Universities in Capacity Building in Sustainable Development:
Focus on Solid Waste Management and Technology

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Abstract
This paper analyses some of the higher education and research capacity building experiences gained during the period 1998-2006 by Danish and Malaysian universities. Focus is on waste management, thereby directly relating to both the environmental and the socioeconomic dimension of sustainable development. New Danish education methodologies were introduced in Malaysia, specifically problem-based learning, PBL, and the arrangement encapsulated a unique inter-institutional cooperation through staff exchanges, training programs and research networks. Results were new and enhanced study curricula as well as improved professional and international competence of faculty and postgraduate students. This, in turn, strengthened academic environmental programs at Malaysian universities, including more direct and mutually beneficial cooperation between academia and business in Malaysia. Though still embryonic, this kind of reach-out activity is considered vital to development in Malaysia and other countries actively involved in globalisation. For Danish students and faculty the gains have been new international dimensions in PBL curricula, enhanced career development, and research cooperation based on real life cases and challenges not available in Denmark. It is suggested that the area of solid waste management offers opportunities for much needed capacity building in both theory and practice and that universities should be more actively involved in research, education and training to make the necessary progress in all countries. ISWA might be the mediator and platform for such capacity building by providing a lively forum for debate, securing dissemination of new knowledge, and furthering international networking beyond what universities already do by themselves. A special challenge to ISWA may be to improve national and international professional links between academia and business, thereby making education and research key driving mechanisms in sustainable development in solid waste management.

Introduction
Capacity Building involves development of abilities, relationships and values that will enable organizations, groups and individuals to improve their performance in achieving development goals (UNEP, 2002). Using this definition of capacity building, the present paper analyses some of the experiences gained during the period 1998-2006 by 19 universities in 5 countries, linked into 4 international consortia by grants from the Danish International Development Agency, DANIDA. Cf. LUCED-I&UA (2004).

For universities capacity building means improved performance in terms of higher education and research, in both instances to the highest level of understanding and ability to handle complexity in both theoretical and practical context. For the individual, for example student or faculty, it becomes a challenge to exert this ability to the benefit of development at the personal, corporate and societal level. For the university it becomes a challenge to improve internally, for example through new curriculum and governance developments as well as novel research projects, externally, for example through more productive links to business and society, and internationally, for example through innovative global networking and including in this context developing economies and international aid programmes. In this paper focus is on waste management, including cleaner
production, management and treatment technologies. Though thereby limited in scope, it still relates to both the environmental and the socioeconomic dimension of sustainable development.

Universities are often target groups for capacity building through international aid programs. This paper aims to present some experiences from capacity development activities and the transfer of knowledge between Malaysian universities and into the Malaysian society as a result of collaboration between Danish and Malaysian universities in developing capacity for environmental technology, management and governance. The role and close collaboration among academia, society and stakeholders are shown in Fig.1.

![Figure 1: The Tool in Education and Research and National Coupling between Stakeholders in capacity building.](image-url)

In 1998, a Danish University Consortium for Environment and Development-Industry and Urban Areas, DUCED-I&UA, started to strengthen the Danish resource base for international aid; cf. Hansen (2004). The pilot phase of the programme financed by the then DANCED (Danish Cooperation for Environment and Development) now DANIDA (Danish International Development Agency) involved creation and development of curricula at Danish universities to provide the basis for the training of Danish students in developing countries and was supplemented with educational conferences, continued education and increased mobility of students and faculty. DANCED later provided financial support to similar university consortia in Malaysia, Thailand and southern Africa, once the Danish universities concluded their pilot phases and entered the consolidation phases.

As a result, three new university consortia were established in Malaysia (MUCED-I&UA), Thailand (TUCED-I&UA) and southern Africa (SACUDE-I&UA) respectively in 2000. They subscribed to similar goals - developing the capacity of academic staff and students and developing a resource base in environmental engineering and management and sustainable development with more specific targets corresponding to priority areas within the respective countries. The consolidation phase of the Danish university consortium (DUCED-I&UA) was geared to support the 3 new consortium programmes. The acronym for all four consortia became LUCED-I&UA, Linked University Consortia for Environment and Development-Industry and Urban Areas.

