviewed manuscripts per year, however in its totality (including the other research schools the PIs are involved in) their output totals about 80 peer reviewed manuscripts per year. There are some fluctuations in PhD graduations with only 2 in the past year, however in the coming year 10 students will graduate. The involvement of MIB in several doctoral schools leads to cross-fertilization, and during the interview it was clear that the group values the interaction with multiple organizations including the regular evaluations received through this.

Societal impact

The research performed in the group is highly relevant for society and commercial applications are regularly realized. They adhere to focused research driven by existing interest from science or application. Within the self-evaluation document prepared for the SENSE review, the PI mainly focused on the PhD training aspect and limited information was provided on outreach efforts and contact with a broad collection of stakeholders. The MIB Rebuttal report contains a listing of recent presentations to the general public (e.g., public lectures, radio, and newspapers), industry/government, and students that are non-majors. The list does show that the MIB group is interfacing with society in a positive way. The panel felt that given its size and impact, MIB could develop a more defined or visible strategy to articulate the societal relevance of the research and expand the number of stakeholders contacted.

Vitality and feasibility (viability)

The group is headed by three senior academics, two of whom are in a late stage of their career (but highly active). In anticipation, MIB has started to attract junior academics such as Diana de Souza. Three junior staff are now in tenure track, and a fourth will join the group later. Given this fact, it is the assessment panel's conclusion that staff continuity appears ensured. The younger staff also commented on the excellent mentoring by the senior staff. Furthermore it is clear that the group has acquired significant research income via various funding channels leading to a stable funding situation at least for the coming 5 years. The researchers themselves highlight the issue of needing to go for co-funding e.g., for GRAVITY grants, which is often complicating the ability to successfully acquire grants requiring co-funding.

Recommendation

MIB is clearly a top group internationally, combining scientific relevance with end user benefit. Our only minor comment is that a more explicit statement be articulated on the societal relevance of the research and expand the number of stakeholders contacted.

Programme 32:	Environmental Policy	
Programme leader:	Prof. A. Mol	
Research input 2013:	tenured staff:	3.9 fte
	total staff:	24.0 fte
Assessment scores:	Scientific quality	5
	Productivity	5
	Societal impact	5
	Viability	4.5

Scientific quality

This is a world leading group in many aspects of environmental policy analysis and planning. It has gathered strength since its last review which also regarded it as excellent in its science and innovation. We see in this group a broad based contribution by a number of key academics together with a clear sense of research direction, especially in policy relevant research and in interdisciplinarity. The faculty are quite small in number (10.1 tenured staff full time equivalent). But the PhD contribution (18.4 fte PhD research capacity, based on over 40 registered PhDs) both to research output and to managing the programme is considerable. The team has extensive contacts with a number of leading universities and research institutes. Its scientific papers are widely cited and appear increasingly to be nationally and internationally appreciated.

We feel this programme is possibly slightly too large for such a relatively small faculty where teaching and research need to be carefully coordinated and managed. Admittedly the team is diversifying its funding base towards international programmes and to business and foundations. But it remains vulnerable to budget cuts and to shifts in the perceptions of value in policy research more generally. There is thus a case for strengthening even further its outreach with sister institutions on campus (environmental systems analysis and environmental economics in particular) and in the Sense network (possibly Copernicus).

We also noted that there could be an issue over succession. The three professors are widely respected and clearly lead from the front in top journal publications. There is always a case for strong proactive management in succession planning and we commend the Group to look into this matter.

We rated this group as “excellent” and commend it on its past performance. Yet we also offer below suggestions for transformation in the current review period.

Productivity

The productivity is also excellent. Here is a group with limited resources publishing in top line journals and also engaging with policy makers. It also places much emphasis on the work of its PhD candidates who are treated as central to the whole research effort.

The team is concentrating on governance generally and on natural resources management, sustainable consumption and social sciences roles in these policy arenas more generally. This is uplift, and it is exciting. There are other emerging arenas particularly in resources management in developing economies and in emerging economies where the team are also

building an impressive outreach. This aspect needs to be further encouraged as it will strengthen the teaching and learning productivity of the group as a whole.

In summary, there is a notable increase in research publications of very high quality along with a nurturing of the research community. So the key proposals of the previous review panel seem to have been met. There is a broader research base, there is a clear research strategy, and there is a widening of the research prospectus with greater integration with the host institution.

On the basis of continual improvement and high profile citations we award this group an “excellent” rating

Societal impact

We applaud very considerable policy and academic achievements of WU-ENP in the world of communication and dissemination. Since the last review there has been a massive explosion of effort by what is still a relatively small team. But the scope for real entry by the social sciences into the policy realms of sustainability research and effectiveness requires even more targeted effort as this relative weakness in science based policy making reveals a critical gap in the lack of success for sustainability science. Here surely is a zone which this group in particular should champion, though it has excellent colleagues in WIMEK and WU-ESA. It would be timely to see these energising linkages being given even more attention.

Vitality and feasibility (Viability)

The team is continuing to evolve in its approach to sustainability orientated policy analysis. It has a track record for analysing governance systems, for assessing associated health risks linked to various policy options over controlling pollution and waste, it is examining fair and equitable sustainability standards in environmental regulation and probing sustainable agriculture.

But we learned that it has access to a fund for supporting further strategic direction. We also hear that it has still to find an appropriate balance between teaching and research. We regard this therefore as an opportunity for some fresh thinking about the handling of their research community in general as well as the rebalancing of research and teaching effort.

We feel there is still work to be done here so we awarded the group a 4.5.

Recommendations

- There needs to be a fresh review of strategic direction. This is the case for any such high achieving group. This reassessment should take the form of improving the inter-linkages between the social sciences and especially the governance aspects of both environmental decision-making in socio-technical areas such as “green” technology, and in regulation and political analysis
- There is also a case for taking much further the special features of sustainability science. Here there is an opportunity for the team to assess the regulatory aspects of governance

in technology, in societal risk, in climate related hazard, and in adaptive forms of political institutions. This new work should explicitly be cooperatively designed with business and civil society organisations, as well as the schools.

- Policy analysis covers governance generally and especially the increasing interconnections between the public/private and civil spheres. This broad canvas requires a careful examination of the institutional architecture and mind sets of policy making and decision review. We feel there is further scope here for the Group to probe into the sustainability science aspects of governance policy making and to offer a lead for the whole of WIMEK and indeed Sense in this arena (bearing in mind there are other highly regarded policy groups in the Sense network). There is a particular need to incorporate the creative and future orientated aspects of sustainability policy analysis as we discussed with the Group in interview
- We also feel there is a good case for carefully calibrated successional planning for the Group over the coming years.

Programme 33: Environmental Systems Analysis

Programme leader: Prof. R. Leemans

Research input 2013: tenured staff: 3.1 fte
 total staff: 18.8 fte

Assessment scores: Scientific quality 5
 Productivity 4.5
 Societal impact 5
 Viability 4

Scientific quality

This, by any standard, is a “hot shot” Group. It is world leading in its firepower. Its researchers are internationally esteemed, and its overall contribution to the world of scientific excellence is without doubt. It has an enviable and growing publications list, it had more and more of its key people in international scientific committees and academies, and its research topics and general approach are constantly innovating.

The particular strength of the Group’s scientific quality lies in its comprehensive approaches to systems analysis and in its overall interdisciplinarity. Its three prime components: pollution and nutrients; biodiversity and ecosystems services; and environmental change and society are all cornerstones of contemporary environmental management. What is impressive is the flexible ability to incorporate researchers of different disciplines and to embrace PhD students with a similar motivation and experience.

The Group is also considerably involved with both national and international dialogues over integrated approaches to environmental management and sustainability and is championing the Dutch input into the emerging Future Earth programme. It also contributes extensively to international scientific forums, possibly at or beyond the point where senior faculty are very highly stretched and often absent. This has potentially adverse implications for Group level interdisciplinary excellence and for overall PhD supervision.

In this context, we note that this considerable commitment and stretching of scientific “space” could make the Group vulnerable to changes in scientific priorities or to spiky shifts in policy direction and policy requirements, and that the Group is currently not envisaging possible new research directions and programmes.

In essence there is considerable scientific “churning” but no clear sense of adaptability to emerging fields of sustainability science.

Nevertheless, we rate the scientific contribution of this group as “excellent”.

Productivity

The publications list is hugely impressive, covering modelling, policy analysis and social behaviour, reaching out into business, science, government and to a lesser extent, to civil

society and community organisations. Its citation and impact performance indicators are also progressively improving, a sure sign of a research community on the move.

But there is a discrepancy in the listing of first authors relative to all research-active faculty. Some appear more than once and others not at all. We suggest that the management of author listing be given careful attention and that in future assessments, the contribution of the lead authors is stated with clear explanation.

We also feel the emphasis (which we recognise is not mandatory) on four published or submitted articles for reviewing scientific productivity can lead to distortions in both collegiate research working and in effective participation. There is a case for even more attention to be given to qualitative support for publications for teams in the form of written assessments of support services such as mentoring, editing and encouraging informal research dialogues. We do not detract from the need for high profile publications. We are concerned that the emphasis on first (or second) authorship may not encourage informal collaboration of overall fairness of treatment, especially within the PhD community. We are impressed by the care and attention offered by the ESA team to all PhD students who they rightly regard as their most precious resource

Because of the somewhat focussed approach to research emphasis as well as to lack of clear innovative direction in opening up the graduate as a potential teaching resource, we evaluate scientific productivity as 4.5.

Societal impact

This group is well positioned in the fields of science policy and of policy analysis more generally. It is continually improving its penetration into these areas and is surely influencing them, both in the Netherlands as well as internationally. There is scarcely a major science conference where this group is not well represented. And in the emerging field of Future Earth, Rik Leemans is widely regarded as a world leader. Yet this is a still emerging field, so there is a need for signs of even more effective engagement with business, government and civil society than is the case at present.

In the growing and exciting fields of “citizen science” the Group is excelling. The use of mobile GIS in smart phones to record changing phrenology is very well executed. Overall engagement with local schools and in helping to design integrated applied environmental planning and management in schools are also exemplary.

Vitality and feasibility (Viability)

There is always irony. The more impressive the research record and outreach, the more there is expectation. The more successful, the more there is a search for greater innovation and even deeper impact. A group at this level of excellence cannot rest on its laurels. But the next phase of “laurel evolution” will be more challenging and may well involve whole new styles of learning, engagement and effectiveness. Being top is a lofty but precarious locale.

We comment below on the scope for a change in both scientific emphasis as well as the treatment of the mighty PhD programme. In the context of these comments we evaluate this Group as “very good”.

Recommendations

- The Group should address sustainability science more purposefully. This means also addressing the opportunities being offered by further embracing Future Earth. We recognise that the Group (and especially Rik Leemans) have played a key role in establishment of the Future Earth over the past two years. We recommend that they need to refocus on the research opportunities offered by the emerging Future Earth agenda. This suggests giving refreshed attention to even more interdisciplinarity, especially in the arenas of governance, the politics of policy making, and the role of power relations in environmental management generally and in the faltering transitions to sustainability. We do not see sufficient capture of political processes, of regulatory capture and failure, of the concern and appropriate weighting of impacts of policy choices for future conditions and future generations, and for better and more effective engagement with governments, business and civil society more generally.
- The emerging fields of ecological economics and biodiversity valuation in policy-making also require a fuller governance and societal dimension. Valuation requires both reliable modelling and prediction and well as good interconnections between ecological and decision policy analysis. But the primary requirement lies in social judgements which in turn are rooted in knowledge and aspirations. The work of this element of the Group would be enhanced by greater social science and humanities involvement and widening the success of the citizen science programme.
- The PhD students should be even more effectively brought into both strategic decision making and into the collaboratively evolving sustainability science realm. The graduate student body should be regarded as a teaching resource as well as a self-supportive learning experience
- There is also a case for the PhD students to be given scope for collaborating with external research contacts both in terms of work experience as well as to be ambassadors for the transformation to sustainability more generally.

Programme 34:	Environmental Technology	
Programme leaders:	Prof. H.H.M. Rijnaarts; Prof. C.J.N. Buisman	
Research input 2013:	tenured staff:	3.4 fte
	total staff:	27.2 fte
Assessment scores:	Scientific quality	4.5
	Productivity	5
	Societal impact	4.5
	Viability	5

Scientific quality

This group has a long history of doing high quality work in environmental technology. The vision and mission articulated in the report indicate that they know who they are and where they are going. New processes are being developed regularly, and the practical technologies being developed have a sound scientific underpinning. The presentation revealed that several interesting and meritorious interdisciplinary projects are underway. The recent hire of Prof. Rijnaarts in 2009 has helped put this subgroup on a good trajectory. The high visibility of both Professors Buisman and Rijnaarts in the peer-reviewed literature and at major conferences is laudable. A challenge will be to develop strong profiles in the junior faculty as the new lines of research are being set up.

