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solid waste issues in the well-organized group. By identifying and separating the roles of universities and governments, this project aims to establish a collaborative approach dealing with related issues.

Concept 2: Education

In order to develop elites who would play active roles worldwide, students of Okayama University are expected in advance to contact the environmental problems in Asian countries. This project is expected to support the students’ research in the context of Asian solid waste issues. Also, in order to educate elite students from participating countries, Okayama University conducts a variety of education and research activities and aims at educating students from the case study regions.

Concept 3: Social Contribution

A lot of training workshops and consulting activities would be held for local municipalities in developing countries in Asia, aiming at introducing the Japanese technologies and promoting ESD. Comprehensive information would be provided for private industries, aiming at widen the collaboration among universities, governments and private sectors.

Concept 4: Outcomes Reporting/Succession

The information and data prepared within this project would be accumulated and open to the society, being utilized actively in the forthcoming activities. Accumulating the comprehensive waste data, the Solid Waste Management Research Center of Okayama University aims at playing the role of the information center of integrated solid waste database.

The aforementioned concepts of this project are presented in the following figure.

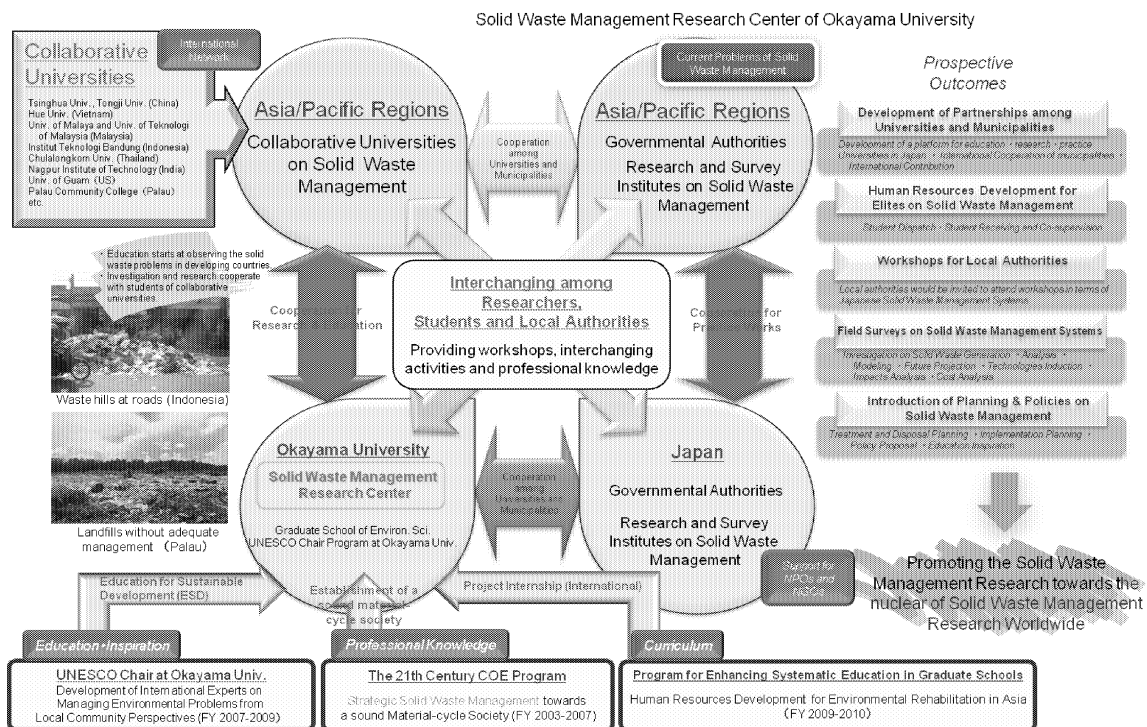


Fig. 1-1 The concepts of the “Partnership” project.