The Malaysian university consortium MUCED-I&UA involved four public universities – the University of Malaya, Universiti Kebangsaan Malaysia, Universiti Putra Malaysia and Universiti Teknologi Malaysia. The immediate objective was to ensure adequate skills and knowledge in integrated and problem-oriented approaches to environmental engineering and management. This was realized through structured activities such as 1) Traineeships and field studies for Danish students in Malaysia, 2) Joint Field Courses, 3) Curriculum developments and faculty training, and 4) Research Projects. These activities are briefly described below with special regard to experiences from the Malaysian-Danish (MY/DK) partnership 1998-2006.
MY/DK Environmental Capacity Building in Higher Education and Research

Traineeship and Field Studies (TFS)

The TFS program was one of the main activities of the Danish consortium of universities during its pilot and consolidation phase. The aim was to train Danish students in interdisciplinary and problem-oriented project work through field studies in one of the partner consortium countries. Both a Malaysian and a Danish supervisor supported the students during their 3 to 6 month stay, where students worked on real-life problems within the social and cultural limitations of a developing country. A total of 56 students from Danish universities completed projects in Malaysia from late 1999 to mid-2004.

The co-supervision of TFS students exposed local supervisors to new concepts and ideas that have developed into teaching and research projects (Danish University Consortia for Environment and Development, DUCED - I&UA, 2004). This has been a two-way learning experience for both students and supervisors. Malaysian supervisors gained from experiencing how these students worked, which may be very different from that of local students especially in problem-based approaches and qualitative research methods. This provides a greater insight not only on how to develop new and interesting projects but also on specific techniques that are being applied to successfully complete and report on projects.

The TFS program had great impact on the students. They experienced enrichment in their intercultural skills, hands-on experience in their area of study, and application of theory in new project areas. On the local side, the co-supervision of students has facilitated a physical exchange of experience and knowledge between the local and Danish supervisors. This can be translated into joint publications, development of new collaborative research projects and networks, as well as future student supervision.

As an example, one of the first TFS projects involved two Danish students in the final year of their Masters and working in Malaysia from December 2002 to March 2003. This four month TFS project exposed the two students to solid waste management problems in Malaysia. One important aspect investigated was the environmental assessment of household waste disposal in Kuala Lumpur, where 25% of the country’s total solids is being generated. The study focused on energy usage in waste management and the major polluters involved. The work revealed existing pollution points within the system and predicted (based on models) the future environmental impact for alternative scenarios. An important aspect of this collaborative research was that the Malaysians could take it a step further and seriously explore remediation options in reducing pollution impacts.

The students gained hands-on experience to tackle a very practical problem and shared the knowledge acquired earlier in Denmark. They were also able to interact with local populace and students of different cultural backgrounds. Malaysian students involved in the same project were able to acquire techniques in approaching the private sectors and to work in groups. They were exposed to Problem-Based Learning, which is a relatively new concept to the Malaysian academic fraternity and students. The Danish students presented their final report in a well-attended seminar in Kuala Lumpur before returning to Denmark for the final evaluation and grading of their work.

Additional TFS benefits have been identified and documented, such as the intercultural experience, hands-on practical research in a foreign environment, interaction with new people (both students and faculty) and improved employment opportunities. Another important offshoot from such collaboration is that supervisors from Malaysia and Denmark are able to proceed with new joint research. One such project, which has been developed, is the project on bio-covers for landfills,
which is funded separately in Denmark and Malaysia. The academics involved will become joint-researchers, which would allow further research-based visits as consultants.

