

# **KTH International RAE 2008**

## **Report Panel 11: Technology for the Built Environment**

### **General Assessment of the Research Field**

In the opinion of this Panel, there seemed to be overlap between the materials assessed by the different RAE Panels. For example, some of Panel 12: Architecture, Built Environment and Management, could have been included in Panel 11. Furthermore, the common ground between the UoAs assessed by Panel 11 was limited. However, it was informative to see the different approaches between the three Schools (ABE, ITM and STH) represented in Panel 11.

Overall, there seemed to be a loose managerial structure (at school level) which is unlikely to deliver KTH's vision of being a leading international technical university in this field. This problem was particularly marked in the School of Architecture and the Built Environment. Stronger leadership is required to define a long-term coherent strategy developed with the willing staff and imposed on unwilling staff; the ethos needs to be "join the team or leave". Currently, department staff seem to be confused about the structure; the strong take advantage and the weak struggle. There is a lack of collaboration between strategically similar areas. There seems to be much potential benefit in rationalising the UoA structure; specific suggestions are made in ensuing sections.

There is no common policy on teaching loads for staff (particularly new) which can disadvantage new staff in some divisions. There is no succession planning, reflecting the lack of strategic direction.

If KTH has the ambition of being a world class engineering institution, it cannot continue to penalize laboratory-based research groups. The shrinkage of laboratory space has gone beyond rationalization.

Intellectual Property Rights (IPR) as an integral part of strategy is nonexistent. There are a few members of staff who hold patents but none of these patents have been achieved within the KTH system.

### **UoA: Civil and Architectural Engineering**

#### **General Assessment**

This UoA consists of nine divisions in the Department of Civil & Architectural Engineering: Building Materials, Building Services Engineering, Building Technology, Concrete Structures, Geotechnical Engineering, Highway and Railway Engineering, Industrial Safety Ventilation, Structural Design and Bridges, and Environmental and Natural Resources Information Systems. The Department of Civil & Architectural Engineering is a part of the School of Architecture and the Built Environment.

The UoA provides a focus on Building and Transportation Infrastructure which is of critical importance for the Swedish economy. Some of the divisions are very small in terms of academic staff and there is an opportunity for restructuring to provide fewer (perhaps four) critical mass divisions with a good strategy and strong leadership. There are a number of senior academic staff due for retirement in the next few years which will provide an opportunity to appoint new internationally-leading researchers in areas highlighted for development. The UoA have addressed this in the evaluation package provided to the panel by suggesting four cross-disciplinary research areas for the future: Long-Life Buildings and Transportation Infrastructure, Sustainable Design and Construction, Engineering Systems and Management, and Environment and Construction. The exact name and composition of the groups needs to be determined by KTH internally but the Panel supports the overall objective for rationalization into a smaller number of critical mass groupings with strong leadership and vision.

There may also be a significant strategic benefit from combining this UoA with Land & Water Resources Engineering to produce a bigger combined department. Many of KTH's key international competitors combine these disciplines and also include areas such as Transportation Engineering in a large single unit. This would result in higher international visibility, better name recognition and hopefully a better international ranking. There would also be the enhanced opportunity for additional multi-disciplinary research. One of the main strengths of this UoA is the inclusion of Architectural Engineering which many competitors do not have in the same department.

It was noted by a number of the divisions that there had been a severe rationalization of laboratory space over the last few years, in some cases resulting in closure although some of these laboratories remain empty or are being used as a furniture store. The Panel's view was that this significantly affected the research that could have been undertaken leading, in some cases, to a significant reduction in quality. The fundamental problem is that experimental research uses more space than non-experimental research and, for the same number of people, often cannot attract significant additional income to cover the extra space costs. KTH need to decide whether to support these activities or whether it is happy to become an engineering institute without significant laboratories. The view of the Panel was that the lack of significant laboratory facilities would significantly damage the international reputation of KTH (for both research and undergraduate / postgraduate teaching) and that a more appropriate internal space allocation model needs to be formulated that doesn't overly penalize laboratory-intensive research.

