Chapter 1
Managing Environmental Risks and Promoting Sustainability, Scientific Advancement, and Leadership Development

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Abstract As entrenched population growth and industrialization continue to raise demand for natural resources and their exploitation, there is increasing concern over the detrimental impacts on the global environment and humanity. Economic growth was expected to save people from poverty, but conventional economic growth models simply prompted intensive resource use and undermined the basis for livelihoods that are sustainable over the long term. Whilst research and policy measures have articulated environmental risks and key factors of sustainability, compartmentalized approaches have failed to forge a scientific foundation for averting risks and promoting sustainability. Countermeasures to address environmental risks often involve trade-offs weighed against other socio-economic factors. A holistic viewpoint and trans-disciplinary science are therefore needed to foster appropriate decision making and implementation that can ensure optimal risk management and promotion of sustainability. The Leadership Programme in Sustainable Living with Environmental Risk (the SLER programme) spearheaded by Yokohama National University from 2009 to 2014, is one of the programs playing an instrumental role in addressing this need. It provides a platform for strengthening the expertise and skills graduate school students need to become environmental leaders. Moreover, the process of implementing the SLER programme has revealed both the potential and the challenges inherent in developing future environmental leaders to effectively manage environmental risk and promote sustainability.

Keywords Environmental risk • Leadership development • Risk trade-off • Sustainability • Trans-disciplinary science

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1.1 Introduction: Environmental Risks and Their Implications for Future Sustainability

Economic growth and increased use of resources due to industrialization have raised the pressure on the global environment and serious warnings have been sounded that further pressure could destabilize the Earth's systems and trigger abrupt and irreversible environmental changes (Rockström et al. 2009). The average global surface temperature rose by 0.85 °C over the period 1880–2012, and by 2100 is projected to increase by 2.68–4.8 °C, accompanied by a rise in sea level of up to 0.98 m (IPCC-WGI 2013). The global wild animal population declined by more than 30 % over the period 1970–2010 and the annual economic loss attributable to deforestation and forest degradation could be equal to USD 4.5 trillion (SCBD 2010). Environmental degradation undermines the basis of people's livelihoods and often impoverishes communities. At the same time, poverty drives people to exploit natural resources for their survival and exacerbates environmental degradation in a vicious cycle (Bremner et al. 2010).

In June 2012 global leaders gathered at the United Nations Conference on Sustainable Development held in Rio de Janeiro. In the conference's outcome document, entitled "The Future We Want," they reaffirmed their commitment to promoting sustainable development for our planet and for present and future generations, and to saving the world from poverty and hunger as a matter of urgency (UNGA 2012). In paragraph 259 the document called for countries to strengthen leadership capacity to promote sustainable development and engage citizens and civil society organizations. Among a number of factors enabling sustainable development, the document underlined the importance of supporting educational institutions in (1) conducting research and innovation for sustainable development, and (2) developing high-quality, innovative including the entrepreneurship and professional training required to achieve sustainable development goals.

The Leadership Programme in Sustainable Living with Environmental Risk (the SLER programme) spearheaded by the Yokohama National University Graduate School of Environment and Information Sciences (YNU-GSEIS) is one of a number of programs designed to develop future leaders who will manage risks and promote sustainability. The SLER programme was commenced in 2009 for a 5-year duration with the support of the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Japanese Science and Technology Promotion Agency. The Government of Japan lists environmental science as a priority area in research and development, and promotes innovation by consolidating knowledge and revitalizing research and development capabilities at both universities and private corporations (CSTPJ 2010). It is believed that Japan can make an essential contribution toward achieving sustainable development throughout the world by developing future environmental leaders within its higher education system.

This paper is intended to delineate environmental risks to sustainability, and their characteristics and implications, to examine what the SLER programme's pedagogical approaches and newly invented curriculum have achieved in terms of filling the gap

in development of future environmental leaders. It is also designed to provide a forward-looking perspective on how universities can enhance the effectiveness of their programs for developing future environmental leaders.