Another TFS project involved two students from Africa pursuing their Masters degrees in Denmark and performing field studies in Malaysia. Two Danish and one Malaysian professor were their supervisors. The topic of research was “Household Waste Generation and Composition in Petaling Jaya”, Petaling Jaya being the satellite town adjacent to the capital city of Kuala Lumpur. Since this project involved analysis and field surveys, the students were literally on the streets daily collecting waste, and performing analyses or conducting questionnaire surveys. The students were able to extrapolate local scenarios to recycling and source separation, which is the critical problem for waste treatment or minimization. Other TFS projects involving different Danish and Malaysian universities have dealt with cleaner technologies in industries or oil spills in the Malacca Straits.

Once again, it is evident that collaboration of this nature benefits all parties involved. Students from Denmark identified problems not normally acknowledged or foreseen by local students. And the local students were able to experience the PBL approach and acquire new learning skills as well as new knowledge. Supervisors benefited from their involvement by identifying future collaboration opportunities. For example, one Malaysian and one Danish professor are currently developing a “solid waste scenario” for Problem Oriented Project Based Learning (POPBL) in a project financed under the Asia-Link Programme. Also, Danish supervisors from several universities are now involved as consultants for new modules of a Masters Degree program in environment to be used at the University of Malaya and the National University of Malaysia (UKM). It is the intention of the consortium to extend this program to other Malaysian universities.

**Joint Field Courses**

Joint field courses are intensive three-week problem-based courses that were developed collaboratively between Danish and Malaysian professors. Three joint field courses were organized from 2002 to 2004 in Malaysia on themes ranging from public participation to environmental planning, management and regulation. About 25 to 30 postgraduate students from Danish and Malaysian institutions participated in each course, which consists of one week of lectures supplemented with field trips, and two weeks of group project work. In total 39 students from Malaysian universities participated in these courses. Joint field courses are a means to introduce innovative teaching techniques, inter-disciplinary and problem-oriented approaches, and intercultural learning both for students and educators (Wangel et al., 2005).

Overall joint field courses were a useful and unique experience for student and academic staff development. The pedagogical approach of working on real-life problems is a challenging and rewarding learning process that was previously not experienced by Malaysian students and faculty. In addition, intercultural exchanges between participants often go beyond the classroom, which itself is an invaluable learning experience. The exposure of Malaysian educators to innovative learning and field research methodologies plays an important role in building the academic capacity of local institutions on an international level.

**Curriculum development and faculty training**

New curricula were to be core output of the project. This meant development of course modules based on problem-oriented approaches, which are now being used within Masters Degree level environmental programs in the four MUCED-I&UA universities. Academics from these institutions collaborated and developed twelve common course modules in a joint effort to utilize resources and expertise available at the respective institutions. The course and case development process was conducted through a series of workshops throughout the project period as well as on an individual team level basis where the course outline was defined and assigned to various team members. Teams consisted of between two to five members from four local Malaysian universities.
Relevant materials were sourced through numerous initiatives (study visits to Danish universities, the training workshop series, and research components) and incorporated within the modules. However, physical collaborations with Danish academics were limited, partly due to co-ordination and logistical difficulties involving two distant locations, Malaysia and Denmark. Better information technology and communication tools may play an important role in enhancing the process of knowledge transfer.

One of the project components was the training of university academic staff to support capacity development. Hands-on training and academic resources for the course development process was the objective, both on methodological approaches in teaching and learning, and specific areas of focus on environmental management and technology. Workshops were conducted on problem-based learning, teaching methodologies, and module writing specifically to assist team members in preparing their modules. In addition, short courses and workshops were organized with the participation of resource personnel from the Danish universities. Some examples are given in Table 1.