1-3 Research Collaboration

Primarily, this project focuses on the research and education activities in Asian and Pacific countries, the contents of research collaboration cover the following items:

- Clarification of the solid waste problems through field observations;
- Promotion of the research cooperation among collaborative universities;
- Collaboration with the local authorities;
- Student Interchange / Co-supervision;
- Invitation, interchange, internship, and field observations for local governments' officials;
- Implementation of investigation and research;
- Practice and policy formulation based on the research outcomes.

As for serious solid waste problems, it is appropriate that developing countries would rather tackle the problems using the outcomes from the experienced countries than seek for the solutions by themselves. Based on the research outcomes from Japanese universities and experiences from local authorities, adequate solutions for the contemporary problems could be found, given that the implementation of necessary surveys, research and plans. Nevertheless, in the field of solid waste management, good cooperation networks among Asian countries and Japanese universities are not found till the present. Although "international collaboration" is usually mentioned, at most universities, such concept is still implemented by conducting research at desks indoors. Regarding in-situ research abroad, it is necessary to collaborate tightly with foreign universities in the study, so that concrete and practicable outcomes could be generated. In addition, while solid waste management is one part of the public works, administrative works are required, e.g., the routine clearance works at urban districts, to a great extent. Cooperating with the four stakeholders (universities and governments in/out of Japan), firstly, the in-situ solid waste problems are to be found, then investigations and analyses would be conducted, and consequently, if possible, feasible proposals of the solid waste administration would be made. The abovementioned items are our ultimate goals for this project. In order to achieve the goals of this project, the Solid Waste Management Research Center of Okayama University would be devoted to the above 7 items.

The prospective image of the research collaboration can be presented as Fig. 1-2.

1-4 Implementation of the Partnership Project and the Supportive Organizations

Regarding the objectives of this project and the conditions for the use of the budget, most of the budget of this project would be spent on the research activities and trip expenses for the faculties, students and local governments' officials at both Japanese and foreign ends. In order to improve the partnerships, field observations in Japan and other Asia/Pacific regions, meetings and seminars would be held frequently. In addition, collaborative research studies would be launched, and students among collaborative universities would be co-supervised under the research activities.

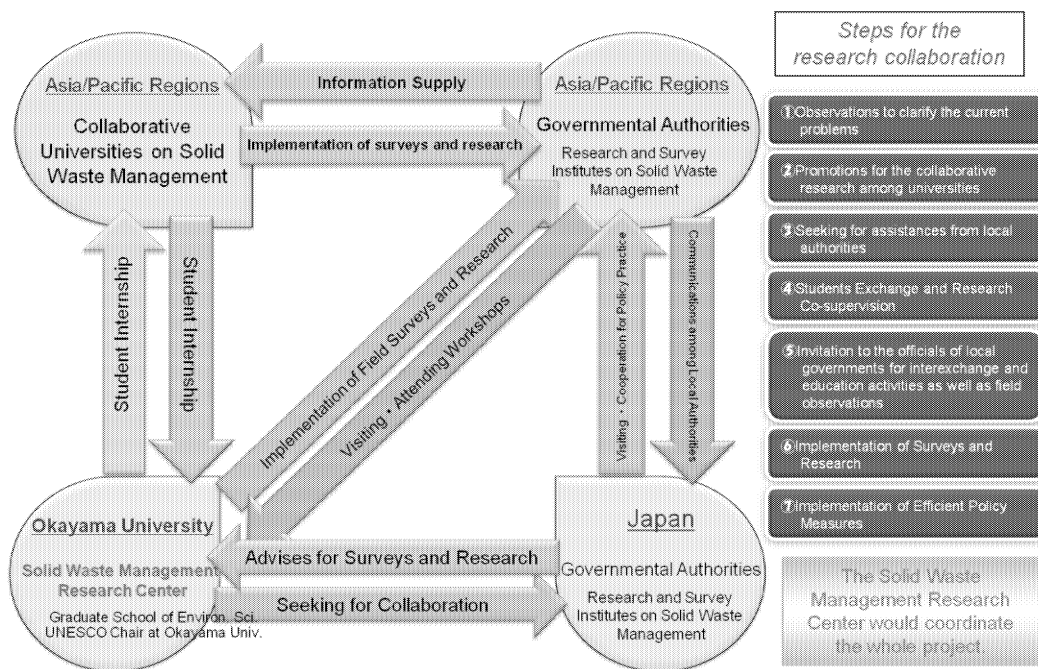


Fig. 1-2 The prospective image of the research collaboration.