1.2 Environmental Risks, Their Characteristics, and Sustainability Implications

Environmental risks are defined as risks with the potential to fundamentally disrupt the stability of the Earth's systems (IGBP 2012), while risk itself is defined as the combination of the probability of an event and its negative consequences (Nadim 2011). The destabilization of the Earth's systems could trigger environmental changes that would be deleterious or even catastrophic for human beings (Rockström et al. 2009). Such environmental risks encompass a wide range of areas such as climate change, water scarcity, deforestation, land degradation, biodiversity loss, ozone depletion, and chemical pollution. By their nature, environmental risks are characterized by (1) spatial propagation, (2) time-lag occurrence, (3) multiplier effects, (4) accumulation, and (5) irreversibility (Zhang et al. 2010). However, the most striking characteristic of environmental risks is their interconnectedness (IGBP 2012). For instance, excessive logging causes deforestation and destructs wild life habitats, thereby depleting biodiversity. Deforestation not only accelerates soil erosion but prompts the emission of greenhouse gases and their concentration in the atmosphere, thereby increasing the likelihood of climate change and destabilizing the water cycle. A negative change in one of the areas can aggravate another area and vice versa.

Risk management decisions often need to take into account the various trade-offs associated with environmental risks (Power and McCarty 2000). Environmental risks and their countermeasures always entail positive and negative environmental, economic, and social trade-offs (Table 1.1). For instance, rapid reforestation with a newly-introduced species of exotic fast-growing tree may be effective in increasing forest cover and sequestrating carbons, however it may also make the long-term integrity and autonomy of the forest ecosystem uncertain. It would reduce the space for endemic/indigenous tree species and wildlife habitats and would also hinder the access of local villagers to diverse forest resources such as leaves, fodder, fuel woods, and other non-timber products. It is therefore vital to ensure that reforestation would damage neither the environment nor people (Peskett and Todd 2013). We need to safeguard the overall environmental value of forest areas and the interests of local and indigenous people even as we pursue the goals of carbon sequestration, reduction of greenhouse gas emissions, and climate change mitigation (WRI 2012).

Environmental risk trade-offs also need to take into account differing local conditions. DDT (dichloro-diphenyl-trichloroethane) and its application is a classic case often cited to describe environmental risk trade-offs and the complexity involved in assessing and making decisions about such trade-offs (Pfau 2011).

Table 1.1 Environmental risks and their trade-offs

Primary environmental risks	Typical countermeasures	+ / –	Environmental benefit and trade-off risks	Economic benefit and trade-offs	Social benefit and trade-offs
Climate change	Promoting biofuel	–	Deforestation, changes in land use	Investment cost	Competition with food
		–	Biodiversity loss		Loss of access to forest resources
		+	Reduced fossil fuel use	Revenue from the sales of biofuel	Employment opportunities
		+	Reduced GHG emissions		
Biodiversity loss	Increasing protected areas	–	Possible increase in incidents of wild animal attack against humans	Increased demand for budget	Restriction of productive activities Social disturbance by visitors
		–	Possible increase in pests		
		+	Increased flora and fauna	Possible revenue from park admission fees	Increased employment and income generation opportunities
Increased waste generation	Promoting recycling	–	Possible leakage of hazardous substances from recycling plants	Investment in the construction of recycling plants	Need to develop social systems conducive to recycling such as segregated waste collection at source
		+	Reduced demand for resources	Development of recycling businesses	Increased social unity and vigilance
		+	Reduced waste		
Water scarcity	Harvesting rainwater	–	Possible increase in mosquitoes and insects	Investment in installation of micro rain harvesting system	Possible increase in vector disease
		+	Reduced demand for piped water and irrigation	Reduced revenue/increased cost for the water service corporations	Increased water supply sufficiency Reduction in conflict over water use
Land degradation	Implementing agroforestry	–	Reduced sunlight on farms	Reduced income from crops	Requirement for coordination with forestry and agriculture groups
		+	Prevention of soil erosion	Diversified income sources	Stability in income
		+	Wind breaking	Averting risks of poor harvests	Respect and self-esteem from innovation and entrepreneurship
		+	Reduced heat and evaporation	Investment in timber production	
		+	Enhanced moisture level		
		+	Improved nutrient cycle		
		+	Enhanced biodiversity		