## **Performance Against Evaluation Criteria**

### **Scientific Quality (basic research)**

Scientific quality varied considerably across the divisions of the UoA; a high international standard, with some parts reaching a world-leading standard, was recognised for two groups; a nationally high and internationally recognised standard was more typical of the remaining. This assessment is based on the UoA's contribution in the field and its output in terms of quality and number of publications and dissemination at international conferences. Over the last five years, the UoA has produced 154 journal articles and 128 conference papers which is a good level of activity. Over the same period, a relatively stable amount of funding (approximately 3.8M SEK per annum) has come from Research Councils which is highly competitive and the UoA are involved in a number of National Centres of Excellence and international collaborations. The Divisions of Building Services Engineering and Highway

and Railway Engineering were highlighted as examples where the scientific quality of the research is world leading.

### **Applied Research Quality**

Applied research quality was again heterogeneous with six of the divisions achieving an internationally high standard throughout, and in parts a world-leading standard, whilst the remaining groups performed at a nationally high and internationally recognised standard. Overall, the quality of applied research was high with many significant examples of projects that are closely aligned with industry priorities. On average, approximately 30% of the UoA's research funding over the last five years has come from industry although this percentage (and the absolute value) has dropped in the last two years which should be addressed. The general level of innovation activities (e.g. spin-offs, patents) is low considering the high level of applied research. There is significant scope in this area for additional activity and KTH centrally are revising the level of support provided to staff members which will help the situation. The UoA are a partner in the EcoBuild Institute Excellence Centre which involves a number of non-academic partners. The Divisions of Building Services Engineering, Concrete Structures, Geotechnical Engineering, Highway & Railway Engineering, Industrial Safety Ventilation and Structural Design & Bridges were highlighted as examples where the applied quality of the research is world leading.

### **Scholarship**

Scholarship was assessed as emerging across the majority of the UoA, though again there was considerable variety with some groups achieving excellence in parts. The UoA currently has 60 PhD students which demonstrates a good level of activity. 45 PhDs have been graduated over the last five years with a high proportion funded by industry, although again it is notable that the number has decreased significantly from 18 in 2003 to 5 in 2007. The UoA does not seem to have a history of employing post-doctoral researchers which is unusual in comparison to the international competition. Engagement in scientific society (esteem) is generally good with a significant number of staff members contributing to activities such as plenary or keynote addresses at international conferences, editors or members of journal editorial boards and prizes.

### **Vitality & Potential**

Vitality and Potential was assessed overall as good in some parts of the UoA but needing to be improved in the remainder. Over the last five years the average annual income of the UoA has been approximately 45M SEK although this has decreased by approximately 15% since 2003. Approximately 45% of this income comes from KTH which is appropriate for a research-led university. As noted earlier, many of the research divisions are small in size and there are a significant number of senior professors due to retire in the next few years which have detrimentally affected the vitality and potential of the UoA. The publication record of the UoA is good in terms of quantity. For example, in 2007 30 journal articles and 22 conference papers were published. The teaching load also seemed to vary significantly across the divisions. The summary of future research directions was well written, and identified four important areas of research for the future: Long-Life Buildings and Transportation Infrastructure, Sustainable Design and Construction, Engineering Systems and Management, and Environment and Construction. Because of the number of impending retirements in the next few years there is the opportunity to appoint high profile international researchers who would bring new ideas and new ways of doing research to the UoA. This will also help develop international collaborations between institutions as well as providing means for solving potential leadership issues.

## Strategy

Strategy was assessed as weak in the majority of the divisions within the UoA, with just three divisions able to present a strong vision for their future. A significant number of the divisions were found to lack any significant strategy which was an area of concern. However, many of these divisions were small and in some cases lacked professorial leadership, so the lack of a coherent strategy is perhaps understandable. Although their strategy work was still in progress, the new leadership in the Division Highway & Railway Engineering presented the clearest direction and most coherent picture for the future of a division within the UoA.

## UoA: STH Health

### General Assessment

This UoA consists of three divisions in the School of Technology and Health (STH): Fluid and Climate Technology (FCT); Ergonomics; and Design, Work Environment, Safety and Health (DASH). Initially, FCT was established in 2003; then DASH was incorporated into the school and this year the new Division of Ergonomics was added to STH. The current structure forms a synergy between these important and related activities within the built environment and process industry as it focuses on the safety at home and the workplace, quality of life and well-being of building occupants, and productivity. FCT and DASH are located in the Haninge campus and the Ergonomics Division is at the main KTH campus in Valhallavägen.