The group scores well in the quality of its peer reviewed publications, with an RI value that is very high (2.30 on average with 29% of their papers amongst the top 10% of the most frequently cited and 6% amongst the top 1% of the most frequently cited). The quality of the group is also evident by a steady increase in external funding (both from NWO and EU). There is a good supervision strategy for Ph.D. students.

The Self Assessment Report does not reflect the actual quality as Table 2.1 on Research Staff and Table 5.1 on Publication Numbers contain faulty data and are incomplete. For example, the data in Table 5.1 indicate that the number of Ph.D. students has remained essentially the same over the past 7 years, but some of the students are not counted (so the data in the table are low). The current number is around 50 Ph.D. students. More importantly, the data on publications (Table 5.1) is incomplete. The Ph.D. students are making many conference presentations, and there are stories about the group's findings frequently in the newspaper and television. The low numbers for conferences and publications for the general public in Table 5.1 are not accurate.

Productivity

There is an excellent upward trend in funding, the group is publishing in good journals, and the group is maintaining a high level of productivity. This group has good critical mass and good metrics. This includes >5 papers per year per tenured staff and a good Ph.D. student to staff ratio. There is a strong emphasis on publishing in high quality journals rather than in conference proceedings (a good objective). Based on the two program leaders (Rijnaarts and Buisman) and the number of tenure staff, the productivity of the group is very good. The current leadership has been able to generate more productivity with the same staff.

Societal relevance

The group is working on many important environmental issues organized around biorecovery, reusable water, and urban system engineering. The work is on a more technical and technical system level. For example, new technologies based on biomass for creating a more sustainable future is a core area in today's energy and environmental research internationally. The group has developed a number of new, partly patented, technologies in this area and has thus contributed to a high extent to the knowledge and options for future sustainable system developments. A number of start-up companies have been initiated from the research which shows excellent societal relevance in this field. The team excels in knowing which topics to study in terms of relevance and has experience in translating research either to commercial outlets or to the public.

There is limited discussion in the report of a strategy for identifying what kinds of benefits for society are associated with different research areas. For example, are the spin-off companies making a profit and/or are they working on technologies that are likely to have a large global impact? The group is likely doing more than was reflected by the self-assessment report.

Vitality and feasibility (viability)

The viability of the group is excellent given the numbers of Ph.D. students and the existing team of research staff. With new and energetic leadership the group has managed the transition time well. They recently moved into a new facility that carries increased costs to maintain. Despite the big turnover in staff and the recent move to a completely new facility, this did not impact or disrupt the productivity of the group. Although the SWOT analysis shows some significant challenges (e.g., infrastructure costs and the cost per Ph.D. student have increased), the ambitious and well thought through plan indicates vital leadership. The key researchers are very active in international conferences, editorial work, and professional service, which are good signs of a vital organization. The continuous increase in funding (with a substantial fraction coming from external funds) over the evaluation period is good and allows for an expansion of research projects. Not reflected in the self-assessment report, but communicated during the presentation is that there is considerable interaction of ETE with other groups, including Microbiology and Colloid Science. This will help to bring in fresh ideas and provides a balance between basic and applied research. This interaction is also essential to work on the complex technologies being studied.

The long term funding prospects remain good as water is among the top sectors in The Netherlands. The group has been successful with projects funded by NWO and is a partner with WETSUS, a new center for sustainable water technology. A large proposal was recently submitted to study water availability at the system level. The strong cooperation with industry also helps with funding sources. Seeking additional NWO funding is a challenge for the multidisciplinary projects being proposed by this group as the NWO funding is typically distributed along disciplinary lines. The group is building a research program in environmental urban management and also moving to increase their research portfolio on the relevance and fate of micropollutants in aquatic systems. Both of these areas have a bright future.

The age distribution of the staff is good. Both the group and WUR provide good mentoring for the junior staff. One area for growth that could benefit the program is to bring in more

post-docs to interface between the research staff and Ph.D. students. There is an excellent framework to guide Ph.D. students through the program. WUR has courses on professional development for Ph.D. students that appear to be worthwhile. And SENSE helps promote interaction among the Ph.D. students. One good goal of this group is to recruit Ph.D. students with higher talent.

Recommendation

In general, the self-assessment report was short on highlighting the interactions this group has with other groups on the Wageningen University campus and with other institutes. The quality of the research and societal impact is better than reflected by the report. The educational program and business model by this group is making a good contribution within the University. The recommendation is that future self-assessment reports include expanded descriptions of the high quality contributions being made by this group. Furthermore, the incomplete data in Tables 2.1 and 5.1 should be updated in the SENSE database.

Programme 35: Hydrology and Quantitative Water Management

Programme leader: Prof. R. Uijlenhoet

Research input 2013:	tenured staff:	1.5 fte
	total staff:	7.4 fte

Assessment scores:	Scientific quality	4
	Productivity	4.5
	Societal impact	4
	Viability	4

Scientific Quality

The group consists of the chair professor (Prof.dr. Remko Uijlenhoet, who was appointed in 2007), two associate professors (1 tenure track), two assistant Professors (1 tenure track) and a guest expert (0.20 fte.) The self-assessment listed the group's research areas as: (1) hydrometeorology, (2) environmental fluid mechanics, (3) catchment and land surface hydrology and (4) hydrogeology. In the discussion with the assessment team, the chair presented the vision that the group's scientific focus is centered on questions related to the global water cycle and their implications at local scales, which include the need for an improved understanding of the functioning of hydrological processes at fine spatial resolution (i.e. catchment scales.)

The trend of improved scientific quality of HWM noted in the WIMEK Midterm Evaluation report (2007-2009) has continued, and by almost all metrics has accelerated over the last few years. This can be attributed to the leadership of the chair professor.

During the assessment period a new hydraulic laboratory facility was opened, and is used as both a teaching lab as well as a research lab. The lab is an important facility for HWM and WUR. Publications based on experiments in that lab are starting to appear in very good water journals (e.g. *Water Resources Research*). The operating budget of the lab is quite large (~€100,000 per year) but by international standards the lab is quite small. It is important that the selection of problems in the hydraulics and environmental fluid mechanics areas be strategically selected to maximize the impact of the research from the facility.

Since the appointment of Prof. Uijlenhoet, the group has made a significant effort to achieve the highest international standards. A network of international collaborations has been established through the involvement of the Group members in international scientific organizations and EU projects. Their efforts in organizing scientific symposia and reviewing papers has been valuable. During the last 7 years the Group has identified topical research questions to exploit the expertise of the members with the target of producing a impactful scientific output and securing research funds for promoting the involvement of staff and Ph.D. students. During this period the Group has been able to efficiently combine the teaching and research activity. A substantial and successful effort has been made to educate Ph.D. students, which are motivated to produce a significant scientific output during their training. A careful attention is dedicated to students for the sake of stimulating their passion for research and teaching.

The group has a very good publication record, and publishes in the top journals of their field (84% in Q1 ISI journals), and with 2 high impact papers that were published on high profile journals (*PNAS, Nature Geoscience*).

The programme has been successful in securing funding from highly competitive national and international sources, including the coordination of an EU project, which attests to the scientific standing of the group.

Productivity

The HWM group has produced a steadily increasing output in terms of number of refereed publications, with a peak of 41 published items, including 27 refereed articles (~5 per faculty member) in 2013. As noted earlier, they publish in the top journals of their field (84% in Q1 ISI journals).

Their funding profile of 40% direct funding, 19% research grants and 40% contract grants, including a suitable mix of national and international sources, including the coordination of an EU project. This is a good balance for the research profile of HWM, but the direct funding does indicate the extent of their teaching activities that, by their very nature, does impact research productivity.

The number of PhD theses varies considerably, year by year, over the assessment period with no PhD from 2010-2012, and 5 in 2013. A more stable profile of graduating PhD students would benefit the group. It would make the funding of PhD students easier and would provide a better flow of journal articles.

Currently there are 9 PhD students which is a suitable number, especially considering the eminent retirements of two faculty. When these are replaced, a sustainable number in the range of 15 seems achievable.

Societal Relevance

The societal relevance of the research topics carried out by HWM is very high (drought, rainfall measurements and extremes, river restoration), which offers the group opportunities to demonstrate the social relevance of their research.

The self-assessment tended to under report these activities, which were clarified in the face-to-face discussions. At the national level, their stakeholders are the Dutch Water Boards, with whom they share research results, interactions with the water ministry and participation in Dutch river research networks. The EU drought project has provided a scientific foundation to improved drought policy at the EU level, with one staff coordinating the European Drought Center, and is also active in UNESCO's International Hydrology Programme

A number of staff participate in their scientific societies by serving on technical committees and organizing scientific sessions, having editorial positions on journals, and participating in the IPCC process. All of these activities increase the scientific visibility of HWM, which the review committee feels is important for the group.

Vitality and feasibility (viability)

As noted earlier, the group improved over the assessment period under the leadership of the chair professor. Our assessment is that this trend should continue. The younger faculty (Drs. Teuling and Hoitink) are doing well in securing funding from highly competitive funding sources. We expect that they should continue to develop and this will help off-set the retirement of Dr. van Lanen, who has been very successful in developing EU funding and projects.

The chair faces a number of challenges over the next assessment period (5 – 7 years.) Two staff (40%) will retire, even though for a limited term Dr. Van Lanen will continue in research. The chair report indicates that one position will be filled in 2015 and the other in 2016 or 2017. It is important that these positions be filled as soon as feasibly possible since the impact of the 40% faculty reduction from retirements will put additional strains on the teaching and research responsibilities of the remaining three faculty members of the research group. The review committee sees any delay in filling these positions as a risk factor. To strengthen the academic depth of the group, we believe that the selected candidates must offer synergy to the current scientific strengths within the group. The self-assessment identified the fields for the recruitments of Van Lanen and Torfs (“sub-surface hydrology” and “computational hydrology”.) The chair should be prepared for the possibility that no suitable candidate/s will be identified, and the search area may have to be re-positioned to obtain a stronger hire.

The committee expressed concern with the size of the research group, five faculty is small and the teaching load large. The chair, perhaps with the help of WIMEK, should explore the strategic advantages of an increase in the group size, perhaps through an assistant professor who wouldn't be on the tenure track system. The committee felt that this could help it achieve higher international visibility through sharing the teaching load more widely and providing the opportunity to bring in and manage more research grants.

Recommendations.

- Due to the relatively small size of the research group, the importance of the research themes (both scientifically and of social relevance), and the planned retirements of two faculty, the Committee recommends that the group develops a more detailed and self-consistent vision for their future research, in order to maximize the efficiency of the group for better integrating the teaching and research activities. This will help better to guide the recruitment process. Additionally, a more structured vision will also allow the group to better identify and address the most relevant research questions in the broad field of catchment hydrology.
- The Committee believes that a more substantial effort should be made to increase the visibility of the research activity related to the fields of environmental fluid mechanics, impact hydrogeology/subsurface hydrology and geomorphology so as to identify “niches” where the group can have impact in fields where there is considerable competition. The group has high potential in these areas that should be better exploited.
- The Committee also recommends, as part of strategic plan of the first recommendation, to explore opportunities for increasing the size of the group, as discussed in the viability section above.

Programme 36:	Landscape Architecture	
Programme leaders:	Prof. A. van den Brink (since 2009) Prof. J. Koh (until 2009)	
Research input 2013:	tenured staff:	2.7 fte
	total staff:	7.1 fte
Assessment scores:	Scientific quality	3.5
	Productivity	3.5
	Societal impact	4
	Viability	4

Scientific quality

This is a group with an intriguing mix of applied design and research practice in timely research areas located in both urban and non-urban settings, and in many countries. The field of landscape architecture is presently evolving from an applied design professional field to a research-based discipline. Landscape architecture programs worldwide face the challenge of developing a robust research portfolio while supporting a time-intensive studio-based teaching programme. The Group has noted these points in their last assessment so sought another more recent informal review of their research quality, productivity, relevance and vitality earlier this year from four internationally well regarded researchers in landscape architecture over the past three years.