Malaria is one of the most lethal diseases in the world. Although the total number of infections is declining gradually, it is estimated that in 2010 there were 219 million cases of infection, of which 79 % occurred in Africa. A total of 660,000 people were killed, with the death toll in Africa accounting for 90 % of these (WHO 2012). DDT is considered to be the most cost-effective insecticide for containing malaria (Pedercini et al. 2011). However, it is known that DDT may have a variety of human health effects, including reduced fertility, genital birth defects, breast cancer, diabetes, and damage to developing brains. In addition, its metabolite DDE (dichlorodiphenyl-dichloroethylene) can block male hormones (Cone 2009). DDT's stigma was made known to the world by Rachel Carson's "Silent Spring," published in 1962 (Dugger 2006). DDT and DDE stay in the environment long-term and their bio-magnification threatens animals at higher trophic levels. Despite being banned in many countries during the 1970s on the grounds of its adverse effect on human health and ecosystems, DDT has been used particularly in developing countries to control malaria (Secretariat of the Stockholm Convention 2013). The Stockholm Convention on Persistent Organic Pollutants, adopted in 2001 and enforced in 2004, lists DDT as one of the "persistent organic pollutants" to be banned or regulated. On the other hand, in 2006, the World Health Organisation (WHO) reversed nearly 30 years of policies restraining the use of DDT and instead endorsed DDT use for indoor residual spraying (IRS) in epidemic areas as well as in areas with constant and high malaria transmission (WHO 2006; Boddy-Evans 2006).

As people have different perceptions of malaria risk, the use of DDT remained contentious, while associated measures to tackle malaria were carried out in ways that outraged communities. In one case in Uganda the government decided to start spraying, but did not give any advance warning to the communities, let alone consulting with them beforehand. Houses were sprayed even when people were not at home and food and cotton harvests had been left exposed. People were complaining that after the DDT spraying women suffered miscarriages and cattle died, but those who refused DDT spraying were imprisoned. Meanwhile, their cotton produce was rejected in the ecological market on the grounds of marginal DDT traces. It was rumored that corruption between the government and the chemical industry was involved, and that malaria risks had been exaggerated, and false claims made that alternatives to DDT were unavailable (Den Berg 2010). In fact, alternatives to DDT were promoted in a global program launched by the Global Environment Facility, WHO, and the United Nations Environment Programme in 2008. The program advocated integrated vector management including use of a mosquito-net, repellent, and mosquito coils (UNEP and WHO 2008).

The example of malaria risk management reveals the variability and complexity involved. Clearly, risk management must move beyond the assessment of a single risk to mobilize multi-disciplinary expertise in assessing multiple scientific and social risks (Pfau 2011) (Fig. 1.1). Moreover, stakeholder involvement is pivotal in developing and implementing long-term and self-reliant measures for managing risks and promoting sustainability. Public access to information, communication of risks, and stakeholder participation in decision-making are all fundamental to the process of determining countermeasures.

