TTC技術レポート
Technical Report

TR-1058

遠隔地域での
ICT ソリューション導入に向けた
ハンドブック

Handbook
to introduce ICT solutions
for the community in rural areas

第 3 版

2018 年 3 月 28 日制定

一般社団法人
情報通信技術委員会

THE TELECOMMUNICATION TECHNOLOGY COMMITTEE

＜参考＞

１．国際勧告等との関連

本技術レポートに関する国際勧告はない。

２．改版の履歴

版数	制定日	改版内容
第 3.0 版	2018 年 3 月 28 日	ケーススタディの追加 “e-Aquaculture (2) in Vietnam”
第 2.0 版	2016 年 2 月 16 日	ケーススダディの追加 “E-disaster risk management”
第 1.0 版	2015 年 3 月 10 日	制定

３．本技術レポートの作成について

TTC は 2007 年に普及推進委員会を設置し、アジア・太平洋電気通信共同体 (Asia-Pacific Telecommunity (APT)) の活動プログラムであるアジア・太平洋電気通信標準化機関 (APT Standardization Program (ASTAP)) に設置された標準格差是正エキスパートグループ (EG BSG) での討議に参加するとともに、アジアのルーラルエリアにおける ICT ニーズや有用性を把握するため、APT パイロットプロジェクトに参画し 3 カ国（インドネシア、マレーシア、フィリピン）・5 分野で ICT ソリューション実証実験を実施してきた。これらの討議・ケーススタディを積み重ねていく中で、ICT ソリューションをアジアのルーラルエリアに広く普及させるためには、他地域にも展開可能となるようルーラルエリア共通の要求条件や導入ガイドライン等を「ソリューション利用標準」として標準化し普及させる必要性があることを強く認識した。
本技術レポートは、これらの活動を通じて得られた知見をもとにして作成されたものである。

なお、2017 年 8 月に開催された ASTAP-29 に、本技術レポートをもとに "Handbook to Introduce ICT Solutions for the Community in Rural Areas” の改訂を提案した。この文書はレポートとして承認 (APT/ASTAP/REPT-13(Rev.2)) され、APT ホームページより参照可能である。

４．執筆者

本文書は BSG 専門委員会委員および実証実験プロジェクトを共に遂行した SHARE ミーティングメンバーが執筆した。

※SHARE ミーティング： “Success & Happiness by Activating Regional Economy” Meeting
BSG 専門委員会が主催する、ASEAN 各国（インドネシア、フィリピン、マレーシア、タイ、ベトナム）通信主管庁・大学関係者等との連絡会組織　　各国にて農業・水産業・教育・医療・環境等に関する ICT ソリューション導入パイロットプロジェクト等を実施

５．工業所有権

TTC の「工業所有権等の実施の権利に係る確認書」の提出状況は、TTC ホームページで公開されている。

６．標準策定部門

標準格差是正(BSG)専門委員会

HANDBOOK

TO INTRODUCE ICT SOLUTIONS

FOR THE COMMUNITY

IN RURAL AREAS

Revision 2

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1. Overview of the Handbook

This handbook summarises a selected list of projects which were conducted through the provisions of APT J2 and J3 programmes. The APT J2 programme is titled “HRD Programme for Exchange of ICT Researchers/Engineers through Collaborative Research” and APT J3 programme is titled “ICT Development Programme for Supporting ICT Pilot Projects in Rural Areas”.

The goal of these projects is focused on strategies to demonstrate how rural needs can be addressed by deploying state-of-the-art ICT solutions. The proponents from every country proposed to address specific areas in their country for rural deployment. In these projects e-Aquaculture, e-Education, e-Environment and e-Healthcare were proposed in the Philippines, Malaysia, Indonesia; with support and assistance from local project leaders, and through regular consultations and collaborative meetings, the other team members and Japanese collaborators shared in the development and deployment of each project work. There has been instances in which innovations in one country flowed quickly to another team in another country. An important feature of these SHARE projects has been the development of a strong local build to the programmes. To meet the goal, it necessitated careful site selection for each project to ensure long term reliability and local co-ownership of the projects. To achieve the collaborative goal within a short period designated for each project, every team leader thrived on already existing relationships with local governments or relevant organizations. In this way the local people became co-innovators in the SHARE project.

Each project was carried out in one country; however every solution and constructed network system is applicable and useful to other member countries as well. The sharing of inforamtion about experiences with local communities in each country is invaluable; it has helped shape the strategies to engage and to deploy solutions that aligned with the SHARE goals. In the handbook four projects are presented as case studies of solutions. Each project begins with an introduction to the local sites, analysis of problems, decision processes for the design of solutions, system configurations and a conclusive description about the outcome of each project.