We are impressed by the progressive uplift of both research publications and of student awards in the general fields of landscape design. It is clear that the Group has placed more emphasis on research in design rather than in teaching and applied design, though this is not to say that they have sacrificed the more applied elements (as the notable student awards reveal). This is a bias which we support but note that there is a case to be made for the incorporation of more specialised researchers in particular aspects of landscape design (such as biodiversity enhancement, flood management and urban climate).

In this last context we are also impressed by the emphasis the Group places on looking at the challenges facing landscape design posed by global issues such as climate change, water management, energy landscapes and urbanisation, both as a research framework as well as a teaching opportunity. The Group is actively involved in multi-disciplinary European research networks and is poised to extend their commitment to more integrationist interdisciplinarity.

Because of all of this, as well as the clear determination and evidence of achievement to upgrade their scientific credentials, we award the Group a “good/very good”, 3.5, on the evaluation scale with the clear implication that they are on a clear trajectory to a “very good”, 4 in the coming years.

Productivity

The productivity of the Group is modest in comparison with other scientific disciplines. But it is at or above international norms for landscape architecture, particularly in programmes with considerable design instruction. It is important to note the substantial improvement of

scholarly production in the review period. In 2007 there were no publications of note: in 2012 there were 8. The strategy of the Group to publish research in related scientific domains has resulted in some important new publications in a wider range of scientific journals. This propulsive trajectory is commended.

Research in this field generally faces the difficulties of supporting high quality, time-intensive design-based instruction while maintaining high productivity in published research. We probed this relationship at length in our interviews. The group is promoting the values of its “extraordinary” professors (who are distinguished practitioners in the design fields) as guides of new approaches to design-based instruction and research. And it is likely that they will increase this kind of joint relationship between classroom teaching and professional experience in design offices and applied landscape architecture settings. We applaud this effective aspiration.

On the basis of the sharp and progressive rise in research and publication productivity we recommend an evaluation grade of “good-very good”, 3.5.

Societal impact

The Group has selected high profile research topics set in an intellectual and interdisciplinary powerhouse at Wageningen University. Their successful mixing of teaching and research offers a promise of a sound basis for even greater interdisciplinarity. We liked the production of a design guide for urban planning in relation to climate change (with some chapters prepared by graduates). This is the kind of output with direct societal relevance and we urge the Group to combine with the natural and earth science groups in the university (and beyond) to continue the mix of research based design and interpretable planning and landscape guidelines. Indeed we support the notion of “climate defence” landscape design especially for urban areas (dealing with flooding, windstorm and heat) and “climate accommodative” landscapes for rural and near-urban areas (particularly for biodiversity and flood management). Each of these notions is integrated in multiple research themes, and would include a combination of new approaches to teaching and to design-based research informed by transdisciplinary inputs. And both can be applied to many different geographies and cultures of landscape meaning.

On the basis of this aggregate record, and very real promise for continued societal impact, we awarded the group a rating of “very good”, 4.0, on this dimension.

Vitality and feasibility (viability)

We discussed at length the relationship between teaching and research as the Group commented that because of its relatively small size, its high commitment to design in action and its real involvement with students from all over the world, the Group faces considerable (but all too familiar) academic pressures. We believe the Group has developed an effective strategy for addressing this pressure. But we also believe the Group can make much more use of the Ph D students as a teaching and learning resource, as well as its “extraordinary professors”.

We applaud the commitment to identifying and recruiting a new Chair of Green Urban Planning and Design. We understand that this appointment has not yet been made even

though it has been advertised. We very much hope that a strong research but also professionally located person takes this vital position. In this very important research arena for this Group, but also for the field as a whole, such an appointment would set the scene for a fresh approach to “research by design” which is the hallmark of this group.

We also encourage the deployment of graduates in work experience in applied design offices. Here they would gain invaluable understanding of the design in action process. But more to the point they would act as ambassadors for innovative and creative planning and management procedures. In this way teaching can become learning with graduates (Masters and Ph Ds) working in cross cultural and cross national teams addressing the many aspects of “defensive and accommodative” landscape architecture.

We evaluate the overall vitality of this group as “very good”.

Recommendations

- There is considerable scope for using the recruitment for the Chair in Green Urban Design and Planning to further the creative interface between research and applied design through greater interaction between faculty and students and design consultants and planners.
- There should be even more effective use of the many research units in Wageningen (and beyond) to offer more intensive natural resource, earth science and ecology-based interdisciplinarity to inform and support planning and design, especially for climate change adaptation, water management, energy landscapes, and coastal change.
- We believe the uniqueness of the Group lies in its commitment and competence in overall landscape planning and design, in action. Therefore we support the retention of these special qualities and research directions, but seek the retention of the applied design aspects of its notable contributions to date. This means that the recommendation above places emphasis on collaboration with disciplinary experts but continuation of the special “research by design” portfolio of the Group.
- The production of applied landscape design manuals based of sound and creative research, supported by research student input and backed by informed discussions with planners, developers and community organisations (already under way especially in the areas of sensitive participatory approaches in many different national and planning cultures) is encouraged.
- The success of creative approaches to the use of dialogue, scenarios, video representation, social media, mobile GIS recording via smart phones, and carefully managed culturally friendly approaches to stakeholder involvement in all aspects of landscape design, urban and non-urban, should be encouraged by this highly committed group with case studies drawn from a broad international portfolio.

Programme 37:	Meteorology and Air Quality	
Programme leaders:	Prof. B. Holtslag; Prof. M. Maarten Krol	
Research input 2013:	tenured staff:	2.5 fte
	total staff:	13.1 fte
Assessment scores:	Scientific quality	5
	Productivity	4
	Societal impact	4
	Viability	4.5

Scientific quality

The research group articulates its overall science vision as the advancement of fundamental understanding of atmospheric dynamics and chemistry, connecting small-to-large scale dynamics, and educating the next generation of researchers. The group focuses on four themes within its broader research domain: (1) Boundary-layer meteorology and land-atmosphere Interactions, (2) Atmospheric composition and air quality, (3) Urban meteorology and air quality, and (4) Weather and climate dynamics. The group is very “discipline oriented” with the first listed area their most established area and the 4th listed area rather new with through an opportunistic participation of Professor Hazeleger of KNMI (Head, KNMI climate division) as a part-time professor. Across all these four themes they are doing excellent research with an international impact, and it is recognized the research group is scientifically highly competent and among the leading groups in the field and sub-fields they cover. In addition to its scientific standing, the group is also very visible internationally, given its service on the editorial boards of key journals, as well as participation in scientific steering bodies of international projects.

The team is guided by clearly-stated and traceable research goals. The levels of leadership and academic reputation are high and the group has been academically proficient. Young scientists in the group are likely to develop strong credentials over time as well. The team has made important contributions to modelling and data assimilation, as well as in the area of instrument development.

The research themes (sub-areas) interface well, with logical overlaps, and provide the group with research subjects that span scales from small-scale turbulence to regional and global-scale modeling. The addition of Professor Hazeleger, who provides the research guidance for the weather and climate dynamics theme, is a significant addition to the research group by adding both breadth by the new area and strength by linking into a very well respected KNMI group.

The review panel found the urban meteorology research to be innovative across the four sub-domains of study. Recent work exemplifying the team’s multiple capabilities include urban meteorology research, which was found to be innovative; the tracking carbon fluxes across South America, through the combination of terrestrial biome and atmospheric transport models, observations (including those derived from remote sensing), and data assimilation; and the development of their scintillometer, which has offered new observations at medium scales. They are making interesting use of social media for urban weather data collection.

Productivity

Tenured staff has remained stable, but the number of non-tenured staff has increased steadily. The number PhD theses reported over the review period (15) was not particularly impressive given the size and scientific standing of MAQ; but this situation is expected to change with the recent increase in the number of PhD candidates associated with the entrainment of new faculty. The encouragement of PhD students to assist in educating BSc and MSC students and to target for publication 4 dissertation-associated peer-reviewed papers was viewed as positive, as was the tracking of post-PhD job placement.

The number of refereed journal publications, given the size of the group, is on par, and arguably better than average. Aside the mere number of publications, we note that the group is publishing in the top journals of their field.

We note the small number of PhD theses during much of the reporting period (4 years with only 1 defence per year). While the group chair stated in the review meeting that the number is expected to increase in the near future (and for the current year has increased), it is important for the group to graduate a larger cohort of PhDs than they did over the reporting period. It is important for the younger faculty members to mentor PhD students and guide their research as this is a critical element in establishing their scientific careers. This can be done while maintaining the quality of the publications.

The review team noted that the group is very involved in outside activities such as participating in international research programs (e.g. GEWEX), sitting on advisory panels, having journal editorial positions, and being on review panels. These external activities are important as they bring visibility and recognition to the group.

Societal relevance

The group's societal relevance self-assessment focused essentially on its training of students and reporting its scientific findings through workshops, conferences and journal articles. This was reinforced during discussions with the review panel. We also noted that they are active in pursuing a wide variety of engagement strategies, from membership on governmental and NGO commissions, testimony to parliament, links to urban observatories and advice to local officials, to crowd-sourcing for urban climate measurement. While these are certainly highly important aspects, the review committee felt that MAQ could do more pro-actively to shape themes and directions that have large social relevance and public interests. Thus MAQ should not only serve as a source of highly valuable information for its stakeholders (like KNMI, or IPCC where some chair members are active) – MAQ's perspective of being socially relevant – but rather take the lead more directly in public forums on topics of their undoubted competence and of public interest, such as climate change.

Vitality and feasibility (viability)

The review panel found that the group has a healthy balance of direct funding (33%), research grants (44%) and contract grants (23%) that support this team. The funding mix fits well with its broad research agenda, but there was noted a tentative posture with respect to the role and pursuit of contract funding as part of any sustainable funding strategy. The reviewers concluded that the team is underestimating its earning potential.

In some ways the MAQ is a unit in transition, with three senior faculty having retired during the assessment period, recent recruitments (new people) and new themes. There are five assistant professors (50% of the faculty), which provides an overall good mix of senior to junior faculty. The mix of scientific activities across the assistant professors is diverse, and the new themes integrate well with the traditional strengths of the group. Scientifically, the group is well positioned going forward.

Recommendations

- The group can increase its earning potential and still maintain its financial sustainability, which is a recognized concern of the group's chair. This can occur because of the opportunities offered by the new research themes introduced over the last few years, and the hiring of assistant professors with interests in these themes. The benefits of increasing research and contract funding, particularly in these new themes, is an increase in the research impact and visibility of the group (particularly in the new theme areas) and therefore the potential to increase further the group's scientific reputation.
- The group should increase the societal relevance of its work beyond the training of students and publishing their scientific findings. The assessment team believes that MAQ isn't recognizing opportunities to have larger societal impacts and showing the social relevance of their work, given that they are working in a field that is very relevant to society.

Programme 38: Soil Chemistry and Chemical Soil Quality

Programme leaders: Prof. Comans (since November 2012)
Prof. W. van Riemsdijk (until January 2012)

Research input 2013: tenured staff: 1.5 fte
total staff: 11.7 fte

Assessment scores: Scientific quality 4
Productivity 4
Societal impact 4
Viability 3.5

Scientific quality

This is a very well recognized soil chemistry group. Over the review period of 2007 to 2013, the group scores well in the quality of its peer reviewed publications, with an RI value that is high (1.71 on average with 23% of their papers amongst the top 10% of the most frequently cited). The quality of the group is also evident by a steady level in external funding (both from NWO and EU).

One of the strengths of this group is their fundamental understanding of molecular scale processes and their ability to extend that insight into geochemical models (CD-music, multi-surface models, etc.). The group tackles relevant scientific questions such as the characterization of mineral phases and organic matter (solid and aqueous) which are certainly challenging. Judging on past achievements, the group has the potential to make major contributions in this field. This and the special analytical capabilities of the soil chemistry lab provide an opportunity to successfully tackle new fields such as nanoparticles in soils or nano-pesticides to name just two examples. Integration of the knowledge gained into developing practical solutions for soil quality assessment and quantitative evaluation of soil functions has a high potential as well.

The SOQ is now under new leadership since the end of 2012. Some 4-5 years ago the group was in better shape; the current transition period is difficult, but the group has the potential to come out of it strengthened. They are at a crossroads in their development and it is crucial that they make good decisions on further directions.

The teaching load is high and how the new arrangement of the group will work out in the future is not clear yet. Success and future scientific quality will depend on the plan for new hires at the PostDoc and junior researcher level and continued strategic planning for the development of future research directions.