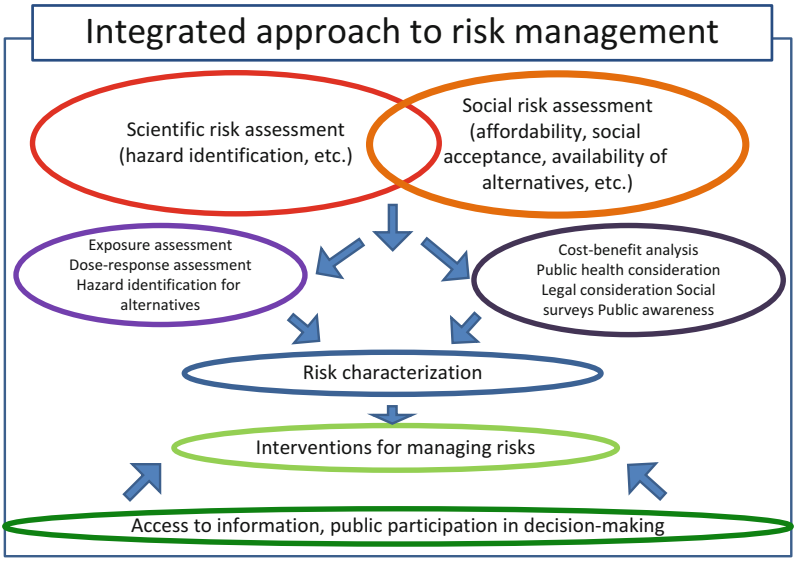

Fig. 1.1 Integrated approach to risk management (developed from Pfau 2011)

Effective measures for managing risks and promoting sustainability call for trans-disciplinary, multi-partnership, multi-dimensional research (Dedeurwaerdere 2013; Earth System Governance Project (ESGP) 2012). Spearheaded by the International Council for Science (ICSU) and others, the newly launched Future Earth sustainability research initiative is expected to play a key role in providing a reinforced, overarching framework for sustainability science (Yasunari 2013). The platform for enhancing the science-policy interface needs to be bolstered by building upon the prototype recently provided by the Intergovernmental Platform on Biodiversity and Ecosystem Services (Takeuchi 2013). Sciences that address risks and sustainability are changing to involve multiple actors in addressing issues from a trans-disciplinary perspective across a wider range of temporal and spatial scales (Benn et al. 2008). Universities must be pivotal players in transforming the platform of trans-disciplinary science to support risk management and the promotion of sustainability.

1.3 Developing Expertise and Skills for Future Environmental Leaders

An increasing number of initiatives and programs have been launched by universities, NGOs, business communities, and research institutes to develop more environmental leaders who can contribute to building sustainable societies. These programs are essentially designed to help students or participants develop (1) scientific expertise, (2) the ability to plan solutions, and (3) skills to steer the implementation process. They also provide a platform for dialogues with leading practitioners (MOEJ 2011;

CLiGS 2013; Wharton-UPENN 2013). Current understanding of leadership and its relation with environment and sustainability is in the developmental stage and it is inevitable that such understanding will evolve over time (Redekop 2010). Heifetz et al. (2009) assert that leadership needs to be adaptive, and adaptive leadership is crucial for thriving on experimentation and mobilizing people to tackle tough and varying challenges. Various attempts have been made to define environmental leadership or leadership for sustainability, and they can be summed up in the phrase "the ability to mobilize and direct people toward achieving sustainability in a changing world."

This then leads us to ask what capabilities can be developed to enable people to play a role as environmental leaders. Williams (2010) presents various skills and expertise that qualify people as environmental leaders, such as (1) technical knowledge, (2) facilitation skills, (3) direction setting, (4) securing resources, (5) creativity, (6) developing relationships, (7) making decisions, (8) communication, (9) determination, and (10) mentoring. Thomas (1993) underscores the personal and professional ethics involved in the leadership role in terms of, for example, complying with rules and norms, and putting the public interest first. However, sustainability issues and their management have become so complex that policies and laws cannot necessarily articulate every detail, and the behavior of practitioners can therefore vary. Moral choice constitutes a critical issue, particularly when practitioners encounter situations for which there are no preceding governing norms. It is therefore still a challenge to know how to address ethical, moral, and value judgments in leadership development.

At the Joint Congress of Environmental Leaders Program 2013, the Japanese universities that are currently implementing, or have already implemented, environmental leadership programs at the graduate school level presented their progress and outcomes (Tsukuba University 2013). Representatives of 17 universities in Japan gave presentations, many of which highlighted the features and characteristics of their particular programs. The common elements are summarized as follows: (1) English language-based, involving non-Japanese students and teaching staff, (2) a cross-sectoral approach addressing the nexus of various interwoven environmental and sustainability issues, (3) an inter-disciplinary curriculum requiring students to learn disciplines other than their major, (4) regional and global features to train students in thinking beyond national borders, (5) development of pragmatic skills, such as communication, writing, and facilitation, (6) internship, (7) partnership with other Japanese and overseas universities, and (8) dialogues with practitioners. The programs are operated primarily with funding from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Japanese Science and Technology Promotion Agency (JST) for a 5-year duration. Five universities completed their 5-year programs in March 2013. Seven others will complete their programs in March 2014, to be followed by the other five in March 2015. By and large, all the programs are considered to have performed satisfactorily in achieving their stated objective of promoting sustainability science and leadership development in universities.