1.1 Introduction

The Telecommunication Technology Committee (TTC) Promotion Committee began its activities in April 2007. Its philosophy was based on the slogan “Let’s SHARE -**Success & Happiness by Activating Regional Economy-** together.” Through cooperation among five countries in Asia (Indonesia, Malaysia, Philippines, Thailand and Vietnam), and with the support of the Asia-Pacific Telecommunity (APT), TTC has been conducting ICT pilot projects in rural areas, with solutions for social issues in Agriculture, Aquaculture, Environment, Health, Education and constructing Telecommunications infrastructure.

In the 14th meeting in June 2008, a Case Study Team (CST) was established in 2008, under the standardization gap, from the point of how to use the latest ICT for improving people’s lives and bringing more happiness in developing countries and how to implement latest technologies, systems and services at affordable cost toward that goal. These goals were realized through the development of various case studies enabled by APT funding, which were implemented in each country. The solutions created and deployed were extended to neighboring Asia countries upon completion.

In sum, SHARE members and CST were able to apply latest standardized technologies and systems to various applications and services through the collaborative experience in designing and developing innovative solution-based projects supported by APT’s J2 and J3 programmes.

SHARE members have selected the following five applications over ICT to be developed as the solutions for social issues in rural areas.

- e-Agriculture and Aquaculture
- e-Education

- e-Environment
- e-Healthcare
- e-Disaster Risk Management

Details about each solution are presented in the following sections.

1.2 Generic Model of SHARE Pilot Projects

Figure 1-1. shows the generic model for pilot projects demonstrated in rural areas of South-East Asia. The model centres on the building of sensor networks, to gather data which are measured by various sensors on a file server, and the processed data are sent to specialists in urban areas through the network. Specialists would then be able to analyse the data, and provide prompt feedback through the network, to enable efficient resolutions to issues faced on location.

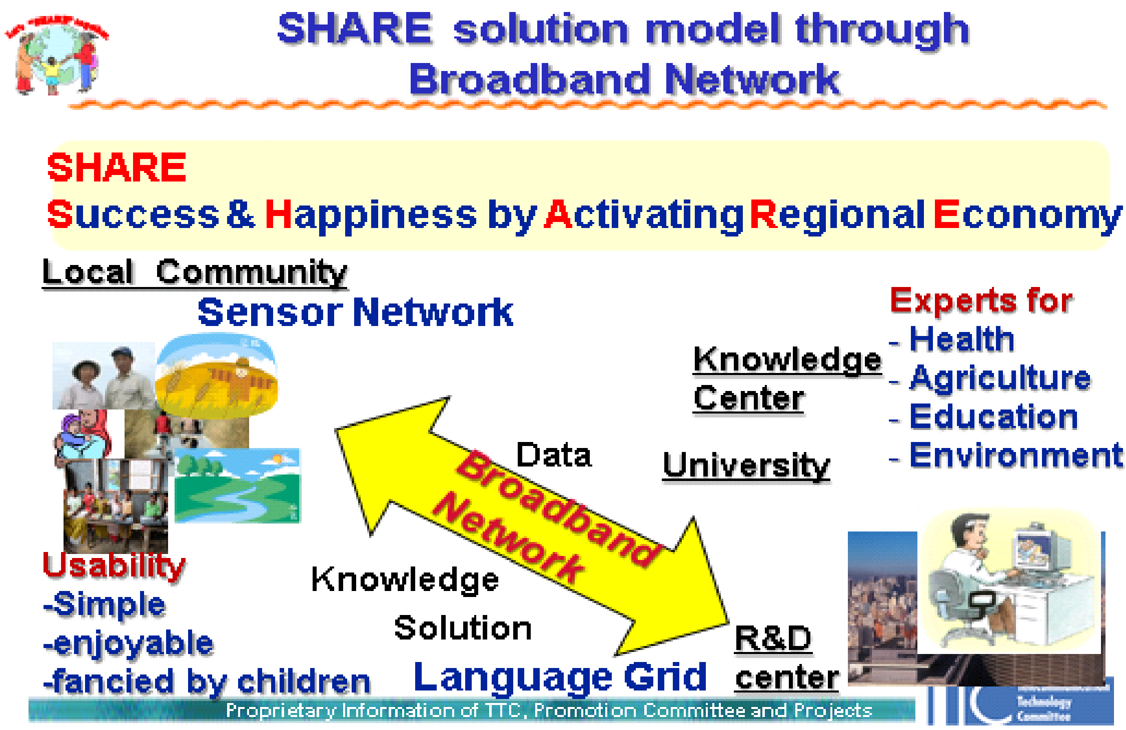


Figure1-1: SHARE solution model through Broadband Network

2. Case Study of Solutions

2.1 Aquaculture Solution in the Philippines

-APT J2 in the Philippines: “A Broadband Farm to Market Ecosystem for Fisher folk Communities”