Regarding the in-situ field survey, supports and cooperation from local authorities and universities are expected. The required expenditures of the consumables, the meetings, the manpower and the machines/facilities renting for this project would be afforded by the Solid Waste Management Research Center of Okayama University.

In order to promote intensive and deep research/education cooperation, collaborative universities would make formal Memorandum of Understanding (MOU) with Okayama University. With formal agreements, students exchange and interchange activities could be promoted extensively, with less restrictions.

The aforementioned collaboration activities are being conducted as Fig. 1-3 shows.

1-5 Establishment of the Organization of the Collaborative Groups of the Project

The Solid Waste Management Research Center would make a comprehensive list presenting the local communities, municipalities, NGOs, NPOs and private enterprises that make contributions to the projects. All the supports and collaborations would be appreciated and welcomed. Furthermore, advices from local authorities and NGOs and NPOs are expected.

In order to promote the information interchange among the collaborative groups, this project would hold events in Japan. In the events, the progress and achievements of the project would be presented. Constructive information for foreign countries would be set up and spread worldwide.

Questionnaires in terms of “developing the human resources playing active roles tackling environmental issues worldwide” and “expectation for the university education from the students”

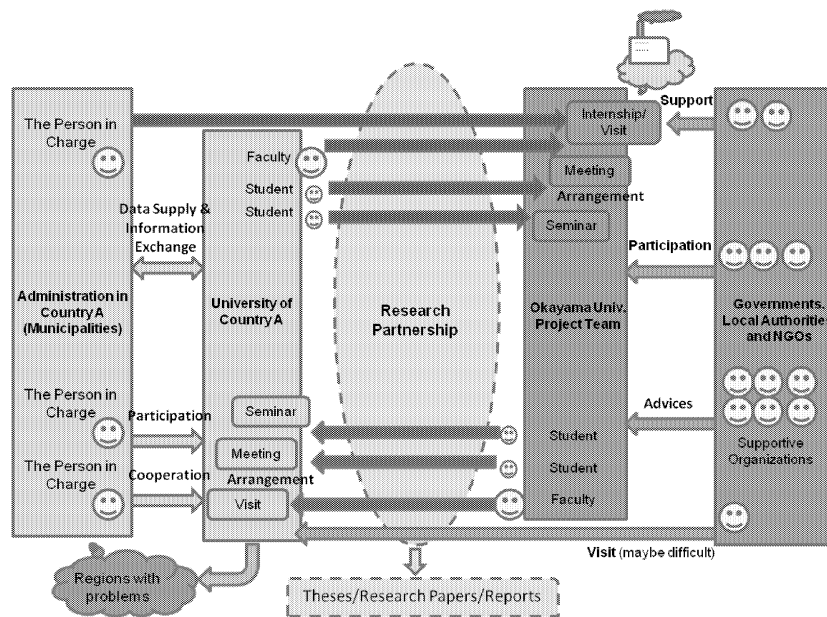


Fig. 1-3 The collaboration partnership among the main stakeholders in this project.

would be performed and considered by this project.

1-6 Respective Research Study in the First Year

In the Partnership project, researchers are divided into the Technical Support Group and the International Practice Group. The project promoters would become leaders carrying out individual project. The expertise group working on individual project is called a team.

International Practice Group

The International Practical Group would build partnerships with universities and local authorities of participating countries to work on their project. Few project promoters can work in one subgroup. The project promoters of the Technical Support Group would take active parts in supporting advanced technologies and methodologies to the International Practice Team.