Nonetheless, it remains a challenge to measure the effectiveness and impacts of such environmental leadership development programs. The universities can of

course cite how many students completed their programs and obtained master's or doctoral degrees, and the sectors in which they were employed after graduation. Indeed, such figures are useful indicators of the programs' achievements. However, it will take some time to find out what role the program alumni eventually play as environmental leaders.

The faculty members of universities responsible for the programs are especially concerned about the continuation of the programs, and the associated institutional set-up. All the universities operate under stringent budgets and depend on external resources provided as subsidies by MEXT and JST. Budgets for operating the programs are not yet integrated into universities' core budgets, and it is unlikely that they ever will be. In the past, some universities received subsidies for different but related projects, which took over at least some of the activities in the environmental leadership development program. Many program coordinators in the universities with programs under way or approaching their conclusion are experiencing difficulty in arranging for their programs to be integrated into operations funded by their university's core budget once the 5-year funding by MEXT and JST ceases. It therefore remains to be seen over the coming years where future environmental leadership development programs will take place and how they will evolve. It is undoubtedly a challenge for many universities to find a way of integrating these programs' activities into operations funded by core budgets, or to secure alternative sources of funding for their continuation.

1.4 Leadership Programme in Sustainable Living with Environmental Risk

The Leadership Programme in Sustainable Living with Environmental Risk (the SLER programme) was launched in 2009 and is spearheaded by the Yokohama National University Graduate School of Environment and Information Sciences (YNU-GSEIS). The SLER programme has its own distinctive features aimed at developing the expertise and skills required for future environmental leaders (Kaneko et al. 2013). Many features are similar to those implemented by other universities as presented in the previous section. Some of the key features of the YNU-SLER programme are highlighted below (Fig. 1.2).

1.4.1 Interactive Multimedia Education System (iMES) (Arisawa and Sato in This Book)

YNU collaborates with nine overseas universities, namely: East China Normal University (ECNU, China); University of Lampung (UNILA, Indonesia); Universiti Sains Malaysia (USM, Malaysia); University of the Philippines Los Baños (UPLB, Philippines); Kasetsart University (KU, Thailand); The University of

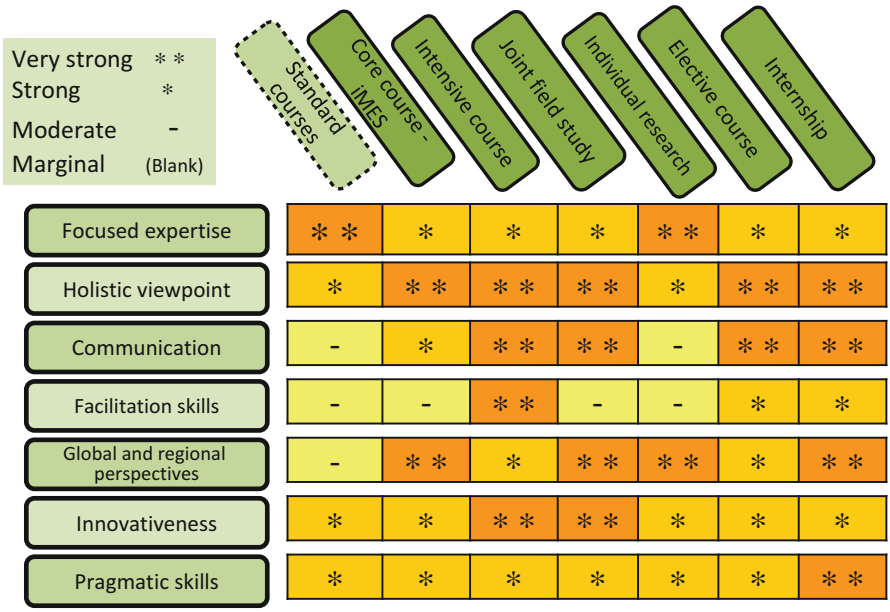

Fig. 1.2 SLER programme components and their expected impacts in development of expertise and skills required for future environmental leaders