-APT J3 in the Philippines: “Broadband Farm to Market Ecosystem for Fisher folk Communities”

The APT J3 project in the Philippines is the continuation of a previous study funded under the APT J2 Programme, which was conducted in CY 2009 to explore the technologies and protocol as needed with a view to designing the implementation (on a pilot scale) of an open access broadband farm to market ecosystem. The Project “A Broadband Farm to Market Ecosystem for Fisher folk Communities” cover activities leading to the pilot deployment and development of a network of sensors, field servers, ICT telecenters and knowledge management systems aimed at enabling a fully functioning research, social, economic and education ecosystem centered around the tilapia raising industry of a well-organized community of fisher folks in the Seven Lakes of San Pablo City, Laguna, Philippines.

2.1.1 Background of the Project

Aquaculture production in the Philippines rapidly grew in the last fifty years (Figure 2-1-1). It is important to note that Aquaculture production has increased twice of marine production (Fig. 2-1-2) and consequently requires strong support to expand further. At the project site, the seven lakes of San Pablo City Laguna, Philippines, has been diagnosed to have a lack of oxygen supply, leading to sudden killing of many fish. The project aims to reduce fish kill thathas been caused by oxygen deficiency in the lake since 2010, by monitoring water quality. The solution was to monitor the dissolved oxygen, conductivity, turbidity, and temperature of the water.