Productivity

Despite illness and re-staffing during the evaluation period, the group maintained a high publication rate. Productivity in terms of PhD graduates has been low but is now increasing again. There is a need to attract more MSc students (also as potential future PhD students) and the group should develop means to make their teaching of more interest to potential students of soil chemistry.

Societal relevance

Significant societal relevance is given by engagement in standardization committees at the national and international level. This also applies to input provided to environmental regulations and advice provided to government, such as valuable contributions to the Dutch Soil Quality Decree. Interacting more with Dutch Water Boards is another means to improve the utility of the group's research output. Future committee work should focus on the transfer of the group's own original research results into practice. The outreach linked to professional training including consultants is good, as are the interaction with stakeholders (which occur already at the PhD level). Future plans for addressing issues concerning the "circular economy" are also of high societal relevance. While this work is appreciated, we also encourage more outreach to the general public, for instance via popular science communications and press releases.

Vitality and feasibility (viability)

The group seems to be in a difficult transition process. A period of understaffing has just been overcome and a business plan for the laboratory, a deficit plagued operation which the group recently took over responsibility for, is under development. Hiring strong researchers (PostDocs with tenure option) who can develop future research directions and overcoming the funding deficit of the lab are both crucial for further development of the group. Without that, it runs the risk of being too narrow with too little organizational resilience.

Overall the group has the potential to exploit new areas given the right leadership. Opportunities to improve viability exist in national and international (EU) collaborative networks, in specialized and unique analytical methods (also for nano-materials), and in the very high interest in the modelling capabilities of the group. Furthermore, collaboration with neighbouring groups at WU (e.g., the "soil cluster") including exchange of lab staff can help to improve the viability of the group.

Recommendations

- We are concerned that the group does not have the critical mass required for organizational resilience and long-term viability. We view the links that have been established with the Soil Biology group and the discussions about formation of a "soil cluster" as interesting initiatives that could lead to a solution of this problem. We suggest that a stronger organizational integration of these groups be seriously explored.
- The soil chemistry laboratory should be restructured to focus on providing unique services that are derived from the group's research and that are not readily available on the open market. The business plan should include a strategy for developing a market for these services.
- The group should pursue a better integration of the research conducted by the individual staff scientists. This would allow better exploitation of the apparent synergies and the development of solution oriented methods for soil quality assessment based on the fundamental understanding of molecular processes available in the group.

Programme 39: Soil Physics and Land Management
 Programme leaders: Prof. C. Ritsema; Prof. S. van der Zee

Research input 2013: tenured staff: 2.8 fte
 total staff: 23.1 fte

Assessment scores: Scientific quality 4
 Productivity 5
 Societal impact 4.5
 Viability 4.5

Scientific Quality

The Soil Physics and Land Management (SLM) group was formed in 2012 as a merger of the Land Degradation and Development group of Prof Leo Stroosnijder and the Soil Physics Ecohydrology and Groundwater Management group of Professor Sjoerd van der Zee and is currently under the leadership of Professor Coen Ritsema. The SLM research themes are (1) soil physics that focuses on flow and transport of water and mass; (2) ecohydrology that focuses on soil-water-plant interactions; and (3) land management that focuses on soil degradation, conservation and restoration.

Professor Stroosnijder has retired recently. Professors Coen Ritsema (who was a personal professor in the land degradation and development group) and van der Zee are excellent scientists with H-indexes that are greater than the number of years since their PhD. As result each of the two separate groups has greatly improved since 2007 with a good record of publications that are better than the world average. The group has a large and productive group of graduate students many who have finished in the last six years. The quality of the publication of the young assistant professors was relatively good and many with H-indices approximately equal to the number of years since the PhD.

Since this group is a combination of two groups, they have focused on building a coherent research vision between the soil physics scale and the watershed scale. The group has had in-depth discussions about bridging the scale issue, but due to the short time of the merger clearly has not achieved the integration yet. We were impressed with the commitment of the chair professor to achieve an integrated research program, and the review panel is confident that this group will do world class research in the next six years if effective integration can be achieved. In fact there very few research groups that are able to do landscape research in water, soil and nutrient movement on scales ranging from the Darcy (pore) scale to the river basin scale, so the potential for the group to have scientific impact internationally is high. The score of four is based on the fact that integration is still taking place. When it fully integrated we expect the score to go up and the relative impact score to increase from the current 1.3

Productivity

The groups (LDD and SEG, transitioning into SLM) has continuously improved its productivity metrics over the assessment period, with the number of refereed journal publications and increases in T10 and Q1 journal. They are directing more of their research

into journals that have high impact, which is commendable since many journals in their field tend to have low impact – even those that are considered top journals in their field.

The number of PhD students increased substantially over the assessment period, starting from 20 in 2007 and recent years in the 30's. A large number of guest scientists visit and work in the group for weeks to months, which underpins the productivity and impact they have. There has also been a substantial increase in the proportion of external grant funding, reflecting the greater concentration on land management in an international context, particularly Africa. A large fraction of external funding comes from very competitive European and international projects in which the group has mostly the lead role (coordinator).

For success of the junior faculty in the tenure track process, they will need good guidance and mentoring.

Societal Relevance

SLM is very cognizant of the social relevance of the research group. Historically LLD worked in less developed countries and focused on research related to the Millennium Development Goals, so capacity building was an integral part of their agenda. SLM's vision going forward is to have a balanced portfolio in capacity building related to developing and developed countries, which includes a 50/50 balance in PhD students from these regions. This appears to be a thoughtful strategy.

The new research group appears to be working hard to formulate their strategy with regard to interactions with non-academic stakeholders, with LLD having inclusion of stakeholders a central theme of their work and SEG focusing more on fundamental scientific research. The assessment team was impressed with the research group's recognition that finding the right balance for SLM is important and that they were working hard to develop a common vision. Going forward, the harmony of the group will depend on whether the previous cultures are melded successfully.

SLM sees opportunities for targeted communication for appropriate societal audiences. Their area of research is of societal relevance, and being successful in such communication can increase the overall impact of the group.

Vitality and feasibility (viability)

In reporting, it appears that the group has concentrated on its position nationally and internationally since being substantially re-formed in 2012. They see the group as unique and collaborative, hosting a significant number of overseas research visitors and PhD students, and focussing more on being valuable collaborators than on achieving pre-eminence in their field. This approach is well exemplified in the very large number of large EU funded projects with many collaborators internationally, but their strength and vitality could be further enhanced by being more proactive, not only taking a strong leadership role in their community but also working towards higher levels of international excellence in at least some particular aspects of their field. The self-assessment describes themselves as "one of the key players in its field" – they need to think how to become *the leading player* in their field, without losing the flexibility to respond to external opportunities, and the sometimes rapidly changing grant environment.

During the two years since re-organisation there have been clear improvements both in the growth of external grant income and in the balance of teaching across the group and these components seem likely to improve further as the new partnership settles down more completely.

The self-assessment document would be improved by more clearly articulating the integrated scientific vision of the group over the next 5-10 years' time horizon. The amalgamation of groups on soil physics and land management/conservation provides unique opportunities to improve scientific understanding at the scales that span between the fine textured concerns characteristic of soil physics and the coarser scales and more empirical approaches typical of soil conservation. This midpoint is articulated by the group as eco-hydrology. The group should continue to work actively in the coming 5 years to integrate this research theme to bridge the two scales.

The group comprises a relatively large number of high quality junior staff with high future potential. Overall it seems to be a vital group with a large number of PhD students and good infrastructure. Sound strategies have been developed for the future which among others address also societal and gender issues. The long term viability of the group may be compromised by the relatively large number of internal appointments that have been made in combining the former groups. Perhaps there is a case for making one or more additional external appointments at more senior levels (below chair).

Annex 1. Main characteristics of the SEP, terms of reference, interpretation of criteria and scores

The Standard Evaluation Protocol entails two main characteristics:

- **Two levels of assessment:** The assessment takes place at two levels of research organisation, i.e. the level of the research school SENSE and its partnering institutes, each with their own responsibilities (A-level) and the level of research groups (B-level);
- **Four main criteria:** The assessment entails four main criteria, i.e. quality, productivity, relevance, and vitality & feasibility.

The evaluation committee is requested to report its findings along the given terms of reference. Regarding the institute level the findings should be reported in qualitative terms with a focus on policy and management questions. For the assessment of the research groups, the verdict should be cast in both qualitative and quantitative terms. In the text, the most important considerations of the committee should be clarified, while the conclusion should be summarized in a single term (allowing 0.5 scores) according to a five point scale.

A-level: Terms of reference for SENSE research school:

1. Mission / Organisation / Finances

- Mission
- Organisation and Management
- Financial resources

2. PhD training and education

- PhD education programme
- Relevance of SENSE Honours programme / supporting MSc talent
- PhD progress monitoring
- PhD career prospects

3. Network for environmental and sustainability research

- Research context and interdisciplinary cooperation
- Structure of SENSE Research Clusters
- Quality monitoring
- International cooperation

4. Bridge to society

- A reflection on societal impact and relevance

A-level: terms of reference for the SENSE partnering institutes

g. Mission, vision and policy

- Reflection on the institute's vision, mission and objective(s) and its research activities.
- Are the overall mission and goals of the institute/research programme well-chosen and phrased in view of the actual developments in the relevant research field(s)?

- Quality of the leadership, management, strategy and policy of the institute.
- To what extent has the institute achieved its mission and goals formulated for the period under review?

h. Research quality

A reflection on the quality of the institute, thereby considering:

- academic reputation (recognition and visibility);
- financial and human resources ;
- research facilities and infrastructure;
- organisation and internal processes;
- leadership, national and international positioning.

i. Societal relevance

A reflection on the relevance (in research, in society, and with respect to valorisation)

j. PhD policy

A reflection on the quality of the PhD supervision and training, thereby considering:

- PhD policy
- PhD regulations
- PhD education & training
- PhD courses & facilities
- PhD progress & monitoring

k. SWOT

A reflection on the vitality and feasibility, and vision for the future (based on the positioning and benchmarking, and also the strengths and weaknesses in the SWOT-analysis: strategy for future years, competitive strength, robustness and stability; earning capacity)

B-level: Terms of reference for the research groups:

Criterion 1: Quality

Quality refers to the level of the research conducted by the researchers of an institute and its groups or programmes compared to accepted (international) standards in that field. As a rule, quality is measured by judging the international academic reputation, the position and the output of the unit to be evaluated. However, in the case of a national orientation of a research field, the point of reference consists of other groups in the country. When judging research quality, the following elements are to be considered:

- Quality of the research
- Leadership of the individual leadership of the principal investigators, including research policy and research management
- The academic reputation of the group or programme
- PHD-training
- Organizational aspects of the research programmes such as the human and financial resources.

Criterion 2: Productivity

Productivity encompasses all the various activities and outputs of the research. Productivity should always be assessed relative to the group's mission. Elements to be considered are:

- The output to the scientific community and the output for wider audiences are to be judged. Quantitative and qualitative measurements may be used.
- The policy measures to render the output to the best and most relevant level possible. Of course the output needs to be reviewed in relation to the input in terms of human resources (tenured staff).

Criterion 3: Relevance

This criterion covers the societal impact of the work.

To address the second element the results of the research can be considered from different angles:

- *Societal quality*. This concept refers to the value put upon research and its (expected) results by specific stakeholders or society at large. It may also refer to the contribution of research to important issues and debates in society.
- *Societal impact*. This concept refers to how research affects specific stakeholders. This can be measured, for example, via behavioural change of actors or institutions.
- *Valorization*. This concept refers to economic, technological and socio-cultural benefits of research.

Criterion 4: Vitality & feasibility (Viability)

This dual criterion addresses the group's ability to adequately react to important changes in the environment. It refers to both internal (personnel, research practice, earning capacity) and external (developments in the field and in society) dynamics of the group.

- Management
- SWOT ad strategy
- HR and finances

An excerpt of the Standard Evaluation Protocol, that describes these terms of reference, was set at disposal of each committee member in advance and was explained once again in the introduction of this assessment.

Interpretation of scores

5. Excellent

world leading / forefront research / important and substantial impact in the field / excellent contribution to future / excellent equipped for the future / hardly any room for improvement.

4. Very good

internationally competitive / well recognised internationally/ nationally leading / significant contribution to the domain / very well equipped for the future / little room for improvement

3. Good

competitive at the national level / valuable contribution in the international field / internationally visible / well equipped for the future / some room for improvement.