Danang (UOD, Vietnam); University of Nairobi (UON, Kenya); the University of Antananarivo (UOA, Madagascar), and the United Nations University (UNU). The students of the UNU Institute of Advanced Studies (UNU-IAS, Yokohama) attend the class at YNU, and students from the UNU Institute of Sustainability and Peace (UNU-ISP, Tokyo) are now invited to do so from fall 2013. The two core courses of the SLER programme are Environmental Risk Management (spring semester) and Environmental Leadership Development (fall semester), and they use the interactive multimedia education system (iMES). Lectures are given in English using PowerPoint for 25 min by guest speakers from international organizations, research institutes, NGOs, business corporations, and governments. The moderators based at YNU facilitate discussions involving both the YNU students and students in overseas universities connected via iMES.

1.4.2 Intensive Course

In September each year, a 2-week intensive SLER course is organized with participants from YNU, UNU, and eight overseas partner universities. The program includes some unique components, notably (1) a tour to study reconstruction in the parts of Tohoku (northeastern Japan) hit by the 2011 earthquake and tsunami disaster, (2) a visit to the city of Kawasaki near Tokyo to learn about the operation

of environmental businesses by both private and public organizations, (3) a visit to the town of Hayama on Tokyo Bay's Miura Peninsula to learn integrated ecosystem and landscape management from local people, (4) dialogues with leading scientists and practitioners at UNU's open joint symposium, and (5) a scenario workshop to develop students' creative thinking and facilitation skills. During the study tour to Tohoku in September 2013, the students observed and interacted with experts and local stakeholders in the city of Nihonmatsu in Fukushima Prefecture, the town of Minamisanriku and the city of Iwanuma in Miyagi Prefecture, and the city of Rikuzentakata in Iwate Prefecture. They learned about (1) the grand design for reconstruction, (2) forest management in radiation-affected areas, (3) coastal woodland restoration, (4) restoration of tsunami-inundated paddy fields, (5) oyster farming restoration, (6) debris and waste management, and (7) revitalization of small and medium enterprises. Students also participated in producing seedling pots containing local evergreen broad-leaved tree species such as laurel or *persia thumbertii*. The YNU Student Association of Films produced a 45-minute video featuring the Tohoku study tour of 2011–2012 that was screened at a public symposium entitled Reconstruction and Invigoration of Disaster-hit Areas—Viewpoints from Rikuzentakata, held at YNU on March 25, 2013.

1.4.3 Madagascar Joint Field Study

A joint field study is conducted once a year in Madagascar in collaboration with UOA. In 2012, YNU and UOA students undertook (1) an ecosystem assessment, (2) a soil survey, and (3) a social survey in the areas of Ambatondrazaka, on Madagascar's eastern side, and Andapa further to the north-east. Together with experts and local practitioners students observed and discussed: (1) environment, forest, and agriculture policy issues, (2) management of protected and watershed areas, (3) reforestation, (4) non-tillage farming, (5) wildlife protection, and (6) innovative community-based activities offering alternative livelihoods. A joint symposium was organized at UOA on the last day of the program to present the outcomes of the field study.

1.4.4 Credit Exchange Agreement with UNU

In order to formalize its academic and educational collaboration with UNU-IAS, YNU-GSEIS entered into a credit exchange agreement with UNU-IAS in March 2012. Between then and July 2013, four students of YNU took three courses at UNU-IAS, and nine students of UNU-IAS took three courses at YNU. The credit exchange agreement was expanded in July 2013 with the conclusion of an additional agreement among YNU, UNU-IAS, and UNU-ISP. With the addition of UNU-ISP, the four other YNU graduate schools have now joined in the agreement.