In FY 2010, the Partnership project takes its first step in Palau, Guam and Indonesia. Afterward, research would be conducted in Malaysia, Vietnam, China and Taiwan in FY 2011, and Thailand and India in FY 2012. Based on the connection network with the collaborative universities and the objective local authorities, the university faculties and their students as well as the local governments officials would be invited from the abroad regions, and Japanese solid waste management systems as well as the technologies would be introduced to the foreign partners. Meanwhile, participators on the Japanese end would be sent abroad to conduct field observations, surveys, and research activities.

Technology Support Group

As the above figure shows, the Technology Support Group conducts three studies for biomass reutilization, one for safety management of waste treatment facilities, one for atmosphere/global

warming, and one for management technologies, i.e. 5 studies in total within this group. In most developing countries, solid waste is almost being disposed of within their current treatment/disposal systems. In such a case, the introduction of the transformation from organic waste into feed or fertilizers would be beneficial to both resources utilization and waste reduction. By developing appropriate chemical processes, the utilization of biomass for developing countries is being built. Furthermore, organic agriculture technologies for biomass utilization are being developed.

Regarding the final disposal sites in developing countries, normally sanitary landfills are recommended. However, in fact, open dumping or general landfilling is popular at present, leading to a critical concern of water pollution due to leachate discharge. In addition, slide collapses usually occur at final disposal sites where some waste pickers work and live for picking up waste of resources. The maintenance management of the final disposal sites is an important issue. Concrete topics include improvement of the stability of the slides at landfills, prevention of water pollution from leachate discharge and the related greenhouse gas emission. Studies for the relevant safety management would be carried out.

Still, the origin establishing solid waste management systems is to obtain the accurate data of the quantities of the overall generated solid waste and its respective waste stream. Holistic waste separation and reutilization plans could not be made until the quantities and types of solid waste are clarified. Nonetheless, the analysis of solid waste components is very difficult. Thereby the image processing technology is trying to be induced to extract the attributes of solid waste for estimating the solid waste components.

The sub-projects in the first year are organized as the following figure.

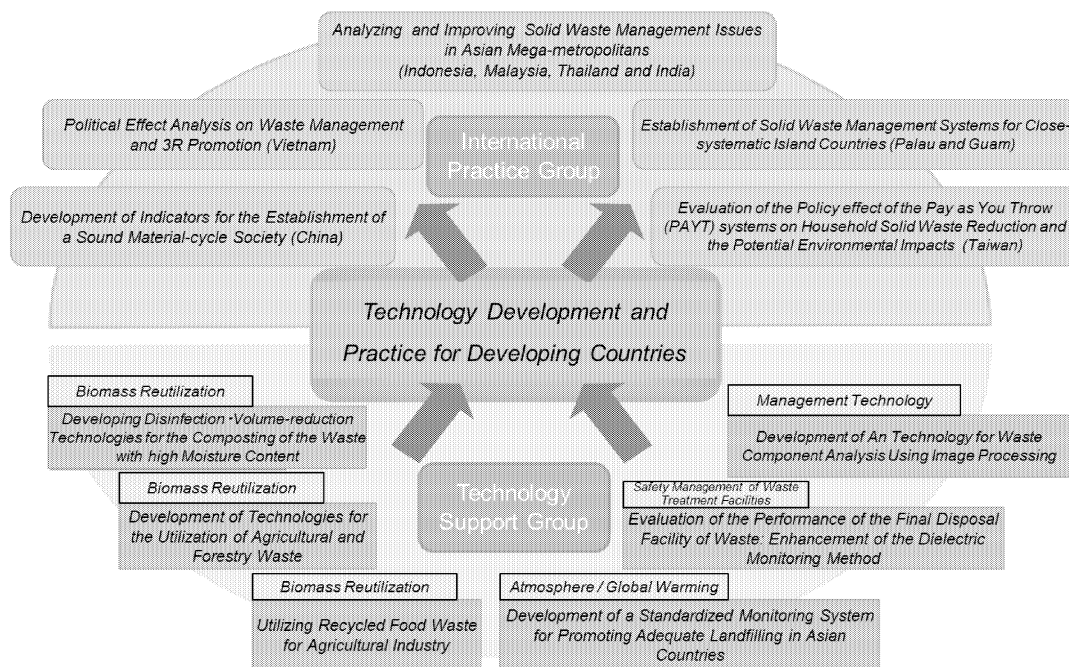


Fig. 1-4 Sub-projects in the first year.