2. Satisfactory

solid, but not exciting research / nationally visible / strategic strenghtening necessary to be well equipped for future / quite some room for improvement

1. Unsatisfactory

neither solid nor exciting research / marginal contribution to society / lots of room for improvement

Annex 2: SENSE Review Schedule

Content:

- 2.1 Overview Time Schedule
- 2.2 Time Schedule Research Assessment SENSE Research Groups
- 2.3 Time Schedule Assessment SENSE Institutes
- 2.4 Time Schedule Assessment SENSE Research School

2.1 Overview Time Schedule

Date & time	Activity	Who	Location
Monday 9 June 2014			University Utrecht Hall
< 16:00	Arrivals	All reviewers	
16:00 - 16:15	Welcome		
16:15 - 16:45	Introduction to SENSE		
16:45 - 17:15	Explanation of the review process		
17:15 - 17:45	Questions		
18:00 - 21:00	DINNER		Restaurant Deeg Utrecht
Tuesday 10 June 2014			
08:30 - 17:45	Review of Research Groups	Research Group Review Panels	University Utrecht Hall
18:00 - 20:00	DINNER		<i>Room 1 - 6</i> University Utrecht Hall
20:30 - 22:00	Meeting chairs review panels		Hotel Mitland
Wednesday 11 June 2014			
08:30 - 09:00	Review of Research Groups	Research Group Review Panels	University Utrecht Hall
18:00 - 20:00	DINNER		<i>Room 1 - 6</i> Restaurant Broers Utrecht
20:30 - 22:00	Meeting chairs review panels		Hotel Mitland

Thursday 12 June 2014			SENSE Institutes
10:00 - 16:30	Review of SENSE institutes	Institute Review Panels	
16:30	Travel back to Utrecht		
18:00 - 20:00	DINNER		Restaurant Broers Utrecht
Friday 13 June 2014			University Utrecht Hall
09:00 -14:30	Review of SENSE Research School	SENSE Review Panels	
14:30 - 14:45	Closing		
14:45 - 16:00	DRINKS		

2.2 Time Schedule Review SENSE Research Groups

(Chairs of each review session are indicated in blue)

Tuesday 10 June 2014	Room 1		Room 2		Room 3		Room 4		Room 5		Room 6	
	Eijkankamer Research Group	reviewers	Kernkampzaal RG	reviewers	Opzoomerzaal RG	reviewers	Torenkamer RG	reviewers	Sterrekamer RG	reviewers	Belle van Zuijlenzaal	reviewers
8:30	9:00 RP meeting: preparations	Eric Wood Mathias Rotach Charles Vörösmarty Mike Kirkby	RP meeting: preparations	Wolfgang Cramer James Meadowcroft Andy Gouldson Halina Brown	RP meeting: preparations	Murugesu Sivapalan Robert Naiman Tammo Steenhuis	RP meeting: preparations	Mike Goodchild Paul Curran Zorica Nedović- Budić	RP meeting: preparations	Sander van der Leeuw Michael McLachlan Damià Barceló Peter Grathwohl	Meeting Room Reviewers	
9:00	10:00 WU-ESS RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
10:00	10:30 RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
Break												
10:45	11:15 RP meeting: preparations	Eric Wood Mathias Rotach Charles Vörösmarty	RP meeting: preparations	Edward Bouwer Michael McLachlan Korneel Rabaey Thore Berntsson	RP meeting: preparations	Murugesu Sivapalan Robert Naiman Graham Jewitt Tammo Steenhuis	RP meeting: preparations	Wolfgang Cramer Nebojsa Nakicenovic Jingle Wu	RP meeting: preparations	Sander van der Leeuw James Meadowcroft Andy Gouldson Halina Brown	Meeting Room Reviewers	
11:15	12:15 WU-MAQ RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
12:15	12:45 RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
Lunch												
13:30	14:00 RP meeting: preparations	Eric Wood Junguo Liu Alberto Montanari Mike Kirkby	RP meeting: preparations	Edward Bouwer Korneel Rabaey Hauke Harms	RP meeting: preparations	Murugesu Sivapalan Robert Naiman Graham Jewitt Tammo Steenhuis	RP meeting: preparations	Paul Curran Mike Goodchild Wolfgang Cramer	RP meeting: preparations	Tim O'Riordan Jack Ahern Zorica Nedović- Budić	Meeting Room Reviewers	
14:00	15:00 WU-HWM RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
15:00	15:30 RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
Break												
15:45	16:15 RP meeting: preparations	Tim O'Riordan James Meadowcroft Andy Gouldson Halina Brown	RP meeting: preparations	Edward Bouwer Michael McLachlan Peter Grathwohl Damià Barceló	RP meeting: preparations	Murugesu Sivapalan Junguo Liu Alberto Montanari Ian Cluckie	RP meeting: preparations	Mike Goodchild Jack Ahern Zorica Nedović- Budić	RP meeting: preparations	Sander van der Leeuw Jingle Wu Wolfgang Cramer	Meeting Room Reviewers	
16:15	17:15 WU-ENP RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			
17:15	17:45 RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions		RP meeting: conclusions			

AbbreviationsInstitutes:

CML: Institute of Environmental Sciences
IHE: Institute for Water Education
ITC: Institute for Geo-Information Science and Earth Observation
IVM: Institute for Environmental Studies
UT: University of Twente
UU: Utrecht University
WU: Wageningen University

Research groups (RG):

AE: Aquatic Ecosystems
C&B: Chemistry & Biology
CSEDP: Coastal Systems and Engineering and Port Development
EG: Environmental Governance
ENP: Environmental Policy
EOS: Earth Observation Science
EPA: Environmental Policy Analysis

ES: Environmental Sciences

ESS: Earth System Science

ETE: Environmental Technology

HWM: Hydrol.and Quant.Water Managem.

HWR: Hydrology and Water Resources

LWD: Land and Water Development

LAR: Landscape Architecture

MAQ: Meteorology and Air Quality

MIB: Microbiology

NRS: Natural Resources

PGM: Urban and Regional Planning and Geo-information Management

SOQ: Soil Chem. & Chem. Soil Quality

SPACE: Spatial Analysis and Decis. Supp.

Time Schedule of Research Groups (continued)

(Chairs of each review session are indicated in blue)

Wednesday 11 June 2014	Room 1		Room 2		Room 3		Room 4		Room 5		Room 6	
	J. Westerdijkkamer	Kernkampzaal	Kernkampzaal	Opzoomerzaal	Opzoomerzaal	Torenkamer	Sterrecamer	Belle van Zuijlenzaal	Sterrecamer	Belle van Zuijlenzaal	Sterrecamer	Belle van Zuijlenzaal
8:30	Research Group	reviewers	RG	RG	RG	RG	RG	RG	RG	RG	RG	RG
9:00	RP meeting: preparations	Eric Wood Mike Kirkby Tammo Steenhuis Peter Grathwohl	RP meeting: preparations	Edward Bouwer Michael McLachlan Robert Naiman Erik Matthysen	RP meeting: preparations	Murugesu Sivapalan Junguo Liu Alberto Montanari Ian Cluckie	RP meeting: preparations	Mike Goodchild Paul Curran Zorica Nedović-Budić	RP meeting: preparations	Wolfgang Cramer Nebosja Nakicenovic Roland Clift Thore Berntsson	RP meeting: preparations	Meeting Room Reviewers
10:00	RP meeting: conclusions	WU-SLM	RP meeting: conclusions	WU-AEW	RP meeting: conclusions	IHE-HERBD	RP meeting: conclusions	ITC-GIP	RP meeting: conclusions	UU-E&R	RP meeting: conclusions	Meeting Room Reviewers
Break												
10:45	RP meeting: preparations	Tim O'Riordan Charles Vörösmarty Nebosja Nakicenovic	RP meeting: preparations	Willy Verstraete Hauke Harms Vernon Snoeyink	RP meeting: preparations	Murugesu Sivapalan Junguo Liu Alberto Montanari	RP meeting: preparations	Paul Curran Mike Goodchild Eric Wood Mike Kirkby	RP meeting: preparations	Sander van der Leeuw Ståle Navrud Andy Gouldson	RP meeting: preparations	Meeting Room Reviewers
11:15	RP meeting: conclusions	WU-ESA	RP meeting: conclusions	IHE-WSE	RP meeting: conclusions	IHE-WM	RP meeting: conclusions	ITC-ESA	RP meeting: conclusions	IHM-EE	RP meeting: conclusions	Meeting Room Reviewers
12:15	RP meeting: conclusions	WU-ENR	RP meeting: conclusions	CML-IE	RP meeting: conclusions	IHE-HI	RP meeting: conclusions	ITC-WRS	RP meeting: conclusions	IHE-SE	RP meeting: conclusions	Meeting Room Reviewers
Lunch												
13:30	RP meeting: preparations	Tim O'Riordan Ståle Navrud Andy Gouldson	RP meeting: preparations	Roland Clift Erik Matthysen Nebosja Nakicenovic Thore Berntsson	RP meeting: preparations	Murugesu Sivapalan Junguo Liu Alberto Montanari Ian Cluckie	RP meeting: preparations	Paul Curran Charles Vörösmarty Graham Jewitt	RP meeting: preparations	Willy Verstraete Hauke Harms Vernon Snoeyink	RP meeting: preparations	Meeting Room Reviewers
14:00	RP meeting: conclusions	WU-ENR	RP meeting: conclusions	CML-IE	RP meeting: conclusions	IHE-HI	RP meeting: conclusions	ITC-WRS	RP meeting: conclusions	IHE-SE	RP meeting: conclusions	Meeting Room Reviewers
15:00	RP meeting: conclusions	WU-ENR	RP meeting: conclusions	CML-IE	RP meeting: conclusions	IHE-HI	RP meeting: conclusions	ITC-WRS	RP meeting: conclusions	IHE-SE	RP meeting: conclusions	Meeting Room Reviewers
Break												
15:45	RP meeting: preparations	Erik Matthysen Roland Clift Jingle Wu Michael McLachlan	RP meeting: preparations	Wolfgang Cramer James Meadowcroft Halina Brown Andy Gouldson	RP meeting: preparations	Wolfgang Cramer James Meadowcroft Halina Brown Andy Gouldson	RP meeting: preparations	Junguo Liu Charles Vörösmarty Graham Jewitt	RP meeting: preparations	Willy Verstraete Hauke Harms Vernon Snoeyink	RP meeting: preparations	Meeting Room Reviewers
16:15	RP meeting: conclusions	CML-CB	RP meeting: conclusions	UU-IS	RP meeting: conclusions		RP meeting: conclusions	UT-WMG	RP meeting: conclusions	IHE-PPRR	RP meeting: conclusions	Meeting Room Reviewers
17:15	RP meeting: conclusions	CML-CB	RP meeting: conclusions	UU-IS	RP meeting: conclusions		RP meeting: conclusions	UT-WMG	RP meeting: conclusions	IHE-PPRR	RP meeting: conclusions	Meeting Room Reviewers

Abbreviations

Institutes:

CML: Institute of Environmental Sciences
IHE: Institute for Water Education
ITC: Institute for Geo-Information Science and Earth Observation
IVM: Institute for Environmental Studies
UT: University of Twente
UU: Utrecht University
WU: Wageningen University

Research Groups (RG):

AEW: Aquatic Ecology & Water Quality Management
CB: Conservation Biology
E&R: Energy and Resources
EE: Environmental Economics
ENR: Environmental Economics and Natural Resources
ESA (WU): Environmental Systems Analysis
ESA (ITC): Earth System Analysis
GIP: Geo-information Processing
HI: Hydroinformatics
IE: Industrial Ecology
IS: Innovation Studies
PPRR: Pollution Prevention and Resource Recovery
HERBD: River Basin Development
SE: Sanitary Engineering
SLM: Soil Physics and Land Management

WM: Water Management
WMG: Water Management Group
WRS: Water Resources
WSE: Water Supply Engineering

2.3 Time Schedule of Institutes

(Chairs of each review session are indicated in blue)

Thursday 12 June 2014	Activity	Review Panel members	SENSE Institutes
< 10:00	Travel to Utrecht University	Wolfgang Cramer Thore Berntsson Halina Brown	Copernicus
	Travel to VU University Amsterdam	Sander van der Leeuw James Meadowcroft Jingle Wu	IVM
	Travel to Wageningen University	Tim O’Riordan Edward Bouwer Eric Wood	WIMEK
	Travel to Leiden University	Roland Clift Erik Matthysen Michael McLachlan	CML
	Travel to UNESCO-IHE Delft	Murugesu Sivapalan Willy Verstraete Tammo Steenhuis	IHE
	Travel to University of Twente	Mike Goodchild Paul Curran Zorica Nedović-Budić	ITC
10:00 - 10:30	Internal preparations		
10:30 - 11:30	Consultation meetings		
11:30 - 12:30	Visit research facilities		
12:30 - 13:30	LUNCH BREAK		
13:30 - 14:30	PhD pitches and poster presentations		
14:30 - 15:30	Consultation meeting with PhD council / representative PhD candidates		
15:30 - 16:30	Formulation preliminary assessment and conclusions		
16:30	Travel back to Utrecht		

2.4 Time Schedule of SENSE Research School

(Chair is indicated in blue)

Friday 13 June 2014	Activity	Review Panel members	Location
09:00 - 10:00	Internal preparations	Tim O’Riordan Sander van der Leeuw Wolfgang Cramer Roland Clift Murugesu Sivapalan Mike Goodchild	University Hall Utrecht
10:00 - 11:00	Consultation meeting with SENSE leaders		
11:00 - 12:00	Consultation meeting with SENSE PhD Council		
12:00 - 12:30	Formulation preliminary assessment and conclusions		
12:30 - 13:30	LUNCH BREAK		
13:30 - 14:30	Presentation preliminary conclusions		
14:30 - 14:45	Closing by Frank Biermann		
14:45 - 16:00	DRINKS		

Annex 3: Brief Curriculum Vitae of the Peer Review Committee Members

Prof. Kenneth Abbott

Arizona State University, Phoenix, USA

Kenneth is Professor of Law at the Arizona State university. Before joining the faculty in 2006 he taught for more than 25 years at Northwestern University School of Law, where he held the Elizabeth Froehling Horner Chair in Law and Commerce. He also served as director of the Northwestern University Center for International and Comparative Studies. He also has a faculty appointment in the ASU School of Global Studies, where he co-directs the global environmental governance program.