FCT has been steadily expanding and consolidating its research foundation in the health aspects of ventilation, indoor air quality, computer modelling (e.g. computational fluid dynamics (CFD)), and low energy heating systems. The appointment of a full professor last year was a natural step to strengthen the activities in these important areas of built environment research and teaching.

The Ergonomics Division is developing research that is based on its individuals' previous experience in the human interaction with technology and the indoor environment and in particular accident prevention at the workplace. It is planning to set up new a laboratory for this activity as well as using the facilities at the Karolinska Institute (KI).

Although the Panel's agenda included meetings with the main members of the FCT and Ergonomics Divisions, there was no scheduled meeting with DASH. It was only possible to meet one member of the DASH Division after a special request. Although this division has clear aims of what it stands for, the Panel's opinion is that it is mainly driven by the professor. The division has considerable experience in social anthropology and is currently planning the establishment of the KTH Centre for Health and Buildings.

## Performance Against Evaluation Criteria

### Scientific Quality (basic research)

Two divisions, FCT and Ergonomics, were considered as producing work at a world-leading standard in parts and of an internationally high standard throughout. The DASH division produced work at a nationally high and internationally recognised standard throughout. It was evident from the presentations and discussions that, since its conception, the FCT has been applying established research techniques in ventilation, indoor air quality, aerosol

transportation and CFD to understanding the impact of indoor air pollutants on human health. More recently the division has expanded into conducting research into low temperature heating and ventilation systems with the aim of reducing energy consumption for buildings. The Panel considers the standard of these research activities to be at the higher end of international activities in similar research areas. This assessment is based on the division's contribution in the field and its output in terms of publications and dissemination at international conferences.

Senior members of the Ergonomics Division have brought with them quality research in work safety and accident prevention to KTH. The output of their research includes articles in referred journals, books, intellectual property for vibration damping and welding visor. Although most of this output was completed before joining KTH, it nevertheless represents a solid foundation for initiating and nurturing similar research activities in the new division.

Although DASH has established strong links with Swedish Government agencies and local authorities and has been successful in obtaining research funding for these activities, their dissemination seems rather limited when compared with similar groups at international level. It would seem that the group is more focused on establishing links with stake holders than dissemination to international audience.

The total number of journal articles published during the research assessment period (2003-07) for this UOA is 42, i.e. an average of about one article per academic staff per year. This rate of journal article publication is not considered on the high side for a research active department. However, considering the history of the department and its divisions, one can expect future rates to increase.

### **Applied Research Quality**

All three divisions were evaluated as producing world-leading results in parts and results of an internationally high standard throughout. The nature of research within the three divisions is very much aligned to the needs of industry and stake holders. This is particularly obvious within DASH and to some extent within Ergonomics but to a lesser degree within FCT. Consultancy is a thriving activity within the former two divisions and much of their income; DASH in particular, is through applied research. Although such alignment has direct benefits to society, there is a risk of the research in these areas becoming more aligned to the stakeholder at the expense of academic rigour. A balance between applied and fundamental research would be a better compromise for all three divisions.

### **Scholarship**

On average scholarship was considered as emerging across the majority of the UoA. The UoA's research is primarily focused on improving the work and living conditions of individuals through better understanding of indoor environmental conditions and their effects on people's well-being and accident prevention. FCT's research activities have been focusing on studies related to assessing and improving the indoor air quality in buildings, control of aerosol movement in ventilated rooms, thermal comfort and low energy heating systems. These activities require experimental research that is backed by sophisticated computer simulation tools. The approach adopted by FCT in these activities constitute a large degree of scholarly work and fundamental approach to fluid flow, aerosol dynamics and heat and energy flow modelling.

The Ergonomics research activity is of great benefit to individuals who perform physical activities at their workplace. In this research area, there remain knowledge gaps, e.g. causes

and prevention of Musculoskeletal Disorder (MSD). As such, there is a good scope for developing scholarly research within KTH in this and new areas in future, given that adequate planning is made and internal and external funding are forthcoming.

