Ecosystem Protection Using IT

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OVERVIEW: The 11th meeting of the Conference of the Parties (COP11) to the Convention on Biological Diversity held in India in 2012 included stronger measures aimed at encouraging corporate action on biodiversity, including the provision of aid to emerging nations. With aim of creating a sustainable society, Hitachi adopted a medium- and long-term Environmental Vision in 2007 based around the three pillars of "Prevention of Global Warming," "Conservation of Resources," and "Preservation of Ecosystems." This includes supplying products and services that contribute to the protection of the environment and operating its global business in ways that reduce the load on the environment. Seeking to place greater importance on environmental activities in its information and telecommunications divisions, Hitachi also adopted its global environment contribution plan in June 2010 to contribute to the global environment through activities that use IT to achieve a bountiful planet. With the preservation of biodiversity being one of the themes of this plan, Hitachi opened the Hitachi IT Eco Experimental Village in April 2011 where it is running a nature restoration project in collaboration with universities and the local community.

INTRODUCTION

THE environments in which organisms live are coming under severe threat due to factors such as global warming or human activity and development, leading to the destruction of ecosystems, loss of natural habitat, and invasion by exotic species.

Recognizing this situation, Hitachi decided in 2010 to look at what it could do as a company to help protect ecosystems. With information technology (IT) being part of Hitachi's core business, this led to the opening in April 2011 of the Hitachi IT Eco Experimental Village in Hadano City in the Kanagawa Prefecture of Japan as a site for studying the use of IT in ecosystem protection.

This article describes the activities and experiments being conducted at the IT Eco Experimental Village, their application to business, the associated corporate social responsibility (CSR) activities, and plans for future expansion.

ACTIVITIES AT IT ECO EXPERIMENTAL VILLAGE

Village Opening

From its corporate perspective, Hitachi has three aims for the work being conducted at the IT Eco Experimental Village. The first is to achieve, through human intervention and in cooperation with the local community, the restoration of the species that traditionally populated the area and an increase in their numbers. The second is to demonstrate the use of IT in the field so that it can be used in future ecosystem preservation work. The third is to improve environmental awareness through a project model that features staff participation.

The choice of a site for the village focused on local bodies that were actively engaged in ecosystem preservation in the Kanto region. Among the potential candidates, Hadano City in Kanagawa Prefecture was particularly strong on environmental activities and was a place in which Hitachi, Ltd.'s business had deep roots, having operated a plant there for more than 40 years. Recognizing this as somewhere it could make an even greater corporate contribution to the environment, Hitachi in cooperation with the city chose a block of land approximately 7,000 m^2 in size (in Chimura, Hadano City) comprising forested hills and fallow farmland that had remained unused for many years.

To ascertain what species were already living on the land prior to human intervention, a wildlife survey was conducted at this point in collaboration with Tokai University (with whom Hadano City had conducted other ecosystem surveys in the past). This survey found that populations of rare species were present at the site, including Lefua echigonia, a species of freshwater fish that is listed as a Class IB Endangered species*1 in the Ministry of the Environment's Red Data Book, a compilation of wildlife at risk of extinction.

Hadano City designates fields or wetlands where rare or precious wildlife live or breed as "Chimura The Living Village." The IT Eco Experimental Village is the first site managed by a private business to receive this designation. The project is an example of regional cooperation between industry, government, and academia. A committee made up of Hadano City Hall, community councils, the Chimure Sato no Kai non-profit organization (NPO), and land holders was formed to act as a parent organization coordinating activities at Chimura The Living Village.

Areas and Activities at IT Eco Experimental Village

The village is split into separate areas based on the land characteristics, with the conservation work in each area having the respective objectives described below (see Fig. 1).

(1) Fallow Farmland Restoration Area

Drains and biotopes (habitats) were established to convert an area of formerly fallow land into paddy fields (approximately 2,975 m^2) and dry fields in a way that provided a suitable habitat for wildlife. Forest thinnings from the Broadleaf Forests Restoration Area were used to build rest stops and footpaths. Kiju Mochi mochi rice and Kinuhikari uruchi paddy rice were grown on the restored paddy fields without the use of agricultural chemicals or fertilizers, producing a harvest of approximately 180 kg.