Table 1: Examples of short courses and seminars conducted

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<th>Title</th>
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<td>1. Networking as an Essential Part of Capacity Development in Environment - A Study of DANCED’s Support to the Cleaner Technology Group at SIRIM</td>
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<td>2. Life Cycle Assessment – Methodology and Use for Policy Making</td>
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<td>3. Trends in Solid Waste Management: Towards Waste Minimization</td>
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<td>4. Public Participation and Awareness Raising in Petaling Jaya Concerning Domestic Solid Waste</td>
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<td>5. Solid Waste Generation and Composition Analysis in Petaling Jaya</td>
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<tr>
<td>7. Future of Hazardous Household Waste Management in Malaysia</td>
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<tr>
<td>8. Economic Instruments for Environmental Management in Malaysia: Case of Household Solid Waste Management</td>
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In general, these workshops facilitated an active exchange of information among local academics and Danish resource personnel and allowed for analyzing typical problems and constraints in a local context, comparing these scenarios with those in Denmark and exploring new ideas and methodologies.

Research
Research activities to establish case studies were conducted in support of the course development component, particularly for the twelve course modules. While funding for research was limited, existing research funds available within the Malaysian universities complemented overall research activities. A total of 29 local case studies were developed for these modules by local academics and 18 joint research projects were established. There was limited input from Danish academics, particularly due to the limited funding available to establish joint projects, time constraints, scheduling conflicts in developing and coordinating these projects, and the overall focus of the project objectives and activities which differed between consortia.

Collaboration between the consortia were gradually developed and supported research networks between Malaysian and Danish academics as well as academics from the other consortium universities in Botswana, South Africa and Thailand. Seven research networks were established within the project period as follows, and represented the participation of 19 universities:
The objectives of these networks was to provide a discussion platform between academics of different countries with an eye on exploring research areas and methodologies, and redirecting the output to provide continued support to the curricula and course development. These networks have, in general, applied two different approaches: the 'Integrated Activity Approach' where research objectives were explored through many different approaches and the 'Comparative Study Approach' where the focus is on comparing similar case studies from different countries (LUCED - I&UA, 2004). Joint projects were carried out through the funding of Masters and Doctoral Degree students from Danish universities at the partner consortium countries. Due to funding limitations, reciprocal exchanges by Malaysian students to Danish universities have not been possible; however this will remain an area of opportunity for the future.

Despite the overall impact and extent of these networks being difficult to evaluate, the general consensus is that Malaysian collaborative research has helped the development of new research areas as well as new approaches, techniques and methodologies in local research projects. The capacity and quality of academic programs in Malaysia has benefited from the exchange of information and knowledge between academics. Also, at least 21 joint research papers between Malaysian and Danish academics have been published in international journals and proceedings from 2001 to mid-2004. The seven research networks were in various stages of development at the end of the project periods and initial efforts have been geared towards strengthening and expanding the collaboration and sourcing for funding to sustain the networks.

**Outreach and Extension of University Capacity Building Activities**

Stakeholders being representatives from research bodies, government institutions, industries, non-governmental bodies and community-based organizations attended the workshops listed in table 1. Stakeholder representatives were able to explain or discuss the environment related problems in their industry or community in special forums designed to expose these issues to academics and students. Subsequently, as a component of curriculum development, academics were able to generate case studies focusing on these issues. This provided valuable experience for local academics and initiated a multi-level stakeholder dialogue, which is recognized as an essential process of solving environmental problems. Many case studies have thus been developed and are being used intensively in current teaching, both at postgraduate level and undergraduate level. An example is the issue of disposal of liquid waste, which contains Calcium Hydroxide, from an acetylene producing plant. After R & D at a Malaysian university, the industry is now able to recycle the waste to another industry and make an income of RM1 million per year (about US$250,000).

External stakeholders, especially non-governmental bodies and community-based organizations gained an opportunity to build their own capacities and forge a closer relationship with the universities. For example, community projects on composting have nurtured participants to develop a sense of environmental awareness and are now able to sustain their own waste management projects with regular guidance from university researchers. New and dynamic waste recycling centers have been established with close cooperation between external stakeholders and universities.
As a result of these collaborations, three projects under the auspices of the European Union's Asia Information Technology and Communication (Asia IC&T), the ASEAN-EU University Network Programme (AUNP), and the Asia-Link Programme were commissioned to involve Danish and Malaysian universities and a few others.