Kenneth's teaching and research focus on the interdisciplinary study of international law and international relations, including public and private institutions, environmental issues, development policy, global health, and international trade and economic law.

He has served as Chair of the International Economic Law Interest Group of the American Society of International Law. He is member of several editorial boards of respected scientific journals.

Prof. Jack Ahern

University of Massachusetts, Amherst, USA

Jack is Vice Provost for International Programs and Professor of Landscape Architecture at the University of Massachusetts Amherst, USA.

He received a BSc in Environmental Design at the University of Massachusetts (1974) and a Masters of Landscape Architecture (MLA) from the University of Pennsylvania (1980). In 2002 he obtained his PhD in Environmental Sciences at Wageningen University. His research and teaching focuses on the integration and application of landscape ecology in landscape planning and design, with emphasis on greenways, green infrastructure, and sustainable urbanism – at multiple scales.

Jack served as Chair of the US Division of the International Association of Landscape Ecology (US-IALE) and is Fellow of the American Society of Landscape Architects (FASLA), and Fellow of the Council of Educators in Landscape Architecture (FCELA).

Prof. Damia Barcelo

Catalan Institute for Water Research ICRA, Girona, Spain

Damia is Research Professor at the Institute of Environmental Assessment and Water Studies IDAEA-CSIC since 1999 as well as Director of the Catalan Institute of Water Research (ICRA, Girona) since 2008. He graduated in Chemistry (1977) and obtained his PhD in Analytical Chemistry at the University of Barcelona (1984). For 10 years he has been Head of the Environmental Chemistry Department (Barcelona, Spain).

His scientific focus is on method development and monitoring of priority, new, and emerging pollutants. In November 2007 he received the Spanish Prize King Jaime I for the Protection of the Environment.

Prof. Thore Berntsson

Chalmers University of Technology, Gothenburg, Sweden

Thore is Professor at the Chalmers University of Technology in Gothenburg. He obtained his PhD in 1971 in industrial energy systems at the same university and became full professor there 1982, a position he still holds.

Thore Berntssons main research areas are technical, economic and environmental aspects on industrial energy technologies and systems, process integration and industrial biorefineries. He has been a member of several national expert or evaluation boards, e.g. in the Energy Development Board at the Swedish Energy Agency between 1998 and 2008 (responsible for all strategic and large project decisions at the agency) as well as in the boards for industrial energy, energy systems, and process integration programs.

He has been very active internationally in e.g. IEA, International Energy Agency. In 2005 he was one of the founders of the Implementing Agreement IETS (Industrial Energy-Related Technologies and Systems) and is now chair of that agreement and he has also represented Sweden in the heat pumping, process integration, pulp and paper and the CADDET (Centre for Analysis and Dissemination of Demonstrated Energy Technologies) implementing agreements.

Prof. Edward J. Bouwer

Johns Hopkins University, Baltimore, USA

Edward is the Abel Wolman professor of Environmental Engineering and Department chair in the Geography and Environmental Engineering Department at the Johns Hopkins University. He earned his PhD in environmental engineering and science from Stanford University California in 1982. He has extensive experience with drinking water and wastewater treatment processes, microbial process engineering, and contaminant transport and fate. His research interests encompass factors that influence biotransformation of contaminants, bioremediation for control of contaminated soils and groundwaters, biofilm kinetics, biological processes design in wastewater, industrial, and drinking water treatment, transport and fate of microorganisms in porous media, behavior of metals in contaminated sediments, and defining and managing environmental risks. He has served on several National Research Council committees that provide guidance on managing human and ecological risks to Congress, regulatory agencies, and the scientific community.

Prof. Halina S. Brown

Clark University, Worcester, Massachusetts USA

Halina is Professor of Environmental Science and Policy at Clark University in Worcester, Massachusetts. She obtained her doctoral degree in Chemistry from New York University. During the 1980s she served as the chief toxicologist and public health scientist at the Massachusetts Department of Environmental Protection. During the two decades at Clark University her research has covered health risk assessment and policy, corporate management of environmental and occupational health, international comparative environmental policy, and more recently on sustainability policy and technological innovation for sustainability, with special interest in energy and buildings. Halina is a co-founder of Sustainable Consumption Research and Action Initiative (SCORAI), the North American knowledge network to address challenges at the interface of material consumption, human fulfillment, lifestyle satisfaction, and technological change. She is a Fellow of the American Association for the Advancement of Science and Fellow of the International Society for Risk Analysis.

Prof. Roland Clift

University of Surrey, Guilford, UK

Roland is Emeritus Professor of Environmental Technology and founding Director of the Centre for Environmental Strategy at the University of Surrey. Previously Head of the Department of Chemical and Process Engineering at the University of Surrey; Visiting Professor in Environmental System Analysis at Chalmers University, Göteborg, Sweden; Adjunct Professor in Chemical and Biological Engineering at the University of British Columbia, Vancouver, Canada. From 1996 to 2005, Roland was a member of the Royal Commission on Environmental Pollution (RCEP). He is a past member of the UK Eco-labelling Board, of the Science Advisory Council of Defra, of the Royal Society/Royal Academy Working Group on nanotechnology and of the Working Group which drafted and updated the BSI/Defra/Carbon Trust standard on carbon labelling, PAS 2050. In 2004-5, he acted as Expert Adviser to a House of Lords Select Committee enquiry into energy efficiency. He is a past President and Executive Director of the International Society for Industrial Ecology.

His research is concerned with system approaches to environmental management and industrial ecology, including life cycle assessment and energy systems.

Prof. Ian Cluckie

Swansea University, Swansea, UK

Ian is Professor and Pro-Vice Chancellor with responsibility for Science and Engineering at Swansea University. He initially studied Civil Engineering at the Universities of Surrey and Birmingham, where he developed his life-long interest in hydrology and water engineering. He served as both a Chairman of Department and Director of the Telford Research Institute at the University of Salford and, prior to his arrival at Swansea, he was Professor of Hydrology and Water Management at the University of Bristol, where he was also director of the University's Water and Environmental Management Research Centre. His particular research interests are focused in the area of flood risk management, hydro-informatics, weather radar and remote sensing. He is a past Chairman of the Natural Environment Research Council (NERC) Aquatic and Atmospheric Physical Sciences Grants Committee (AAPS). Ian chairs the EPSRC Flood Risk Management Research Consortium, is chairman of the United Kingdom IAHS Committee and a member of the Royal Society IUGG Sub-Committee. He was elected to a fellowship of the Royal Academy of Engineering in 1997.

Prof. Wolfgang Cramer

Aix-en-Provence, France

Wolfgang is Scientific Director at the Mediterranean Institute for Biodiversity and Ecology (IMBE), in Aix-en-Provence, Marseille and Avignon (France), since the establishment of the institute in 2012. He received his academic training at the Universities of Gießen, Germany (Geography, diploma 1981) and Uppsala/Sweden (Plant Ecology, PhD 1986). From 1987 to 1993, he taught and conducted his research at the Department of Geography, Trondheim University (Norway). In 1992, he joined the newly founded Potsdam Institute for Climate Impact Research (PIK) as Head of the Department "Global Change and Natural Systems" (switching later to the institute's research domain "Earth System Analysis"). In 2003, he was appointed full Professor of Global Ecology at Potsdam University. In 2012 he joined the IMBE.

Professor Cramer is a contributor in many roles to the IPCC (Peace Nobel Prize 2007) and the Millennium Ecosystem Assessment. He also regularly serves as advisor of the German government and the EU Research Directorate.

Professor Paul Curran

City University London, London, UK

Professor Paul Curran is Vice-Chancellor, President and Professor of Physical Geography at City University London. His research is in the field of environmental Earth observation from satellite and airborne sensors with particular expertise in imaging spectroscopy, geostatistics and the use of remotely sensed data for ecosystem modelling.

Paul studied at the Universities of Sheffield, Southampton and Bristol. During the 1980s and early 1990s he held academic appointments at the Universities of Reading, Sheffield and Swansea and was a Senior Research Associate at NASA Ames, California. From 2005-10, Paul was Vice-Chancellor and Professor of Physical Geography at Bournemouth University. In the intermediate twelve years Paul was Head of the Geography Department, Dean of Science, Head of Winchester School of Art and Deputy Vice-Chancellor at the University of Southampton.

Paul is a Member of the Natural Environment Research Council (NERC) Council and its Remuneration Committee and Chair of its Audit & Risk Assurance Committee; Chair of the Universities and Colleges Employers Association (UCEA) Board; Chair of the national Review Body on Doctors' and Dentists' Remuneration; a Member of Universities UK and two Policy Committees and President of the Remote Sensing and Photogrammetry Society.

Prof. Michael F. Goodchild

University of California, Santa Barbara, USA

Michael is Emeritus Professor of Geography at the University of California, where he also holds the title of Research Professor. He received his BA degree from Cambridge University in Physics in 1965 and his PhD in Geography from McMaster University in 1969. Until his retirement in June 2012 he was Jack and Laura Dangermond Professor of Geography, and Director of UCSB's Center for Spatial Studies. He was Chair of the National Research Council's Mapping Science Committee from 1997 to 1999, and of the Advisory Committee on Social, Behavioral, and Economic Sciences of the National Science Foundation from 2008 to 2010. His research interests center on geographic information science, spatial analysis, and uncertainty in geographic data.

Prof. Andy Gouldson

University of Leeds, Leeds, UK

Andy is Professor of Sustainability Research and Director of the ESRC Centre for Climate Change Economics and Policy at the University of Leeds. He is an inter-disciplinary social scientist who has worked on a wide range of issues relating to environmental policy and management since 1990. His recent work has focused on cities and climate change where following influential work in the UK he has been delivering studies on the economic case for major investments in low carbon, climate resilient cities in China, India, Indonesia, Malaysia and Peru. Andy specializes in applied, engaged, problem/impact-oriented research. He works closely with policy makers and regulatory agencies at the international, national and local levels, as well as with various businesses, NGOs and community groups. He acts as an advisor to the UK Department of Energy and Climate Change and the UK Department of Environment, Food and Rural Affairs and is working closely with the World Bank, the OECD, the UK Foreign and Commonwealth Office and various national governments on cities and climate change.

Prof. Peter Grathwohl

University of Tübingen, Tübingen, Germany

Peter is Professor of Hydrogeochemistry at the Center of Applied Geology, University of Tübingen, Germany. Research interests focus on fate and transport of pollutants in the soil-groundwater system, catchment hydrology, atmospheric deposition, diffusive and dispersive mass transfer as well as sorption in water saturated and unsaturated porous media. Coordination of joint research projects include AquaTerra, an EU-FP6 funded Integrated Project with 45 partner institutions focusing at the dispersion of pollutants in the water cycle (2004 – 2010), the DFG research unit "Reactions in porous media" (2005- 2011), transport modelling in the BMBF program on "Sickerwasserprognose", the EU-FP5 accompanying measure SOWA "Integrated Soil and Water Protection" with 10 Partners (2003 - 2005) and the EU project GRACOS "Groundwater Risk Assessment at COntaminated Sites" with 7 partners (2000 - 2003).