The research undertaken by the DASH group cover important areas relating to safety and well-being of individuals at home and in the workplace. This research activity is gaining much international attention particularly in relation to improving the quality of life for the ageing population. However, the group will need to pay more attention to publication to ensure that its research has a higher degree of scholarly output in addition to solving practical problems in the field.

### **Vitality and Potential**

Two divisions, FCT and Ergonomics, were considered as having vitality and potential that was excellent in some parts of the divisions and good in the remainder. DASH was considered good in parts though its vitality and potential needs to be improved in the remainder. The FCT Division is a medium size group which has plans for further expansion following the promotion of its leader last year to a full professorship. Currently, it has six PhD students which is the largest number among the three divisions. It has established collaborations with Gävle University, to benefit from the extensive laboratory facilities that are not available at KTH, and also with overseas universities. The division is consolidating its activities since it was established in 2003 and is expected to grow by inviting a guest (visiting) researcher and a guest professor from another university this year as well as recruiting more PhD students.

Total external funding for the research assessment period (2003-07) was approximately 37M SEK against KTH internal funding (excluding funding for undergraduate teaching) of approximately 27M SEK. This represents a ratio of approximately 1.4 which is normally considered on the low side for a research active department. However, when it is taken against a backdrop of the evolution history of the three divisions within UoA, with one established in 2003 and another only this year, this relatively low funding ratio is justifiable.

The Ergonomics Division has quickly established itself within KTH by appointing a guest professor and three PhD students. The demand for young researchers in its field was evident due to near retirement of senior researchers in ergonomics in Sweden and the division is well aware of this and intends to address the issue of PhD training.

The DASH Division, although the largest within the UOA, has only three PhD students and does not seem to have plans for training young researchers in the subject area. It would seem that DASH is not as well prepared in meeting the inevitable changes resulting from the retirement of senior academics in the division as the other two divisions are. Currently the division is well motivated by its leader, but its future seems less certain when this leader approaches retirement.

In all three Divisions, there is adequate representation by female academics but the age of the academics in general is a point of some concern. It was evident that FCT and the Ergonomics Divisions had plans to build collaboration in their respective research activities, however no such plans were evident from DASH. The research funding of the three divisions over the last few years has been healthy and this should be exploited in supporting new initiatives in any strategic planning. It is also recommended that the three divisions establish closer collaborations in their fields of research as these are complementary and such collaboration will serve to strengthen the research of the school.

## Strategy

All three divisions were evaluated as having good strategies with real potential to achieve. Documents explicitly addressing mission, vision and their implementation were not presented. However, it is evident that FCT and Ergonomics both have a strategy for consolidating their research activity, developing new initiatives and collaborating with other researchers in their fields both within KTH and outside. FCT is planning to expand its activities in the energy saving area for the built environment as it has recognized this to be an important area where future funding could lie. Similarly, Ergonomics is considering expanding into the ergonomics of quality/lean production and product development as these activities have also been identified as opportunities for attracting future funding. Ergonomics should be able to do this more effectively if it could start collaborating with other groups within KTH who have expertise in the psychological aspects of ergonomics.

DASH is embarking on setting up a full-scale living laboratory to be used for starting research in care and facilities management as a test bed for improved interior design solutions for different age groups of building occupants.

The challenges facing this UOA is in the training of young researchers to take on leading roles when senior professors approach retirement. The need to appoint young researchers to train and benefit from the present leaders in the fields at the three divisions and become future leaders in these important activities is becoming rather urgent. This should be included in the strategic planning within the School and the divisions.

There is a great scope for streamlining and re-aligning with similar divisions in other KTH schools. An obvious case is the relocation of the research and teaching activities in the Industrial Safety Ventilation and Building Services Engineering Divisions (both currently in the Department of Civil and Architectural Engineering) to the School of Technology and Health either as a separate division or as part of the FCT Division. This will permit locating groups of similar activities in one campus to share laboratory and computer simulation (CFD and others) facilities and to create a critical mass in ventilation and indoor environment research within KTH. The research of the Ergonomics Division would be strengthened if it could collaborate with other ergonomics groups within other schools at KTH. However, to deliver these potential synergies would require a strong leader with a clear mandate which seems to be currently missing.