(2) Broadleaf Forest Restoration Area

Originally a stand of mixed forest, this area had, through many years of neglect, become overgrown with bamboo, turning it into a dense and dark thicket. Accordingly, the bamboo was cut down and the trees thinned to let in more light. Also, an area of grassland where seasonal flowering plants would be able to blossom was established on the slope facing the Fallow Farmland Restoration Area. People involved with the village used the thinnings from this area to make notebooks, coasters, and other craft items that have been used as novelties by Hitachi Group booths at environmental exhibitions and other events.

(3) Wildlife Observation Area

This is a region of elevated wetland surrounded by bamboo where Impatiens textori and Reineckea carnea grow in profusion. As rare species such as badgers are known to inhabit the area, human intervention is kept to a minimum and it is maintained as a place for observing the animals in their natural habitat.

(4) Flora Observation Area

This area is currently covered by large amounts of amur silver-grass, a species of grass that grows in wetlands. As amur silver-grass provides a habitat for small mammals, this area is left largely untouched other than the removal of foreign species, and is used as a site for evaluating the recovery of flora and fauna.

Also, to raise interest in aspects of traditional village ways of life, Hitachi is also involved through its CSR activities in rice planting (May) and harvesting (October), with participation by community councils, land holders, Hadano City Hall, nearby elementary schools and kindergartens, and Hitachi staff (see Fig. 2). The harvested rice is donated to homes for the elderly and other welfare facilities, and is used in communal activities such as making mochi (rice cakes).

The aim for the future is to use activities like these to deepen interactions with the people involved in the IT Eco Experimental Village.

*1 Species facing risk of imminent extinction in the wild.

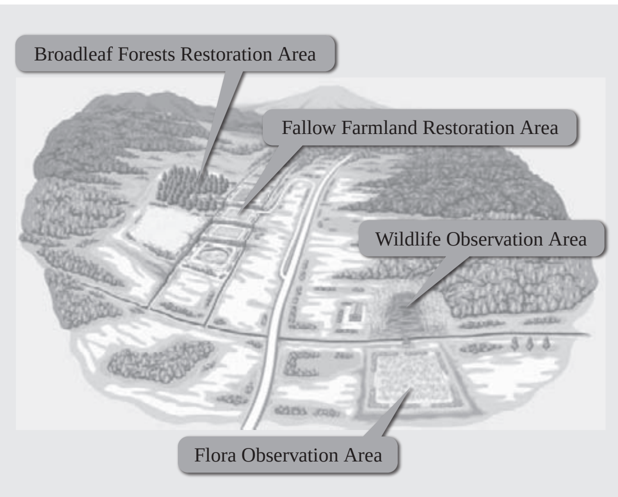

Fig. 1—Hitachi IT Eco Experimental Village.
The block of approximately 7,000 m^2 is divided up into four areas, with different activities in each area depending on its characteristics.

Products and Solutions Used at Village

A variety of different IT devices have been installed to collect environmental information at the village. The following sections describe their features and how they are used.

(1) Hitachi wireless sensor-net system

This system uses small sensors capable of measuring four different types of basic environmental

Fig. 2—Kindergarten Children Planting Rice along with Local Volunteers and Village Staff.
Regular events are held as part of the children's environmental education. These include rice planting and events run by teachers and students from Tokai University that provide children with a chance to view the village's aquatic and plant life.

data (including temperature and humidity) and wirelessly transmitting the results back to a server. The sensors are installed at four different locations around the village (Fallow Farmland Restoration Area, Broadleaf Forest Restoration Area, drains, and Wildlife Observation Area) where they are used to collect temperature, humidity, soil temperature, and water temperature at one-hour intervals. The system at the village is powered by rechargeable batteries charged by photovoltaic panels.

(2) GeoPDF*[2] (Hitachi Solutions, Ltd.)

Observations of plants and animals can be entered into a smartphone and sent via e-mail to a personal computer (PC) tagged with latitude and longitude data obtained using the global positioning system (GPS). GeoPDF also has a mapping function that can show locations and other observation details on a smartphone or PC map.

(3) Sensor cameras (Hitachi surveillance camera system)

Timely 24-hour-a-day observations of wildlife in their habitat are provided by a single networked video camera and six still camera sensors that use infra-red detectors to capture images at night or other times when animals are present (see Fig. 3). Realtime images of the village are also available on the IT Eco Experimental Village's web site*[3] via a web camera.