Prof. Hauke Harms,

Helmholtz Centre for Environmental Research GmbH, Leipzig, Germany

Hauke is Head of the Department of Environmental Microbiology at the Helmholtz Centre for Environmental Research (UFZ) and Full Professor at the University of Leipzig, both since 2004. He received his PhD in 1990 from the University of Hamburg. Thereafter he obtained a long-term fellowship from the European Environmental Research Organisation at the University of Wageningen. He continued his career as Assistant and Associate Professor at the Swiss Federal Institutes of Zurich and Lausanne. His research interests comprise various aspects of microbial ecology and biotechnology with an emphasis on complex microbial communities involved in the conversion of natural and synthetic organic compounds in soil, wastewater and the biogas process. He has been a partner in approximately 40 interdisciplinary, mostly international collaborations with partners in 12 European countries and the United States. Presently, he is the spokesperson of the 500 MEuro Helmholtz Research Program 'Terrestrial Environment'.

Prof. Graham Jewitt

University of KwaZulu-Natal, Durban, South Africa

Graham holds the Umgeni Water Chair of Water Resources Management and is the Director of the Centre for Water Resources Research at the University of KwaZulu-Natal. He leads several water and earth system science related initiatives, both in South Africa and abroad with the relationship between land and water a key research thrust. He is the South African contact point for the International Association of Hydrological Sciences (IAHS), is on the editorial board of the journal, Hydrology and Earth System Sciences (HESS) co-leader of the water theme In The Applied Centre For Climate And Earth System Science (ACCESS), a member of the Waternet Board and is active in several other national and international fora. Recent work has been focused on the effective use of science in management systems and to better inform and land and water resources policy development, especially in developing countries. He has a rating of B – "Internationally Recognised Researcher" with the South African National Research Foundation.

Prof. Sander van der Leeuw

Arizona State University, Phoenix, USA

Sander is Co-Director of ASU's Complex Adaptive Systems Initiative. He received a BA in history, an M.Litt in medieval history and prehistory, and a Ph.D. in prehistory from the University of Amsterdam. He is the founding director of the School of Human Evolution and Social Change at ASU, and he has just resigned as the dean of Arizona State University's School of Sustainability, the first of its kind, where he turned interdisciplinary theory into use-inspired research.

Prior to joining ASU, van der Leeuw conducted archaeological and environmental studies in several countries. An expert in complex adaptive systems, he coordinated a series of interdisciplinary research projects on socio-environmental co-evolution and human-nature interactions in all the southern countries of the European Union. Van der Leeuw's interests currently focus on the role of invention, innovation and sustainability in societies around the world. He investigates how invention occurs, what the preconditions are, how the context influences it, its role in society, and how it leads to sustainability challenges.

Prof. Mike Kirkby

University of Leeds, Leeds, UK

Mike is Emeritus Professor of Physical Geography at the University of Leeds. He obtained his PhD at Cambridge, UK in 1963. After work as a post-doc in USA and Mexico and five years as a lecturer at Bristol University, he was appointed to the Chair of Physical Geography at Leeds University in 1973 and remained in post until being awarded Emeritus status in 2002. He has worked on hillslope and small catchment hydrology; and on geomorphological processes, generally from a modelling perspective. He has edited or written ten books and numerous papers, and is currently working most actively on desertification, runoff generation and soil erosion, with continuing involvement in a number of EU projects. He was Managing Editor of the journal 'Earth Surface Processes and Landforms' from 1976-2007, has received the EGU Dalton medal and RGS Founder's medal, and is a Fellow of the AGU.

Prof. Junguo Liu

Beijing Forestry University, Beijing, China

Junguo is Full Professor at Beijing Forestry University. He earned a Ph.D. in Environmental Science from ETH Zurich in 2007. He worked for the Swiss Federal Institute of Aquatic Science and Technology (Eawag) as a research scientist during 2007-2009, and then joined Beijing Forestry University as a full professor in 2009. He is also a senior Cheney fellow at the University of Leeds in Leeds, U.K.; a part-time research scholar at the International Institute for Applied Systems Analysis (IIASA, Laxenburg, Austria); and a visiting scientist at the Potsdam Institute for Climate Impact Research (PIK, Potsdam, Germany). His main research interests include hydrology and water resources, wetland research, ecosystem services and management, coupled ecological and social systems, water-food relationships, and the impacts of climate change on water, food, and ecosystems. He serves as an editor of *Hydrology and Earth System Sciences* (HESS) and the *Journal of Water and Climate Change*. He is an expert consultant for many international organizations and NGOs, including UN-Water, UNEP, WWF, IUCN, and the Water Footprint Network. He is the recipient of a string of awards, including the prestigious Outstanding Young Scientists Award from the European Geosciences Union (2009),

Prof. Michael McLachlan

Stockholm University, Stockholm, Sweden

Michael is a Professor in Analytical Environmental Chemistry and Head of the Department of Applied Environmental Science at Stockholm University. He has an undergraduate degree in Engineering, a Masters in Applied Science from the University of Toronto, and a Doctorate from the University of Bayreuth. He was Professor of Marine Chemistry at the University of Rostock for 5 years before moving to Stockholm 10 years ago. His research interests are the environmental fate and bioaccumulation of organic contaminants, with a particular emphasis on combining trace analytical methods, innovate sampling techniques, field experimentation and mathematical models to yield new insights and create useful tools.

Prof. Erik Matthysen

University of Antwerp, Belgium

Erik is Head of the Evolutionary Ecology Group of the University of Antwerp. He obtained his Master degree in Biology at the University of Antwerp in 1983 and his PhD in Biology at the same university in 1988. In 2010 he became regular Professor in Animal Ecology at this university. From 1989 to 1994 he held several positions as postdoc (at Ohio State University, as fellow FWO-Flanders). From 1994 to 2007 he was Head of the Laboratory of Animal Ecology, combining this position from 1994-1998 being Research Director FWO-Flanders. His main interest / expertise are long-term population studies of birds, behavioural ecology of dispersal, landscape connectivity, population viability analysis, species invasions and host-parasite interactions in birds. He participated in several committees and advisory boards as the European Society for Evolutionary Biology (ESEB), European Ornithologists' Union (EOU), the Executive Committee, International Ornithologists' Union (IOU), is subject Editor *Ecography* (2006-2012) and joins the Editorial Board *Journal of Ornithology*.

Prof. Hans Mattsson

Royal Institute of Technology, Stockholm, Sweden

Hans is Professor in Real Estate Planning at Royal Institute of Technology (KTH) in Stockholm, Sweden. He is in charge of the Land Management track at KTH. His main interest has been devoted to urban policy and plan implementation. Since 1996 he has also been involved in teaching programmes for students from the former Soviet Union. The task has been to promote land management subjects including land law and real estate valuation at universities in the new countries. He has also been involved in work with changes of university curricula in Eastern and Central Europe. For many years he has been concerned with cadastral issues in practice. Recently, together with Nordic colleagues, he concluded a project concerned with comparing the property purchase and parcelling processes in the Nordic countries.

Prof. Michael McLachlan

Stockholm University, Sweden

is a Professor in Analytical Environmental Chemistry and Head of the Department of Applied Environmental Science at Stockholm University. He has an undergraduate degree in engineering, a Masters in Applied Science from the University of Toronto, and a Doctorate from the University of Bayreuth. He was Professor of Marine Chemistry at the University of Rostock for 5 years before moving to Stockholm 10 years ago. His research interests are the environmental fate and bioaccumulation of organic contaminants, with a particular emphasis on combining trace analytical methods, innovate sampling techniques, field experimentation and mathematical models to yield new insights and create useful tools.

Prof. James Meadowcroft

Carleton University, Ottawa, Canada

James holds a Canada Research Chair in Governance for Sustainable Development and is a Professor in the School of Public Policy and Administration, and in the Department of Political Science, at Carleton University. He obtained his honours BA in Political Science from McGill University in 1985 and his D.Phil. in Politics from Oxford University in 1991. He taught for many years in the Department of Politics at the University of Sheffield, before taking up his current appointment at Carleton in 2004. He has been a visiting professor at the University of Keele in the UK and at the American University in Washington, DC.

His research focuses on reforms to structures and processes of governance to promote transitions towards sustainability. He has written widely on sustainable development, and on energy and environmental politics and policy, including recent work on carbon capture and storage, smart grids, the development of Ontario's electricity system, the politics of socio-technical transitions, and negative carbon emissions. He has served as co-editor of the *International Political Science Review* (1999-2007) and Associate Editor of the *Journal of Political Ideologies* (2006-). He holds an honorary doctorate from the University Tampere in Finland.

Prof. Alberto Montanari

University of Bologna, Bologna, Italy

Alberto is Full Professor of Hydraulic Works and Hydrology at the School of Engineering and Architecture of the University of Bologna, where he is chairing the Degree Programme in Civil Engineering. He has been President of the Division on Hydrological Sciences of the European Geosciences Union from 2007 to 2011 and is currently President of the International Commission on Water Resources Systems of the International Association of Hydrological Sciences. He is chairing the Union Award Committee of the European Geosciences Union and is the national representative for Italy within the International Association of Hydrological Sciences. Alberto is currently Editor in Chief of Water Resources Research and has been associate editor of several other scientific journals. He is member of the American Geophysical Union and European Geosciences Union and is also member of the Association of Professional Engineers of Reggio Emilia (Italy).

His primary scientific interests are rainfall-runoff modelling, water resources management and modelling and mitigation of natural hazards.

Prof. Robert Naiman

University of Washington, Seattle, USA

Robert is Emeritus Professor at the School of Aquatic & Fishery Sciences (University of Washington). Currently he chairs the Independent Scientific Advisory Board for the restoration and management of the Columbia River (USA) and is Visiting Professor at the Centre of Excellence in Natural Resource Management in Western Australia. Before he was Professor (part time) at CENRM (University of Western Australia, Albany). He has been Director of the Matamek Research Program of the Woods Hole Oceanographic Institution and Director of the Center for Streamside Studies at the University of Washington. On numerous occasions he was visiting scientist with the Centre National de la Recherche Scientifique (Toulouse, France).

His research addressed the structure and dynamics of riverine ecosystems, riparian vegetation, and the role of large animals in influencing ecosystem dynamics. In 2008 he was awarded the title of Doctor Honoris Causa by the Université Paul Sabatier, in 2012 he received the Eminent Scientist award from the Ecological Society of America and in 2013 he was chosen to present the E. Baldi lecture to the International Society of Limnology.

Prof. Nebojsa Nakicenovic

Vienna University, Viena, Austria

Nebojsa is Deputy Director General and Deputy CEO of the International Institute for Applied Systems Analysis (IIASA) and Full Professor of Energy Economics at the Vienna University of Technology. He holds bachelor's and master's degrees from Princeton University and the University of Vienna, where he also completed his Ph.D. He also holds Honoris Causa Ph.D. degree in engineering from the Russian Academy of Sciences.

Among other recent positions, he was Director of the Global Energy Assessment, member of the United Nations Secretary General High-Level Technical Group on Sustainable Energy for All; Member of the Advisory Council of the German Government on Global Change (WBGU); International Council for Science (ICSU) Committee on Scientific Planning and Review, the Global Carbon Project, and OMV (Austrian oil company) Advisory Group on Sustainability. He is Editorial Board Member of several scientific journals (a.o. Technological Forecasting and Social Change, Climate Policy, Journal of the Institution of Civil Engineers).

Among his research interests are the long-term patterns of technological change, economic development and response to climate change and, in particular, the evolution of energy, mobility, information and communication technologies.

Prof. Joan Iverson Nassauer

University of Michigan, Ann Arbor, USA

Joan is Professor of Landscape Architecture at the School of Natural Resources & Environment, University of Michigan. Joan investigates public acceptance and cultural sustainability of ecological design for metropolitan, agricultural, and transportation landscapes. Current work focuses on storm water management, post-industrial cities and exurban sprawl. Recognized by the International Association for Landscape Ecology, her research and practice bases design and planning on strong science, interdisciplinary collaboration, and creative engagement with policy. Founding secretary of the National Academy of Environmental Design, she is a Fellow of the American Society of Landscape Architects and a Fellow of the Council of Educators in Landscape Architecture. She has held distinguished visiting appointments at the Japan National Forest Research Institute, the University of Melbourne, and the University of California Berkeley.