The first project was dealing with 'Virtual Open-Access Network for Education & Training' (VOANET) between partners in Spain and Thailand. This is another offshoot of the close cooperation between European universities and Asian universities from LUCED programme. The VOANET program was developed to further enhance the electronic-interconnectivity among universities in these two zones and showcased the excellent collaboration between the European and Asian partners. This 3-year project which ran from January 2003 till December 2005, focused on the conversion of selected modules prepared under the previous MUCED programme into e-learning materials. Basically the VOANET project established an institutional and administrative framework for sustainability of the virtual network and reinforced the existing network established under the LUCED framework.

The second project, “Urban Quality Development and Management” was initiated as an AUNP curriculum development project 2004-2006 and involving 4 cities and 5 universities in Malaysia, Thailand, the Netherlands and Denmark. Real life problems and educational needs in the cities were identified and a new continued education study programme built accordingly. It is based on an interdisciplinary approach involving spatial planning, environmental engineering and socio-economy. The new International “Master in Urban Quality”, MUQ, is a one-year full time or a two year half time study accredited by the universities involved and offered through an existing continued education institution such as Kuala Lumpur Regional Training Centre. The education is planned to make the first run by 2007 and is so far documented and advertised at www.urbanquality.net. As a side effect, existing curricula at the participating universities may be changed or new ones installed. The cooperation with the cities in the MUQ context will then provide good cases for problem based learning in the new university curricula.

The third involved 'Problem-Oriented Project Based Learning (POPBL) in Environmental Management & Technology' with a new partner in the Netherlands. This 24-month (Aug 2005 to July 2007) project aims to strengthen the quality of master programmes in environment at Malaysian universities by utilizing a European problem-oriented project based pedagogical approach. The action targets two universities in Malaysia and the main activities include the establishment of institutional and administrative capacity, the development of a master programme with multidisciplinary curriculum comprising of jointly-developed course modules and project scenarios/case studies and establishment of links with external stakeholders. The project is expected to improve the skills and knowledge of teaching staff in applying POPBL methodologies within the teaching of courses and facilitation of student projects in the master programme on environmental management and technology.

Conclusions and Recommendations
There seems to be a wide field of non-exploited opportunities for interaction between universities and institutions outside, including for example business, cities, government and NGO. Making more use of these opportunities and thereby more use of universities and their international networks is logical, if the goal is to build knowledge based and inter-culturally stable societies. Capacity building in higher education and research may therefore be one way of increasing capacity for fair globalization and sustainable development.
Joint opportunities for universities and external stakeholders have been identified and utilised, not least because of LUCED, MUCED and DUCED-I&UA activities in the period 1998-2004. Important conclusions regarding capacity building are:

- A new working model of inter-institutional and international cooperation has been established
- Curricula and projects in relation to real life problems have been installed and more are in preparation in order to enhance competency of faculty and students as well as participants in continued education programmes
- International collaborative networks of educational approaches and research have been established

ISWA as an independent and international networking institution may have both ability and reason to focus particularly on the role of universities in the area of waste management and sustainable development. The examples given in this paper on capacity building in higher education and research show how both students and faculty in their new learning processes and research projects address existing problems with vigour and inspiration and in an international context. University activities of relevance to ISWA and with mutual benefit are, for example:

- Universities can use real life problems for their PBL studies and the national ISWA members can profit from this interaction with students and faculty and possibly appreciate the results of the work. Career development is one result for the young talents in each country.
- Universities can provide input and accreditation to continued education programmes, for example organised by ISWA. The ISWA International Waste Manager programme is an example for such interaction where the universities typically could provide the input on new technologies, management principles and international networking experiences, while ISWA handles the acknowledgement and certification of already acquired skills and experience.
- Universities can do research and assist in creating the knowledge and evidence base that drives development, nationally, regionally and globally. A better-defined and institutionalised partnership between universities and ISWA and her member institutions can both vitalize and improve this development.

It is a challenge to ISWA and universities to show how to jointly do more of this.

References