1.7 The Outline of Project Outcomes

□ The Outline of Project Management Activities

In the project meeting held every month, some subjects of the project management, plans and reports of overseas trip or invitation of overseas guests, reports on project events, and exchanging opinions were conducted. Especially, when the overseas trip was reported, the reporter gave a brief research presentation to illustrate the situation and his activities in the overseas site to other members for sharing the information of solid waste management in Asian countries.

Moreover, an e-mail newsletter of the partnership project was distributed fortnightly to inform the activities of the administration office and every project promoter as soon as possible.

□ The Outline of the Project Events

The following four project events were held in FY2010.

(1) Kick-off meeting (July 23, 2010)

Kick-off meeting of the partnership project was held at the large conference room on the 4th floor of the Environmental Engineering building. Collaborative researchers from overseas were invited and gave the questions and comments to the research subject which was presented by each project promoter.

(2) Domestic event “Get together ! Citizen’s eco-life and eco-technology” (August 29, 2010)

This big event was held at the 50th Anniversary Hall. The theme was focused on citizens’ eco-life and eco-technology. Reduce and reuse in “3R”, in other words, “first 2R” is an important action as a reduction countermeasure at source. With the common understanding that it is important to enroot the 2R into the citizen’s consciousness and lifestyle, Okayama University (academy), Okayama city (local government), several NGO/NPO associations on environment protection, and citizens co-hosted an event. The event had two parallel attractions: one is a lecture presentation at the big hall, and the other is the display and demonstration at the event floor. Specially, the display and demonstration provided a friendly and enjoyable environment for children to learn about 2R and ESD (Education for Sustainable Development).

In the hall, Dr. Akira Takatsuki who is professor of Ishikawa Prefectural University and also an emeritus professor of Kyoto University and also a famous comic artist as a writer of the cartoon book “Gomic Haikibutu” 「ゴミック魔貴物」, gave the audience a comprehensive lecture entitled “relationship between 3R and eco-life” using an amusing cartoon. Ms. Keiko Ohmori, Director of the Chamber of the Promotion of Sound Material-cycle Society in the department of Minister’s Cabinet Secretariat, and Mr. Motohisa Naito, Deputy Director-General of Okayama City Government, both of them gave a presentation on “Expectation of Eco” and “Promotion of Eco”, respectively. Moreover, Prof. Hirofumi Abe, Dean of Graduate School of Environmental Science (also Director of Solid

Waste Management Research Center) gave a lecture on “Eco and ESD”, and Prof. Takeshi Fujiwara, Deputy Director of Solid Waste Management Research Center, gave a presentation on this partnership project. Children could enjoy learning the environment problem by seeing and touching something objects by NGO. Like handmade home composter, there are some ideas in Japanese eco-life and eco-technology which has the potential to be distributed in the developing countries. Hence, as international contribution, we can transfer such valuable information if we could collect and make an arrangement of the ideas in eco-life and eco-technology.

(3) Interim Meeting (Nov. 7, 2010)

The interim meeting of the partnership project was held at the large conference room on the 4th floor of the Environmental Engineering building. The research progress was presented by the project promoter. Valuable information and opinion were exchanged among the research promoters.

(4) Annual Meeting (Jan. 24-25, 2011)

In the 1st lecture room of Graduate School of Natural Science and Technology, Okayama University, annual year debrief meeting was held. Many foreign researchers from Palau, Guam, Indonesia, Malaysia, Thailand, Vietnam, China, Taiwan, and so on were invited and presented the latest topic of their own countries situation of solid waste management. On the other hand, the project promoter their own research activities and received questions and comments from the invited guests. Finally, our members including invited guests, the project promoters, and other audience had a discussion about how to proceed of the partnership project next year.