In addition to supporting future research, collaboration and streamlining between groups engaged in similar activities will also strengthen and harmonize the delivery of teaching modules that are currently shared between divisions at different schools within KTH.

## UoA: Industrial Ecology

### General Assessment

This UoA comprises the Department of Industrial Ecology from the School of Industrial Engineering and Management. Industrial Ecology is an emerging trans-disciplinary area whose importance as a systematic approach to the problems grouped under the heading of “sustainable development” is increasingly recognized internationally. It is to the credit of KTH that the importance of Industrial Ecology was recognized so that the subject is taught as a component of a number of different degree programmes. The department has evolved from its origins as a teaching programme, and in recent years has gone through major restructuring

to develop into a UoA with a balance between teaching and research. It is to the credit of the leadership in the department that this restructuring has been effective. Research within Industrial Ecology has achieved “critical mass” but there is still a clear need to grow the staff further to grasp the opportunities offered by this new area. Industrial Ecology necessarily straddles a number of conventional academic disciplines, including engineering, natural science, behavioural science and economics. To some extent these disciplines can be brought together by collaboration with conventional disciplinary groups (this is already happening at KTH and by collaboration with other groups within Sweden and in Europe) but there is a clear need to recruit academic staff with backgrounds in the behavioural sciences and economics. However, to maintain the problem-solving ethos of the department, it is important to keep it in a school with an engineering focus; Industrial Engineering and Management appears to be an appropriate home.

Industrial Ecology at KTH is one of the small number of groups worldwide which are at the forefront in defining this new area. Research in the department uses specific case studies, such as Hammarby Sjöstad and management of coastal zones in the Baltic Sea Region, as case studies to inform the development of tools and approaches which can then be applied more generally. This is a well-considered approach which helps maintain the focus on practical problem-solving.

Industrial Ecology is highly relevant in guiding industrialization in developing countries. Establishment of the Joint Centre for Industrial Ecology with Shandong University, Jinan, China is therefore of particular importance, evidence of a clear vision from KTH and the department of Industrial Ecology. It demonstrates what can be achieved given clear, high-profile support from KTH.

Uniquely among the groups assessed by Panel 11, Industrial Ecology has a clearly articulated mission, vision statements and an implementation plan for its future development. Industrial Ecology should have a strong future at KTH. Industrial Ecology is commended as a model of the kind of innovation in research which should characterize an Institution like KTH, and the panel wish to emphasize that this is an area which merits strategic support.

## **Performance Against Evaluation Criteria**

### **Scientific Quality (basic research)**

Part of the UOA currently performs at a world-leading standard with the main part performing at an internationally high standard. The research in Industrial Ecology is well grounded in theoretical understanding, but shows the breadth necessary for a developing area. This group is one of the world leaders in establishing the research agenda for Industrial Ecology. It has a good international profile, recognized by collaboration with other leading groups in this area and active engagement in international programmes. The panel’s only significant reservation in this aspect of the assessment is that, given the quality and extent of its research, the group might be expected to produce more publications in international journals; this would help Industrial Ecology to achieve more recognition at KTH as an intellectually demanding field of research and also to reinforce the department’s international standing.

### **Applied Research Quality**

Against this criterion, Industrial Ecology at KTH is outstanding with the majority of the UOA performing at a world-leading standard. The contribution of the group to the development and applications of methods and tools used in Industrial Ecology is notable. The LCA-based

Environmental Load Profile approach, developed through work using Hammarby Sjöstad as a case study, is a welcome practical manifestation of Industrial Ecology which is widely applicable. The contribution of this group to the debate over Sustainable Consumption has already attracted notice internationally (for example, by the UK Department of the Environment, Food and Rural Affairs). Environmental Modelling and Risk Management are research areas with increasing international impact. The principal users of this research at present are governmental, regulatory, planning and other public bodies, but private sector organizations such as retailers are showing growing interest in the Industrial Ecology approach.

### **Scholarship**

Scholarship was considered excellent in some parts/individuals of the UoA. As one of the leaders in developing Industrial Ecology, the department at KTH already shows recognition as an independent authority. This was reinforced by acting as host and organizer of the 2007 conference of the International Society for Industrial Ecology. As noted above in the context of Scientific Quality, a higher rate of publication in international journals would enhance the group's standing and reputation.