Prof. Ståle Navrud

Norwegian University of Life Sciences, Aas, Norway

Ståle is Professor of Environmental and Natural Resource Economics at the School of Economics and Business of the Norwegian University of Life Sciences (NMBU). He was a visiting researcher and a Fulbright Scholar at University of California (UC) - Berkeley. He was also visiting professor at UC - San Diego several times, and at the University of New Mexico - Albuquerque. He is appointed Review Editor for the "Economics of Adaptation" Chapter of the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), and reviewer of "The Economics of Ecosystems and Biodiversity" (TEEB) program France. His research focuses on cost-benefit analysis and environmental valuation; including biodiversity and ecosystem services (terrestrial, aquatic and marine), soil and water quality, landscape aesthetics, public health effects from air pollution, cultural heritage; and externalities of energy and transportation.

Prof. Zorica Nedović-Budić

University College Dublin, Dublin. Ireland

Zorica is Professor of Spatial Planning in the School of Geography, Planning and Environmental Policy at University College Dublin. She received her PhD degree from the University of North Carolina at Chapel Hill in 1993, and spent 15 years as faculty at the University of Illinois.

Her research is about planning, cities and technology. The primary sources of research funding have been a.o. the US National Science Foundation, Department of Transportation, Department of Housing and Urban Development. Currently, she is the principal investigator on a 30-partner FP7 project Transitioning Towards Urban Resilience and Sustainability (TURaS). Zorica has served on the Board of Directors of the Urban and Regional Information Systems Association (URISA) and the University Consortium for Geographic Information Science (UCGIS), and as the book reviews co-editor for the Journal of the American Planning Association. She has been an editorial board member of several journals (a.o. URISA Journal and International Journal of Spatial Data Infrastructure)

Prof. Tim O'Riordan

University of East Anglia, Norwich, UK

Tim is Emeritus Professor of Environmental Sciences at the University of East Anglia. Tim holds an MA in Geography from the University of Edinburgh, an MS in Water Resources Engineering from Cornell University, and a PhD in Geography from the University of Cambridge. In June 2013, he was awarded the honour of Distinguished Friend of Oxford. He is actively involved in research addressing the themes associated with better governance for sustainability and he is also active in the evolution of sustainability science partnerships. His direct work relates to designing future coastlines in East Anglia in England and in Portugal, so that they are ready for sea level rise and the creation of sound economies and societies for a sustainable future.

He is an Executive Editor of Environment Magazine and has edited a number of key books on the institutional aspects of global environmental change, policy and practice, led two international research projects on the transition to sustainability in the European Union (1995-2002). He received an OBE in 2010 and is a Fellow of the British Academy. He served as a core member of the Prince of Wales' seminar on Business and the Environment. Through his Associate Fellow position with the Cambridge Institute on Sustainability Leadership (CISL), he has many contacts with the business world.

He serves as Special Advisor to the House of Commons Environment Audit Committee and also as Special Advisor to the CISL Collaboratory on sustainable water stewardship. He

chairs the UK Sustainability Knowledge Network which is a web-based association of active researchers all over the UK.

Prof. Korneel Rabaey

Ghent University, Ghent, Belgium

Korneel is Professor at the Laboratory of Microbial Ecology and Technology and Head of the Department of Biochemical and Microbial Technology (Ghent University). He graduated as Bio-engineer in Environmental Technology at Ghent University and obtained his PhD in Applied Biological Sciences at the same university. Thereafter he has been a postdoctoral fellow and later senior research fellow at The University of Queensland. He is at the moment the President of the International Society for Microbial Electrochemistry and Technology. He has been awarded several times in his research domain, including a recent designation by Thomson-Reuters as Highly Cited Researcher.

His group presently focuses on four key themes, being (bio)electrochemical recovery and conversion of inorganics, (electro)fermentation, microorganism – electrode interactions and microbial electrosynthesis. These processes are studied using a combination of engineering, microbial and physicochemical approaches.

Prof. Mathias Rotach

University of Innsbruck, Innsbruck, Austria

Mathias is full Professor for Dynamic Meteorology at the Institute for Meteorology and Geophysics, University of Innsbruck, where he serves as Head of Department since fall 2011. Matthias has studied Environmental Physics with a focus on atmospheric physics at the Swiss Federal Institute of Technology ETH in Zürich, Switzerland, where he has also completed his PhD on a topic related to atmospheric turbulence. After several post-doctoral projects (among others at Risø National Laboratory in Denmark) he became head of the Boundary Layer Meteorology Research Group at the Institute for Atmospheric and Climate Science, IAC-ETH. After a number of stays abroad (among others, one-year visiting scientist at the National Center for Atmospheric Research, NCAR, Boulder, CO), he moved to the Swiss National Office for Meteorology and Climatology, first as head Research and Development, and later as head Environmental Meteorology. Since 2010 he was appointed in Innsbruck.

Mathias is member of a number of international bodies and committees of which the most important are the Scientific Advisory Board of the German Weather Service, the Program Council of the Hans Ertel Center for Weather Research and the World Weather Research Program's working group on Mesoscale Weather Forecast Research.

Murugesu Sivapalan

University of Illinois, Chigaco, USA

Murugesu is a Professor of Civil and Environmental Engineering at the University of Illinois, Urbana-Champaign. He has a Ph.D in Civil Engineering from Princeton University. He spent 17 years at the Centre for Water Research, University of Western Australia and has also served as Visiting Professor at the Vienna University of Technology, Delft University of Technology, Tsinghua University, and the University of Technology Sydney. Murugesu was founding chair of the International Association of Hydrological Sciences' (IAHS) *Decade on Predictions in Ungauged Basins* initiative. He has been a member of the editorial boards of several international journals and Executive Editor of the *HESS* journal.. He has been elected *Fellow of the Australian Academy of Technological Sciences and Engineering* and *Fellow of the American Geophysical Union (AGU)*. He was a recipient of the European

Geophysical Society's *John Dalton Medal*, the *International Hydrology Prize* of the IAHS, and the *Hydrological Sciences Award* of the AGU. He received the *Robert E. Horton Medal* of the AGU, the highest and most prestigious award in hydrology and was conferred an *Honorary Doctorate* by the Delft University of Technology.

Prof. Vernon L. Snoeyink

University of Illinois at Urbana-Campaign, Urbana, USA

Vernon is an Environmental Engineering Professor in the Department of Civil and Environmental Engineering at the University of Illinois. He received his BS, MS, and PhD degrees in the fields of civil engineering, sanitary engineering, and water resources engineering from the University of Michigan, and joined the environmental engineering faculty at the University of Illinois in 1969. He was Director of Water CAMPWS, a National Science Foundation Science and Technology Center for purification of water before his retirement from the faculty in 2005.

His academic interests include the chemistry of water quality control processes for organic and inorganic compound removal, disinfection, and water distribution.

He has received the Clarke Water Prize from the National Water Research Institute, and is a member of the National Academy of Engineering.

Prof. Tammo Steenhuis

Cornell University Ithaca, Ithaca, USA

Tammo is an International Professor of Water Management in the Department of Biological and Environmental Engineering at Cornell University in Ithaca. He is also an Adjunct Professor at the School of Civil and Water Resources Engineering at Bahir Dar University in Ethiopia. Tammo obtained his MS degree from Wageningen University and his PhD from the University of Wisconsin Madison.

The focus of his research on the management of soil and water resources by improving the understanding of physical, chemical, and biological processes related to water flow. The ultimate goal is to improve and protect water resources and ecological systems throughout the world in socially conscious ways. He received the Darcy medal of the European Geoscience Union and is a fellow of the American Geophysical Union. In 2011 he received the International Prize of the AGU for his work on improving the engineering education and research in Africa.

Professor Willy Verstraete

Gent University, Gent, Belgium

Willy is emeritus professor and retired from his function as Head of the Laboratory of Microbial Ecology and Technology at the Gent university since October 2011. He graduated in 1968 from the Gent University as bio-engineer. In 1971, he obtained a PhD degree in the field of microbiology at the Cornell University, Ithaca, USA. Since 1971, he worked at the Gent University, first as assistant and since 1979 as Professor and Head of the Laboratory of Microbial Ecology and Technology (LabMET - Faculty of Bioscience Engineering).

His R&D has as central theme: Microbial Resource Management; i.e. the design, operation and control of processes mediated by mixed microbial cultures. Willy has field experience with respect to drinking water production plants (slow sand filtration), aerobic wastewater treatment (in particular with respect to nitrification-denitrification), anaerobic digestion of wastewaters and sludges, solid state fermentation of organic residues and bioremediation processes of soils and sediments. He has also gained experience in various aspects of pre- and probiotics used in human and animal nutrition and in systems which simulate the latter.

Professor Timo Vesala

University of Helsinki, Helsinki, Finland

Timo is Professor of Meteorology at Department of Physics, University of Helsinki. He graduated in physics in 1988 and earned a PhD in physics in 1991, both at the University of Helsinki. He was nominated to professorship in 2001. Recently he has acted as Interim Director General of ICOS (Integrated Carbon Observation System).

His primary interests are micrometeorology and surface fluxes of greenhouse gases, other trace gases, aerosol particles and energy over forest, wetland and lake ecosystems and urban environment. He is also working with ecophysiological processes related to biogeochemical cycles. He was Review Editor of IPCC Assessment Report: Climate Change 2013: The Physical Science Basis (WGI AR5), Carbon and Other Biogeochemical Cycles. He is the vice-director of the Finnish 'Centre of Excellence in Atmospheric Science – From Molecular and Biological processes to The Global Climate. He has received 3 awards, the Finnish Aerosol Award, the Väisälä Award and the Norbert Gerbier-MUMM International Award. He is the member in The Finnish Society of Sciences and Letters and in International Eurasian Academy of Sciences.

Prof. Charles Vörösmarty

The City College of New York, New York, USA

Charles is Professor at the City College of New York, Department of Civil Engineering. Besides he is Director of the CUNY Environmental CrossRoads Initiative. Before coming to The City College of New York, he was a Research Full Professor at the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire, where he was founder and director of its Water Systems Analysis Group

His research focuses on the development of computer models and geospatial data sets used in synthesis studies of the interactions among the water cycle, climate, biogeochemistry and anthropogenic activities..

Charles routinely provides scientific guidance to a variety of U.S. and international water consortia. He is a founding member and current co-Chair of the Global Water System Project that represents the input of several hundred international scientists under the International Council for Science's Global Environmental Change Programs. He has served on a broad array of national panels. He is distinguished Scientist, NOAA-CREST.

Prof Eric F. Wood,
Princeton University

Eric is Professor of Civil and Environmental Engineering at Princeton University and –until recently- Program Director in Environmental Engineering and Water Resources. He followed his an academic education Civil Engineering at the University of British Columbia and the MIT in Boston.

His primary interests are in hydro-climatology with emphasis on land-atmosphere interactions and hydrologic impacts from climate change. Estimation of the terrestrial moisture and energy budgets, the quantitative application of remote sensing to terrestrial hydrology and the detection and hydrologic impact of climate change are the primary areas of current research. Stochastic hydrology, hydrologic forecasting and rainfall-runoff modeling, environmental data analysis and experimental design, are the other interests.

He has received several honors and awards.

Prof. Jianguo (Jingle) Wu

Arizona State University, Phoenix, USA

Jingle is Dean's Distinguished Professor of Landscape Ecology and Sustainability Science, School of Life Sciences & Global Institute of Sustainability, Arizona State University, Tempe, Arizona, USA.

His research areas include landscape ecology, biodiversity and ecosystem functioning, urban ecology, and sustainability science. He has been Co-PI and Leadership Team member for the Central Arizona-Phoenix Long-Term Ecological Research project (CAP-LTER) since its inception in 1997, and a founding faculty member of Global Institute of Sustainability (2004) and School of Sustainability (2007) at Arizona State University.

Jingle has been Editor-in-Chief of Landscape Ecology since 2005. He is *Founding Director* of Sino-US Center of Conservation, Energy and Sustainability Science (2007-2012) and Center for Human-Environment System Sustainability. He has received several awards and honours a.o. the *American Association for the Advancement of Science (AAAS) Award for International Scientific Cooperation* (2006), the *Distinguished Landscape Ecologist Award* from United States Association for Landscape Ecology (2010); *Outstanding Scientific Achievements Award* from International Association for Landscape Ecology (2011); and *Distinguished Service Award* from the United States Association for Landscape Ecology (2012)., Beijing Normal University (2012) .