The important comments are as follows:

- a) What do you think about the collaboration among project promoters?
- b) This project should be introduced worldwide and provide information.
- c) Do you create e-learning contents on this project?

As for comment a), the collaboration between the international practice team and the technical support team is a critical characteristic. Some works will be planned on this issue from the second year of the project. In the future the collaboration is necessary. As for b), a home page of this partnership project has already launched but the maintenance might be insufficient. A newsletter is distributed to project promoters twice in a month, periodically. English version of the newsletter should be distributed to the collaborative foreign guests. And about the last one, c), this project has aspects of education, upbringing of human resources, and capacity building, the e-learning contents will be created as well.

The Outline of Research Outcomes

● International practice team

Having the collaboration with academic or governmental partners in Asian countries, this team

aims to solve the environmental problems in the country of interest. In FY2010, research works have been done in Republic of Palau, Guam island of USA, Republic of Indonesia, China (and Taiwan) as well as Vietnam will be target areas in the next two years.

1) Republic of Palau

Republic of Palau is an island country with full of nature, and it is a treasure surrounded by Pacific Ocean and coral reef. This island, which has developed as a sightseeing resort utilizing the natural resources, has a common problem that a large amount of materials are imported but the waste cannot help being stocked in the landfill because of the deficient existing capacity for that. Especially increasing plastic waste accelerates the consumption rate of the remaining space in landfill. Ailai state government has never collected the waste generated from households, then each household has continued to bring the waste to “Gomisute-ba” (this is in Palauan) by itself. The opened landfill site is located in the middle of the residential area. The leachate gets through the stream which flows down through the residential area and the landfill hill of waste is danger in falling down to the block of houses. In the partnership project, Prof. Fujiwara conducted questionnaire survey of solid waste generation and discharge for citizens in Ailai state with public works of Palau government. The questionnaire inquires not only the amount of waste discards by waste category, but also the public awareness, experiences and willingness of waste segregation and recycling. The survey was conducted mainly by a graduate student of Okayama University. As a practice of Super Science High school (SSH) of Okayama Ichinomiya High School a teacher and students who are interested in our project came to Palau and joined the research team to distribute the questionnaire, household by household. After analyzing the questionnaires, the appropriate method of segregated waste collection was discussed.

On the other hand, Prof. Nagare of Okayama University surveyed the safety of the leachate water which is flown from landfill site in Ailai state. Along the stream from landfill to the bay, he collected and analyzed a leachate sample at the landfill and several samples of river water and sea water at points along the stream. Moreover, he collected and analyzed a sample water of the balancing pond constructed beside the landfill in Koror state which was rehabilitated several years ago. The sampling succeeded due to the support by government persons of Palau.

[Related association; Okayama University, Palau Central Government, Palau Communication Collage]

2) Guam island of USA

Guam Island also has serious problem of solid waste like Palau. The present landfill is having been used since World War II and has already been over the capacity; however, the next landfill is under construction. Recycling of card board has been regulated but recycling of other recyclable materials is not going well. In 2010, the department of solid waste treatment conducted monitor survey of

segregated collection of recyclable material, such as card board, aluminum cans, steel cans, and plastic bottles, for about 1,000 households.

The partnership project started questionnaire survey on household waste discards. In this year, under a supervision of professor Fujiwara of Okayama University and professor Golabi of University of Guam, a graduate student conducted questionnaire survey, such as telephone survey and visit survey, and collection of the responds while staying in dormitory of UOG for two weeks.

As for the business waste, obtaining basic information on establishing the recycling system of food waste for agriculture, Prof. Kishida of Okayama University and Prof. Marutani of University of Guam conducted questionnaire survey on the food waste from food shops, hotels, restaurants, schools, mass sale stores, and baker's shops.