### **Vitality and Potential**

Vitality and potential was considered excellent across the majority of the UoA. Industrial Ecology clearly provides a stimulating intellectual environment: activity is limited by the availability of people's time, not by lack of ideas. The number of PhD students is growing, and it is notable that they are attracted to KTH from a range of countries (including China). Unusually for an institution like KTH, the department has developed a set of courses for PhD students. This must represent a significant work-load, but the initiative is commended: it is particularly important for an emerging trans-disciplinary area like Industrial Ecology.

The gender and age profile are good, with evidence of "emerging talent". The panel wish to point out that succession planning needs to be undertaken before the present Head of Department approaches retirement age.

### **Strategy**

Industrial Ecology is to be commended for its clearly articulated mission (although designated "policy"), vision statements and implementation plan. Given the demand for this subject area, the Vision could have been bolder if subject proper backing was assured. However, without clearer definition of strategy for KTH as a whole, it is not clear how effective this strategy can be; the current Vision is based on organic growth with little or no support from KTH centrally or its schools. This is why the panel rate the strategy as "Excellent but challenging to achieve".

The Panel note that there are actual and potential synergies with other groups at KTH. However, because of the division of Units of Assessment between panels, the panel do not have sufficient information on other relevant groups, notably Urban Planning and Environment (School of Architecture and the Built Environment) or Energy Transformation (School of Industrial Engineering and Management). It is to be hoped that, in acting on the results of the Research Assessment Exercise 2008, KTH will recognize the importance of encouraging synergies where they support the development of strategically important new areas.

## UoA: Land and Water Resources

### General Assessment

This UoA consists of seven divisions in the Department of Land and Water Resources Engineering. The focus is on research leading to sustainable and effective utilization of natural resources, with competence in modelling of biogeochemical and physical processes to designing treatment techniques for pollution prevention and hydraulic structures as well as to environmental resources management in relation to socio-cultural, gender, legal, economic and cognitive factors. The interplay between man-made infrastructures and environmental effects, sustainable use of natural resources and ecologically sound land-use and urban development are issues that motivate the department's research. Urgent questions in relation to climate change and increasing competition for water include water management policy, drinking-water supply, food and energy production, soil and water pollution, waste management and the function of ecosystems. The department is organized in seven divisions: "Ecosystem Technology", "Water Resources Engineering", "River Engineering", "Water, Sewage and Waste technology", "Water Management", "Environmental Management and Assessment" and "Engineering Geology and Geophysics". It has the main responsibility for two master's programmes and it takes a major role in a five-year engineering programme. Currently, there are 51 PhD students supervised in the department.

Land and Water Resources is a department that is geared to address the environmental issues of our time, and develop economically viable solutions to those issues. It is the combination of these two skills that make the department an important academic resource in Sweden. Most of the important research areas within the field are covered by Land and Water Resources. The ratio of total funding (52M SEK) to that supplied by KTH for faculty and education (21.5M SEK) is currently 2.4, a healthy ratio for a research university. The department is also providing a significant contribution to the education of KTH's students, with 40% of the funds received from KTH being for education. This review will consider the 19 faculty of the Department of Land and Water Resources that are at Docent level and above.

In spite of its accomplishments, the Department of Land and Water Resources seems to be suffering with the slow transition from a Chair-based to a more egalitarian-based system of financing. The School of Architecture and the Built Environment provides funds only to professors with established chairs, creating a significant inequality in the department, and ultimately resulting in an incomprehensible organizational structure. The department is currently organized in one large division of seven faculty and six small groups of between one and three faculty. The large division seems to cover many of the department's research areas, with substantial overlap with the other divisions. The only rationale that the panel could glean was protection from economic stresses, i.e., one group without an established chair wanted to associate itself with an established chair. An individual or a company coming from the outside would not be able to make sense of the organization, because of the overlap, and may become frustrated with the seeming competition in the department. One member of the panel who has experience in Swedish industry stated that, in fact; this is the impression that many have of the organizational structure at KTH. The panel recommends that funding from KTH and the School of Architecture and the Built Environment be more equally divided among the members of staff in the department, allowing the department to organize into approximately four topical groups that would be logical to the outside world, and reducing the "have and have-not" character of the research environment.