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*2 GeoPDF is a registered trademark of TerraGo Technologies, Inc. in the USA and other countries.
*3 http://www.hitachi.co.jp/environment/iteco/

Environmental Data Visualization System

This is an experimental system that takes temperature, humidity, soil temperature, water temperature, and other environmental data collected from the village by Hitachi wireless sensor-net system and automatically stores it in a cloud server for display on the web site. The remote control system is used to transfer the data and the cloud server is provided by SecureOnline, a secure IT platform service that is part of Hitachi's cloud computing solution. The system is designed to provide "visualization" by sharing environmental data with people involved in the project (see Fig. 4). Testing demonstrates that this system is suitable for use in ecosystem preservation and other environmental and agricultural applications.

USE OF IT IN ECOSYSTEM PRESERVATION

Objectives

In addition to its work on preserving natural habitat to support biodiversity, the IT Eco Experimental Village is also involved in efforts to assess scientifically (quantitatively) how environmental change is impacting the flora and fauna.

In the past, the agencies that measure and analyze basic environmental data such as temperature and humidity have operated separately from those who survey and analyze the populations and circumstances of flora and fauna, with nobody engaged in consolidating their respective work. However,

Fig. 3—Wildlife Captured by Sensor Cameras at Hitachi IT Eco Experimental Village.
A variety of wildlife has been observed at the IT Eco Experimental Village.

detailed assessments of how recent global warming has affected plants and animals will likely prove very important for maintaining biodiversity in the future. Accordingly, this project has installed a wide range of different IT devices to continuously collect and collate information about the environment, and is formulating and testing hypotheses about how it can be used to assess biodiversity.

Examples of Experimental Work

Hitachi places top priority on working closely with the local community when conducting ecosystem preservation activities. First among these at the IT Eco Experimental Village was experimental work on rice cultivation involving the restoration of fallow farmland.

The experiment involved using environmental data from the year concerned to predict the best time for harvesting the rice, something that in the past had always been determined by farmers based on rules of thumb. With an ongoing fall in the number of experienced farmers, the aim was to formalize their implicit knowledge so that it could help their less experienced colleagues (or volunteers coming in from outside the area) decide on the best harvest timing, and to do so remotely if necessary.

Fig. 4—Screen from Environmental Information Visualization System.
Hitachi wireless sensor-net system is used to measure air temperature, humidity, soil temperature, and water temperature. The data is sent wirelessly and in realtime from the sensors to a cloud server where it is made available on the web site.

Consultations held with experienced local farmers (known as "tokunoka") and agricultural specialists from the university as part of the experiment identified the following two key points.

(1) Based on their long experience, farmers make their decision about when to harvest based on the time since the ears first appeared on the rice plants.

(2) Theory predicts that a correlation exists between plant development (growth and flowering) and the integral of temperature over a certain period of time (cumulative temperature).

As these two points indicate that the harvest decision is made by experienced farmers based on daily observation of the condition of the rice plants and the effective temperatures they experience in the period after the ears appear, it was hypothesized that an appropriate harvest timing could be chosen by correlating the harvest timing against air temperature measurements. The experiment was conducted to test this hypothesis.

Experiment Method

The experiment was conducted as follows.

(1) In 2011, the measured cumulative temperatures around the farm site were analyzed with reference to the timing of ear emergence and the harvest time chosen by the farmers.

(2) The same information was again collected in 2012 and compared against the data for 2011.

The air temperature data used in this work was obtained by accumulating daily averages calculated from hourly measurements taken in the vicinity of the paddy fields. The basic environmental data was collected from four locations in the village. During summer, the results sometimes showed a difference of several degrees between the daily average temperature at the Fallow Farmland Restoration Area near the paddy fields and that at the Broadleaf Forests Restoration Area. This indicates that it is important to use data measurements from as close to the site being studied as possible.