1.4.5 Other Elective Courses and Supporting Programs

The Asia-Africa Field Work II course helps students to conduct their individual field surveys. Effective Communication for Environmental Leaders enables students to improve their writing and communication skills. Additional elective courses offered in English are Local Risk and Resource Management, International Cooperation for Sustainable Development, and Eco-tourism. A course entitled Capacity Development that was left at the conceptual stage for some time was operationalized in 2012 to give credits when the students undertake internships or attend seminars overseas. In March 2012 an ad-hoc two-day seminar entitled Workshop for Environmental Leadership and Career Development was held in Hayama. Organized in collaboration with UNU-IAS and UNU-ISP, the workshop featured 16 speakers from international organizations, international NGOs, and business corporations.

1.5 Achievements and Future Challenges

During the 5-year period from 2009 to 2013, a total of 257 students enrolled in the SLER programme (64 students for the 2–3 year long-term course at YNU, and 193 students of overseas partner universities for the 1 year short-term course via the simultaneous broadcasting system). As of October 2013, 91 students had already completed their courses (27 for the long course, 64 for the short course). By March 2014, an additional 110 students are expected to have completed the SLER programme (47 for the long course and 63 for the short course). These statistics far exceed the original targets set out in 2008. Moreover, the administration of the SLER programme is highly acclaimed by and large, with the students earning awards in poster competitions and acknowledging the support provided to them. At the same time, however, implementation of the program revealed some future challenges with regard to supporting environment/sustainability leadership development:

1.5.1 Curriculum Development

The SLER programme is expected to generate spin-off courses in English addressing environmental risks and sustainability, and the five YNU graduate schools are expected to align themselves more proactively in support of the program. There is, however, a need to provide further stimulative measures for creating the desired curriculum and ensuring the necessary institutional evolution.

1.5.2 Institutional Set-up

The SLER administrators are proposing to establish an international center for risk studies. A number of options were discussed in the past, including restructuring the existing YNU Center for Risk Management and Safety Sciences (CRMSS) or creating a new center to strengthen research and education on environmental risk and sustainability issues. Although some CRMSS personnel work on environmental risk and sustainability issues, however, the center's portfolio is currently focused on industrial engineering, construction infrastructure, urban disaster management, chemical risks, and road traffic safety. Furthermore, the Japanese name for CRMSS is different from the English, describing CRMSS as a center for "safety and security," which may not be helpful in accessing funds or developing partnerships on environmental risk- or sustainability-related issues. Further institutional changes are therefore required to forge a structure for following up and capitalizing on the SLER programme.

1.5.3 Institutionalizing Collaborative Educational Activities

A proposal was initially considered to expand credit exchange agreements and to introduce a double degree program among YNU and overseas partner universities. Preliminary discussions were held on the requirements and advantages, but no clear decision was forthcoming due to unresolved practical issues such as consistency with the respective universities' existing degree requirements, and differences in academic calendars.

1.5.4 iMES

iMES has been recognized as an extremely useful system for collaboration among universities in risk management and sustainability research and education. However, the staff members who operate the system currently depend on non-budget subsidies, and it is not yet clear whether and to what extent existing organizations such as the YNU Information Technology Service Center can support continuation of the course jointly conducted with other universities.

1.5.5 Joint Research

There have been a number of calls to promote joint research between YNU and one or more of its partner universities. While there was ongoing collaborative research predating the start of the SLER programme, and some attempts have been made to

launch new projects, there has not yet been any success in mobilizing funds to launch new joint research initiatives.

The SLER programme helped to generate future environmental leaders and set a very useful platform and roadmap for invigorating environmental leadership development among YNU and its partner universities, as well as associated organizations, experts, and stakeholders. There are still ways to move forward more vigorously and expeditiously to reduce, halt, and reverse the accelerating environmental risks and to bolster partnership and collective action for a sustainable world. The spirit and compassion generated through the SLER programme must not be allowed to dissipate, but must instead be sustained and bolstered.

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