KTH does not have a department of geology, one of the basic sciences. There are many technical issues for which a geology department is important, such as the dating and analysis of lake sediment cores and ice cores (i.e., for an analysis of climate change), the development of carbon sequestration methodologies, and the impacts of long-term storage of nuclear wastes. With this in mind, it is important to support and expand the Engineering Geology and Geophysics Division of the Department of Land and Water Resources at KTH. They should play an important basic science role at KTH, in addition to their involvement in the engineering sciences.

Water and wastewater treatment is an important part of any department related to environmental engineering, such as the Department of Land and Water Resources. The increased population in the world means that river and lake water will continue to be more polluted, requiring innovative means of drinking water treatment. In addition, there will continue to be an increased requirement to treat waste, and the technologies currently used tend to be archaic. There is much innovation required and possible in this field with new technologies, new methods and new requirements. It is important to support this research area in the Department of Land and Water Resources.

There are many divisions of the Department of Land and Water Resources that play an important role in the international research community. Many of the divisions also have a significant applied research component, solving intractable problems for the Swedish community and the international community of developing nations. In fact, the primary need of developing nations is water and wastewater treatment. Cholera and other water-borne diseases are prevalent in the poorest nations, accounting for the majority of infant mortality in these countries. In addition, much of the population in many developing nations live in flood-prone regions, where flooding often destroys property and brings disease. The research of the Water and Wastewater Treatment, Ecosystem Technology and River Engineering Divisions are especially relevant in this regard. Research in the department on on-site treatment technologies, recycling of wastes, arsenic in groundwater, decentralized wastewater systems, etc. is an important contribution to health in developing nations.

The Department of Land and Water Resources should continue to carefully consider the advantages of forming a larger unit with the Department of Civil and Architectural Engineering. Although the disciplines are quite different, the clientele is similar. Both departments are working to provide solutions for society. One advantage to working for the same group of people is a shared perspective. The four academic members of assessment Panel 11 come from departments where these two units are joined. There are some surprising collaborations that come out of such a joint department, and international reputation is somewhat easier to develop.

## **Performance Against Evaluation Criteria**

### **Scientific Quality (basic research)**

Scientific quality was assessed as being of a high international standard throughout the UoA. The research in Land and Water Resources is well grounded in theoretical understanding. In particular, the River Engineering, Water Resources Engineering and Ecosystem Technology divisions publish in the most respected scientific journals in their field, such as *Theoretical and Applied Climatology*, *Journal of Applied Meteorology*, *Water Resources Research*, *Environmental Science and Technology*, *Water Research*, and *Chemosphere*. In fact, most of

the publications of the entire department are in high-quality journals with an international reputation. The department has the personnel and the research profile to properly represent Sweden's best renowned academic institution.

### **Applied Research Quality**

Applied research quality was assessed as world-leading in parts and of a high international standard throughout. The Department of Land and Water Resources at KTH is outstanding in their ability to solve tough problems in the Swedish environment. These include the development of tools for de-icing salt, uranium and radon in groundwater, the development of tools for large-scale field experiments, small scale water and wastewater treatment, storage of toxic and nuclear waste and carbon dioxide, the development of predictive biodiversity assessment tools, identifying sources of geothermal energy, extreme flows in river basins and the governance of ecosystem services in the Baltic Sea Region. The department also plays a significant role in international applied research, notably arsenic occurrence and mobility in groundwater, salinization of groundwater, water supply and sanitation in developing countries, run-off modelling in arid areas, and microbiological risk assessment for shallow aquifers. The breadth of these endeavours indicates a department with a high level of applied research.

### **Scholarship**

Scholarship was assessed as emerging across the majority of the UoA. The Department of Land and Water Resources currently has 51 PhD students and has graduated 33 PhDs over the last five years, an acceptable level of activity. Approximately two thirds of these PhDs are employed in research positions, a healthy ratio, and 12 are employed outside of Sweden. They also have one Guest Professor from a Swedish institution, which will help with graduate students and funding. There are no post-doctoral fellows in the department, but there are seven non-Docent researchers, which may be a replacement for post-doctoral fellows. The department is probably one of the more visible KTH departments in Sweden, because they are dealing with environmental issues that are important to society. PhD students are encouraged to attend international scientific conferences and there have been some international conference sponsored by the Department of Land and Water Resources in the last five years.