Experiment Results

The experiments in both 2011 and 2012 found that the best time for harvest was when the cumulative temperature during the period after ear emergence exceeded 1,200°C, indicating a strong correlation with air temperature. This was also corroborated by the harvest being three days earlier in 2012, a year in

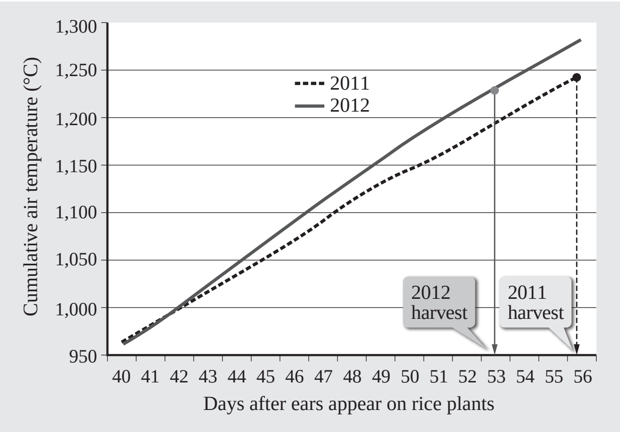


Fig. 5—Graph of Cumulative Air Temperature and Days after Ear Emergence.
In both 2011 and 2012, the best time for harvesting was judged to be after the cumulative air temperature exceeded 1,200°C.

which the temperatures prior to harvest where higher than in 2011 (see Fig. 5).

Future Work

Given that it is only two years since work started at the IT Eco Experimental Village, it is considered important to continue collecting and assessing data to strengthen confidence in the hypothesis.

While Hitachi wireless sensor-net system can be used to collect basic environmental data remotely, a base station and server need to be located within wireless communications range of the sensors. As it is also necessary to provide a power supply at the sensor locations, an experiment was initiated in 2012 aimed at eliminating this requirement by trialing the use of photovoltaic power generation and rechargeable batteries. Three similar systems were installed at sites in the village that experienced different levels of sunlight, and their power generation and usage were then assessed to ascertain the amount of power generation and battery capacity required. In addition to this experiment, further work is planned to facilitate installation at sites that would have been impractical in the past, including the sending of data via a mobile communication network (see Fig. 6).

A major issue associated with checking the condition of the grain (in this case, the timing at which ears appeared on the rice plants) was that it required an on-site inspection. With a view to the technology being applied to large fields or in other countries in the future, it is important to be able to check the growth of the grain remotely. One potential method for achieving this is to perform spectral analysis on satellite images to assess the progress of grain development on the plants. To improve the accuracy of these assessments, an experiment is currently being run using a vegetation map of the village produced from a survey by a plant specialist, with more targeted experimental work planned for FY2013 and later.

EXPANSION OF ACTIVITIES AT IT ECO EXPERIMENTAL VILLAGE

Development of Programs Focused on Ecosystem Preservation

Work aimed at restoring wildlife attracts more participants to the village and leads to more activities by the extra people involved or by those with a raised awareness. Also, increasing the number of people able to contribute to other activities, including those outside the village, is the best way in the long term to expand protection for ecosystems. Accordingly, steps are being taken to promote and expand activities at the village, including bringing in more participants by increasing the program of events held there (including giving people a chance to experience rice planting, harvesting, or other farm work), with numerous nature watching sessions or presentations on work at the village, for example. Regarding the relationship with

Fig. 6—Hitachi Wireless Sensor-net System and Photovoltaic Power Unit.
A trial is being conducted to assess whether photovoltaic power generation and a rechargeable battery are adequate to power the sensors.

the local community and broader society, activities have been run in collaboration with educational institutions such as universities or local elementary schools and kindergartens, bringing the total number of visitors to the village during the roughly two years since its opening to nearly 3,000, and helping increase the number of people with an interest in ecosystem preservation or who are able to contribute to the activities (see Fig. 7).

To expand the use of IT for ecosystem preservation, weather sensors have also been installed since 2012 at three other sites that have also been designated as Chimura The Living Village by Hadano City. These sensors are collecting similar measurements to those in the village. By comparing differences such as the characteristics of the location, its elevation, and the surrounding environment, for example, this work is helping with the "visualization" of mountain habitat protection by local government.

The promotion and expansion of the village itself has come about from the boost in motivation achieved by demonstrating the results of the work, such as how it has led to activities both by companies and by volunteers working with the local community (Chimura Nature Club), or the extent to which conservation has been enhanced compared to the past by undertaking conservation work through the village. Meanwhile, companies have established plans for strategically expanding conservation areas and have obtained the consent of the community. Autonomous volunteer groups have also been formed that are able to conduct their own conservation work. These developments represent a way for companies to go about making a contribution to the environment and society, something that was rare in the past.