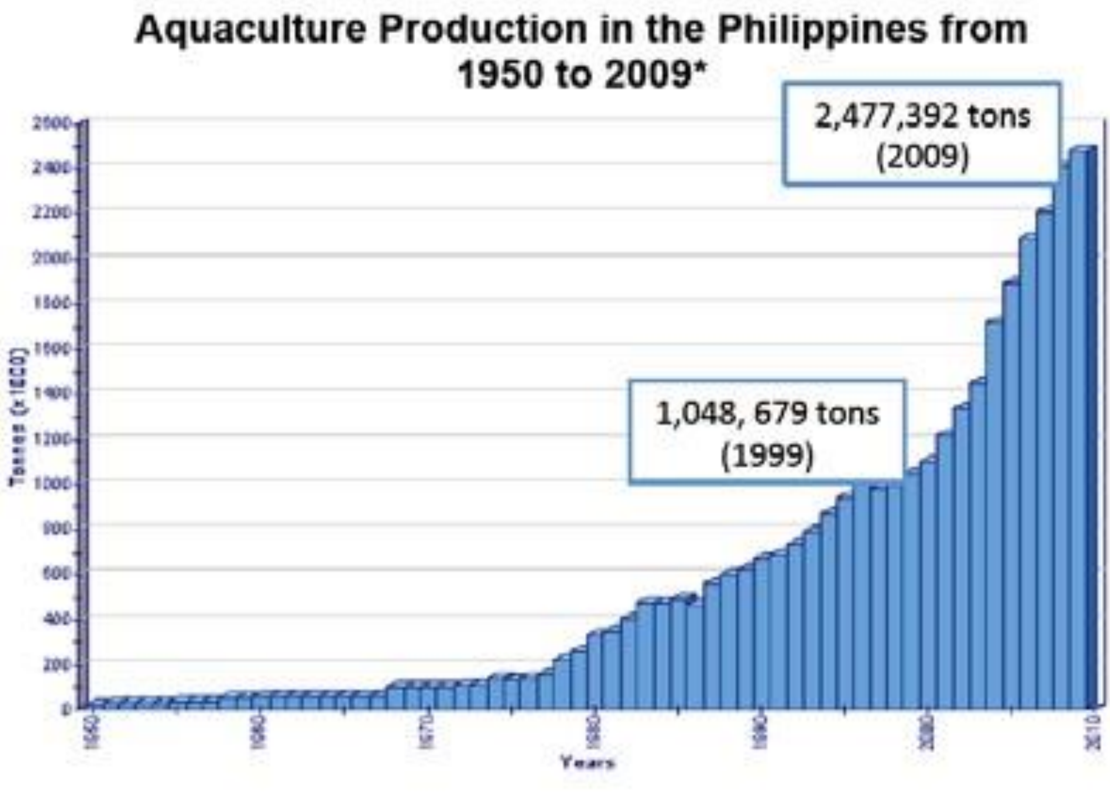


Figure 2-1-1: Aquaculture Production in the Philippine from 1950 to 2009

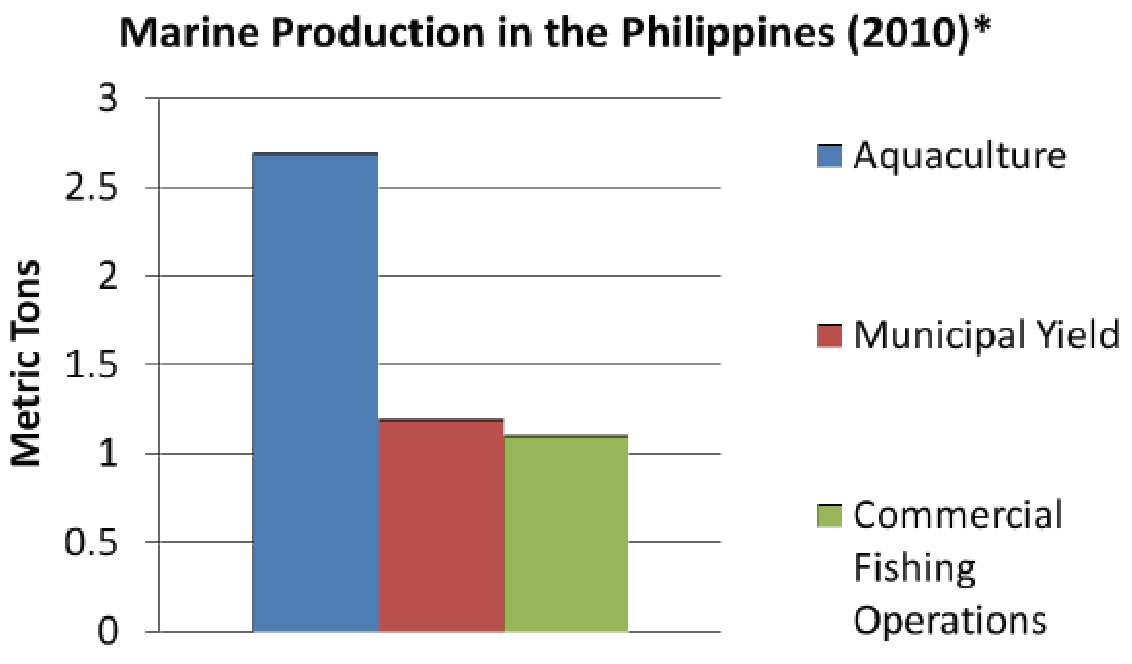


Figure 2-1-2: Marine Production in the Philippine 2010

2.1.2 Objectives

The fish kill problem is one of the biggest problems for fishing communities in the Philippines. Fish kills often happen when there is insufficient dissolved oxygen. Fully polluted water decreases gas absorption in water. Another cause for fish kill is over-feeding, which leads to increased biological demand for oxygen. At the project location, there also exists an issue about the multiple management of the lake resources, which caused misalignment in strategies to upkeep the fishing industry efficiently. The main aim of the project is to reduce fish kill that is caused by oxygen deficiency in the lake. The project constructed a sensor network that measured and monitored the dissolved oxygen level, temperature and transparency of the water. Furthermore it also builds a knowledge database that contributes to market growth and training the young fisher folks. In sum, the data can be viewed on a website in almost real time, enabling lake management best practice.

2.1.3 Project Site

Lake Palacpakin, located 14°06’771’’N and 121° 20’194’E in the city of San Pablo, Laguna is the second largest lake among the Seven Crater Lakes. It has a total surface area of 43 hectares and a maximum depth of 7.5 meters (MSC Technologies Inc., 1998b). It is bordered by the three barangays of San Buenaventura, San Lorenzo and Dolores. The inlet of the lake brings water in from Lake Calibato through the Prinsa River (Figure 2-1-3). Aside from rainfall, this river system is the only source of water for the lake. Water from the lake goes out into a connecting river, and eventually drains into the Laguna Lake.

Figure 2-1-3: Map of seven lakes area

Four sites were sampled, specifically;
Site 1 is at the inlet where water comes into the Palacpaquen from Lake Calibato;
Site 2 is at the pool beside the inlet, where there is relatively calm water;
Site 3 is on the periphery of the lake in between the inlet and outlet, and
Site 4 is at the lake outlet under the bridge.