From viewpoint of education for human, the both professors and Mr. Hamamoto who is an owner of "Hamamoto Fruits World" provided an agricultural field training course of Guam. In the Hamamoto Fruits World, eight students of Okayama University learned the tropical agricultural production system that contributes to low carbon society. By contrary, a hog raiser and a NPO's representative were invited to Japan, and last November they visited Japanese agricultural utilization system of food waste and the applicability was discussed.

Supported by Prof. Golabi of UOG, Prof. Nagare sampled waste leachate and analyzed it, Prof. Kimura and Prof. Azuhar surveyed on the biomass recycling.

[Related association: Okayama University, University of Guam, NGOs in Guam, Private companies in Japan and Guam]

3) Republic of Indonesia

Bandung city, Indonesia, is so populated that the deficiency of final disposal site is a crucial problem. Since the scavenger earns his living by recovering recyclable materials from waste, the recycling rate is high. But the quantity of waste is too large to keep enough space of landfill. In order to reduce the quantity of landfilled waste, it is necessary to increase the current of waste for recycling by segregating the household waste at source and to decrease the discharge of food and green waste. The partnership project aims to survey the waste generation and discards, segregation in transfer stations, the transportation to landfill site, and the recovery of recyclable waste for finding more appropriate solid waste management of Bandung. In this year, Prof. Fujiwara of Okayama University and a student visited Bandung city, observed the situation of solid waste management (SWM) in Bandung, after that, and discussed with professors of Institute of Technology Bandung (ITB) and local government officers about the problem of the SWM. In 2011, the Okayama municipality makes a plan to send technical officers to Bandung city. Four academic and governmental actors will try to rationalize the collection and recycling system of household waste with cultivating partnership.

[Related association: Okayama University, Institute of Technology Bandung, Okayama City

Government, Bandung City Government]

4) China

In China, an attempt was made to establish evaluation indicators for the development of a material-cycle society. The evaluation indicators would be used for future case studies in Asian and Pacific regions, and thus concrete policy measures could be proposed to the municipalities. In this project, Assist. Prof. Ujihara and Prof. Abe are using the concepts of ecological footprint to analyze several areas in China, which includes economically developed and developing regions. The results of analyses found that China has been in ecological deficit (overshoot) from an environmental standpoint. Also, the per-capita ecological deficits are greater in eastern China. The regional gaps between the eastern areas and the middle southern areas in China are not slight. However, no 'ecological reserve' region exists. In addition, in western areas, results show that the environmental capacity exceeds EF in many regions. At the next stage, the research group will discuss comprehensively with the Chinese scholars and the local municipalities to improve the material-cycle society in China.

[Related association: Okayama University]

5) Taiwan

The control of the household waste generation is a critical environmental problem in Taiwan due to the limited land resource. For this reason, some municipalities make attempts to adopt economic incentive measures, e.g., the implementation of the Pay-as-You-Throw (PAYT) systems following the Japanese successful experiences. However, it is important to set up a rational fee level for efficient waste reduction. Collaborating with Prof. Sue-Jane Lin and Prof. Hwong-wen Ma, Assist. Prof. Weng evaluated the policy effects of the PAYT in Taipei City, Taiwan, regarding the fees and the socio-economic attributes. Meanwhile, the mitigation of environmental impacts resulted from HSW reduction would be evaluated. In addition, a questionnaire survey is conducted in Taipei City (with the PAYT) and Tainan City (without the PAYT) to examine the citizens' acceptability in terms of the PAYT measure and to investigate the citizens' willingness-to-pay (WTP) for the HSW management services. According to the research outcomes, the optimal charging level is to be discussed for a better HSW generation/discards reduction. Consequently, the administrative and civic concerns and the modeling results of the PAYT policy is concluded by using the SWOT analysis. Concrete proposals for the prospective improvements are made in aid of the modification of current practices. The research group also established good collaborating networks among several municipalities in Taiwan.