In another initiative, a nature watching event sponsored by Hadano City was held at the IT Eco Experimental Village in 2012 to get more people interested in rare species. Work has also started on using IT to collect observations as part of research into ecosystem preservation by the Research Center for the Future City Design Corresponding to Global Environment Problems that was established in July 2012. This uses smartphone-based augmented reality (AR) technology to share existing information at the site and also as a way of identifying the observed wildlife and recording observations. It was demonstrated with a limited number of species (see Fig. 8).

Initiatives Using IT in Ecosystem Preservation

The Research Center for the Future City Design Corresponding to Global Environment Problems established in July 2012 is an industry-government-academia research consortium made up of nine different organizations, including Hitachi, Ltd. Based in the Yokohama National University, its aim is to design future cities that are adapted to the global

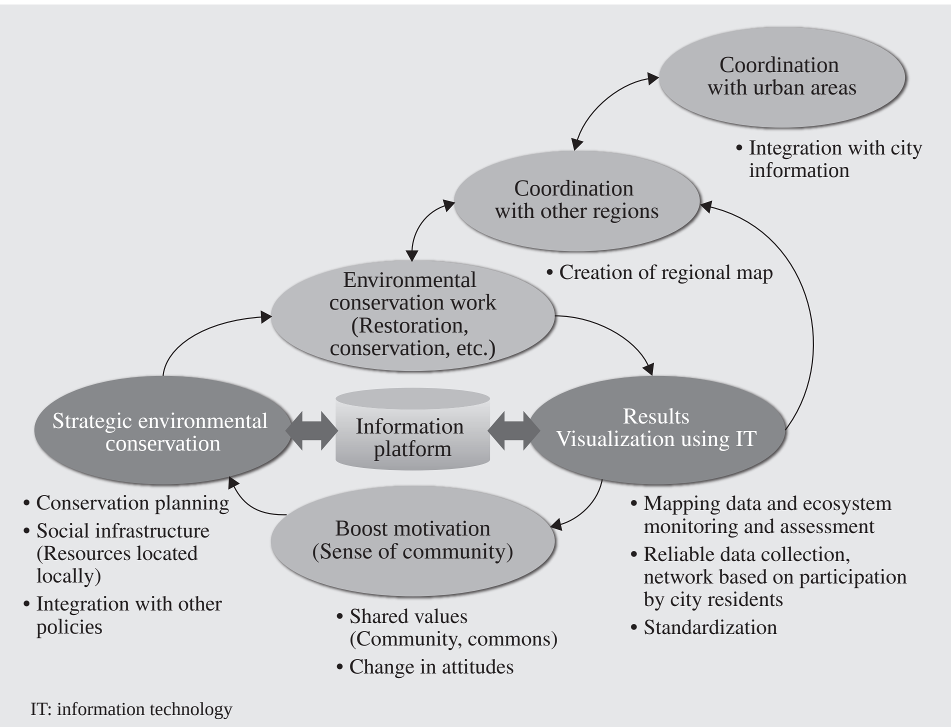


Fig. 7—Ecosystem Preservation Spiral.
The figure shows the concept ("spiral") behind the ecosystem preservation work conducted by the IT Eco Experimental Village and Chimura Nature Club together with an overview of the use of IT for visualization. The Chimura Nature Club is a volunteer group made up of Hitachi associates and land holders that engages in activities at the IT Eco Experimental Village.