### **Vitality and Potential**

Vitality and potential was assessed as good across the majority of the UoA. The Department of Land and Water Resources has a ratio of total funding (52M SEK) to that supplied by KTH for faculty and education (21.5M SEK) of 2.4, a healthy ratio for a research university. The publication record of the department is variable: five reviewed faculty have published more than three peer-reviewed journal articles per year, generally in high quality scientific journals, while roughly five averaged less than one per year. The teaching obligations of the faculty varied greatly, as well. These facts, with the unusual distribution of one large and six small groups, indicate that the department is managed, but not led. The current Head of Department is an Associate Professor who new to the position, and may find it difficult to make changes to the department structure, regardless of intent. However, the summary of future research directions was well written, and identified four important areas of research for the future: water technology, environmental assessment and management, geosciences and ecosystem sciences. This may be an organizational structure that the department can live with.

As stated above, there is currently an opportunity to develop two important areas within the Department of Land and Water Resources by filling established chairs in Engineering Geology and Geophysics and Water, Sewage and Waste Technology. The importance of these areas to the scientific direction of the department is significant. The panel also noted that most

of the faculty in the department had received their PhD from KTH. The panel believe that a greater degree of integration with the European and international community in hiring is desired, to bring new ideas and new ways of doing research to the Department of Land and Water Resources. International searches in the European Community have become common for both established chairs and for entry-level positions. This hiring from outside the department will also help in developing international collaboration between institutions as well as providing means for solving potential leadership issues. The panel believes that the department will fall behind the international community if it does not follow suit in its hiring practices. The panel also noted that three out of the seven research groups are headed by female researchers.

### **Strategy**

The Department of Land and Water Resources is currently struggling with strategy and it was assessed as good but challenging to achieve. Individuals and many research divisions seem to have a strategy to accomplish their goals over the next few years (based mainly on extrapolations of current work), but the department strategy is a work in progress. The department could consider weaknesses, challenges and opportunities from a more global perspective. This is difficult when the vast majority of the faculty received their PhD from KTH and most of the external funding comes from Swedish State Agencies and Local Authorities. Visits to other European universities to get their perspective would be helpful. The currently fragmented structure and inbred nature of the department will obviously present considerable leadership challenges in order to bring about a coherent overall strategy.

Through political events the Division of Water, Sewage and Waste Technology together with the Swedish Environmental Institute (IVL) have recently become 50/50 owners of world class pilot plant facilities at Stockholm Water. This asset could well turn out to be a burden if not properly considered in the division's strategy. Issues that should be carefully considered are e.g. roles vis a vis IVL and Stockholm Water, research versus consultancy and IPR.

The panel also sees substantial potential synergies regarding the relationship of society and the environment with the Department of Industrial Ecology and the Department of Civil and Architectural Engineering at KTH. The Department of Land and Water Resources is poised to exploit these synergies internal to KTH.

### **Additional Information for the Research Field**

There is significant scope for combining the Departments of Civil & Architectural Engineering and Land & Water Resources Engineering. This could also include Transport which is currently also a separate department in the School of Architecture & the Built Environment.

The mechanism for funding chairs within schools seems to be variable. For example, the School of Architecture & the Built Environment seems to allocate funding only to professors with an established chair, while internally promoted professors attract no school funding. Conversely, the School of Industrial Engineering & Management seems to allocate funding to all chair positions. The effect of this was clear in the Departments of Civil & Architectural Engineering and Land & Water Resources Engineering where, in some of the divisions, the holder on an established chair had left and was not automatically replaced meaning that those divisions have to operate without leadership and the funding that comes with an established

chair. KTH should consider a different mechanism to provide baseline funding at division level that is not tied to a particular chair position.

Several of the interviewees mentioned that the criteria for internal promotion to professor were not very transparent. If KTH are to keep their most promising academic staff there must be clear procedures for internal promotion and there should be no distinction between internally promoted professors and external appointments at this level.

The schools and departments should consider entry-level hires as carefully as they consider senior hires to established chairs. Entry-level hires are the future of KTH, and should fit into an overall long-term strategy for the departments.