[Related association: Okayama University, National Taiwan University, National Cheng Kung University]

6) Vietnam

Assoc. Prof. Matsui conducted a new approach for monitoring and managing municipal solid waste collection, which using GIS/GPS application, other field observations and mapping. A case study was conducted to evaluate the current status and operational efficiency of municipal solid waste collection, especially segregate collection by dustbin in Hanoi city. A tracking survey of waste collection vehicles to collect the data on position, tracking, operation time, speed, and distance of each worker by GPS logger was conducted; besides, collection data on waste quantity was also carried out. The results identified existing problems, weak-points, and improper activities. Moreover, the interesting results from this study are expected to provide a support tool for monitoring and managing municipal solid waste collection and transfer systems by using GIS application for waste managers and policy decision makers.

[Related association: Okayama University, Hue University]

● Technical support team

This team studies basic methods and technologies which can be applied in certain stage to the individual project under the partnership project. The outcomes in FY2010 are described as below.

1) Developing Disinfection & Volume-reduction Technologies for the Composting of the Waste with High Moisture Content

For developing a volume-reduction technology, professor Kumura investigated dehydration process of a biomass with superheated steam (SHS). The SHS at 140-190 Celsius degree decreased the weight of the model of substance with a high moisture content, asparagus. The dehydration rate depended on the temperature and 190 Celsius degree was the most effective temperature within the range tested. An alternative effective technology, extraction of valuable components from biomass, was investigated using subcritical water. Reducing sugar and protein were effectively extracted from a shell of nut, *Carya cathayensis sarg*, at 190 and 280 Celsius degree, respectively.

[Related association: Okayama University, University of Guam]

2) Development of Technologies for the Utilization of Agricultural and Forestry Wastes: Preparation of Biochar from Agricultural Residues

In Assoc. Azuhar's study, biochar was prepared by pyrolysis of various agricultural residues such as rice straw, wheat straw and corn stover. The effect of pyrolysis temperature (400, 450 and 500 °C) on the yield and properties of the biochars was investigated. Yields of rice straw, wheat straw and corn stover biochars decreased with the increase of temperature. Specific surface area of rice straw biochar decreased with the increase of pyrolysis temperature, however the same trend was not observed for wheat straw and corn stover biochars. The pH and water adsorption capacity and extractable phosphorous contents of rice straw and corn stover biochars were much higher than the

wheat straw biochar. All of the biochars produced are comparatively moderate in carbon content, and corn stover biochar was high in nitrogen content. This means that rice straw and corn stover biochars have properties that provide water retention, acidic soil neutralization and direct nutrition benefits.

[Related association: Okayama University, University of Guam]

3) Non-Destructive Field Measurements of Unsaturated Seepage Flow by Using Ground-Penetrating Radar

Prof. Takeshita and Assoc. Prof. Komatsu makes attempts to apply the Surface ground-penetrating radar (GPR) as a non-destructive method to measure the temporal and spatial variability of unsaturated seepage flow under uniform wetting conditions on a homogeneous sandy soils. GPR profile survey with 400MHz antenna was conducted after the uniform infiltration. GPR reflected wave from advancing wetting front during uniform field infiltration experiments was used to map the front depth variability with time. The dielectric constant of soil measured by vertical soil moisture probe below the ground surface was used as standard measures of soil moisture to compare with the GPR estimated unsaturated seepage flow behavior. Traceability of the wetting front depth variability with time was found with GPR profile survey.

[Related association: Okayama University, Colorado School of Mines, USA]

4) Development of a Standardized Solid Waste Carbon Modeling for Promoting Adequate Landfill in Asian Countries

From the beginning of 21st century, in developing Asian countries, solid waste has rapidly begun to increase owing to both industrial production activities and consumption behavior. Under high temperature and moist atmospheric conditions, vast of biodegradable solid waste is input into a lot of landfills which inadequately managed, and enormous greenhouse gases are emitted from such landfills. Influence of greenhouse gases from landfills on global climate system is not yet well understood. In this subject, Assoc. Prof. Iwata's group suggests the development of a schematic model which explains decomposition processes of solid waste carbon and quantitatively estimates methane (CH₄) gas emission.

[Related association: Okayama University]