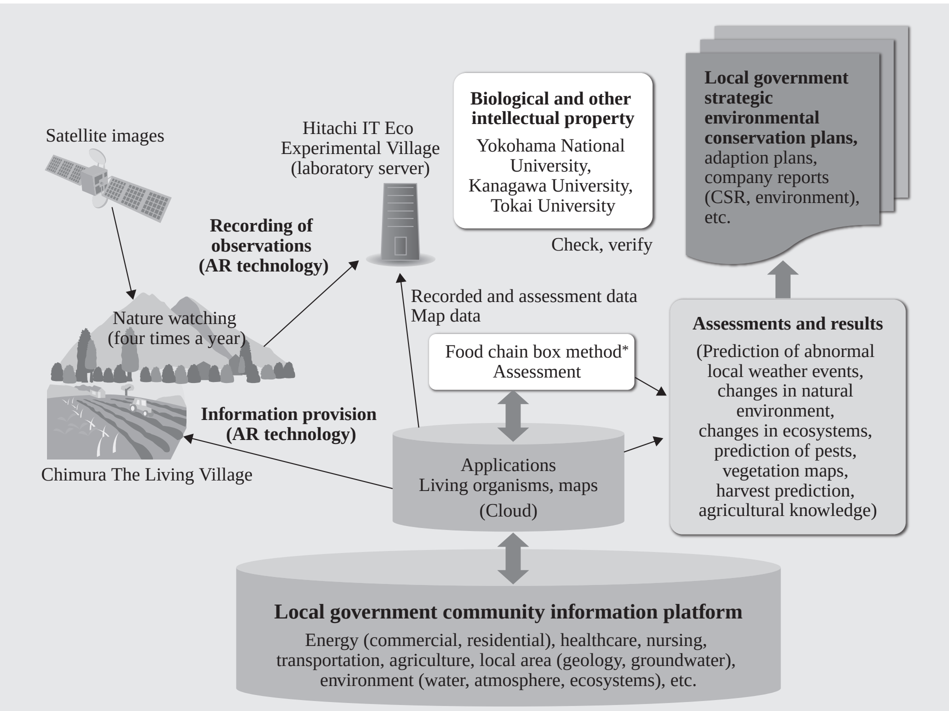
Fig. 8—Nature Watching Event Using IT.
Demonstrations were conducted involving the experimental use of augmented reality (AR) technology at a nature watching event in July 2012.

environment. The work of its ecosystem research group includes producing an electronic guide book of living organisms and research into a geographic information system (GIS) vegetation map and point evaluation using the food chain box method.

This initiative will investigate participation by residents in the collection of local environmental data to raise the visibility of ecosystem preservation. It is intended in the future to include embarking on the design of information platforms for regional conservation plans and for conservation work performed through collaboration between the region and catchment area, with the IT Eco Experimental Village to act as the venue for these experiments and data collection (see Fig. 9).

Measures Encouraging Greater Interest in Participation

Taking note of the views of participants, the IT Eco Experimental Village is considering what form it should take in the future to make itself more attractive. The aims and activities differ depending on whether it is used as a place for ecosystem preservation work and for companies to conduct environmental conservation and CSR activities, or as a place for conducting business experiments that utilize IT. Nevertheless, combining as it does people (land holders and participants), society, and nature, the IT Eco Experimental Village suits many different varieties of activity. In particular, it can be seen as having a role as somewhere where regional resources can be utilized to preserve the natural environment and also as a place for conducting CSR activities. Located in a region with an aging population and where farmland is becoming degraded and depopulated, the IT Eco Experimental Village has the potential to provide a CSR model for restoring natural habitats, and is pursuing a model



CSR: corporate social responsibility
* A simple method proposed by Professor Kawase of Kanagawa University for assessing a regional ecosystem based on a model for assessing the ecosystem pyramid by plant and animal species.

Fig. 9—Ecosystem Preservation and Uses for IT.
Overview of application to environmental conservation, adaption, and other planning involving the collection of observational data from daily nature watching events and integration with the local information platform.

based on collaboration between corporations and the community involving participation in activities such as the formulation of regional conservation plans.

In order to continue acting in a vigorous and sustainable way, the IT Eco Experimental Village intends to continue engaging on its own initiative in a higher level of social contribution, information sharing, and dialogue to meet the implicit and explicit demands of society, while also investigating how people and other organisms can coexist (a society able to coexist with nature).

CONCLUSIONS

This article has described the activities and experiments being conducted at the IT Eco Experimental Village, their application to business, the associated CSR activities, and plans for future expansion.

The IT Eco Experimental Village has been operating for two years since first opening. During this time it has engaged in ecosystem preservation work based on three objectives that are of value to companies, namely working with the community on nature restoration, raising awareness through staff participation, and the utilization of IT to conduct ecosystem preservation activities efficiently. Nearly 3,000 people have participated during these two years in activities such as nature watching or rice planting and other farm work events, working with not only company employees but also local schools and government. Although this means that the village has served to raise awareness of ecosystem preservation, its scope remains limited. Also, while it has succeeded in demonstrating through the analysis of the data collected from the environmental sensors installed at various locations in the village that it is possible to determine when to harvest rice based on cumulative temperature data, a decision that in the past was based on the experience of farmers, the specialist experiments, including the application of data, remain inadequate in some respects. Utilizing the results of these two years of operation, there is a need to produce more definitive results in relation to the three objectives and to establish more efficient ways of strengthening activities and providing benefits to the community.

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