2.1.4 Partner Organization

・Ateneo De Manila University, Philippines

・Department of Transportation And Communication, Philippines

・Congressional Committee On Science Technology And Education (COMSTE), Philippines

・The Telecommunications Technology Committee (TTC), Japan

・NTT-West, Japan

・Kasetsaart University & NECTEC, Thailand

・Tokyo University, Japan

・National Agricultural Research Office (NARO), Japan

・Agriculture Land Reform Office (ALRO), Thailand

2.1.5 System Configuration

This project designed, built and constructed a sensor network that measured and monitored the dissolved oxygen level, temperature and transparency of the water. Eventually, once internet connection is established in the deployment site, the floating field server would be stationed anywhere in the lake to monitor the different lake parameters. Figure 2-1-4 illustrates the network diagram of the field servers at Palakpakin Lake as the pilot deployment site. As part of the lake monitoring, an unmanned aerial vehicle equipped with camera were also deployed for map stitching and surveying to make sure that the carrying capacity of the lake was maintained.

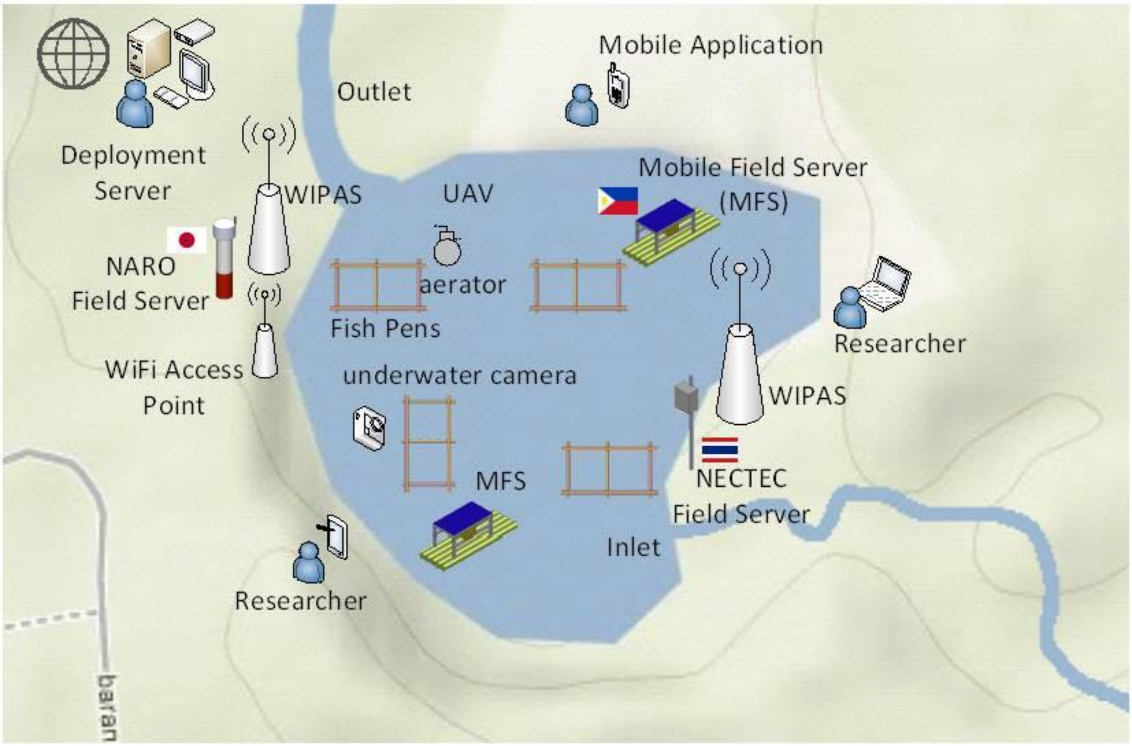


Figure 2-1-4: System configuration in Palapakin lake

The research team used each country's field server, specifically from Thailand and Japan. The Philippine's mobile floating field server was able to capture data about Dissolved Oxygen, conductivity, water temperature under 0.5 and 2.5 m and using GPS location. The Japanese Field Server was able to measure Dissolved Oxygen, pH, air temperature, humidity,-Built in IP camera. The Thai's Field Server-Measures was able to measure Dissolved Oxygen, pH, and humidity (Figure 2-1-5).

Figure 2-1-5: Field Server each country

Furthermore it also builds on a knowledge database that contributes to market growth and training the young fisher fork. In the information system the field server data are all displayed and often data (like pictures taken from the lake) can be added. Through the approach, the research team is able to demonstrate a lake management system.

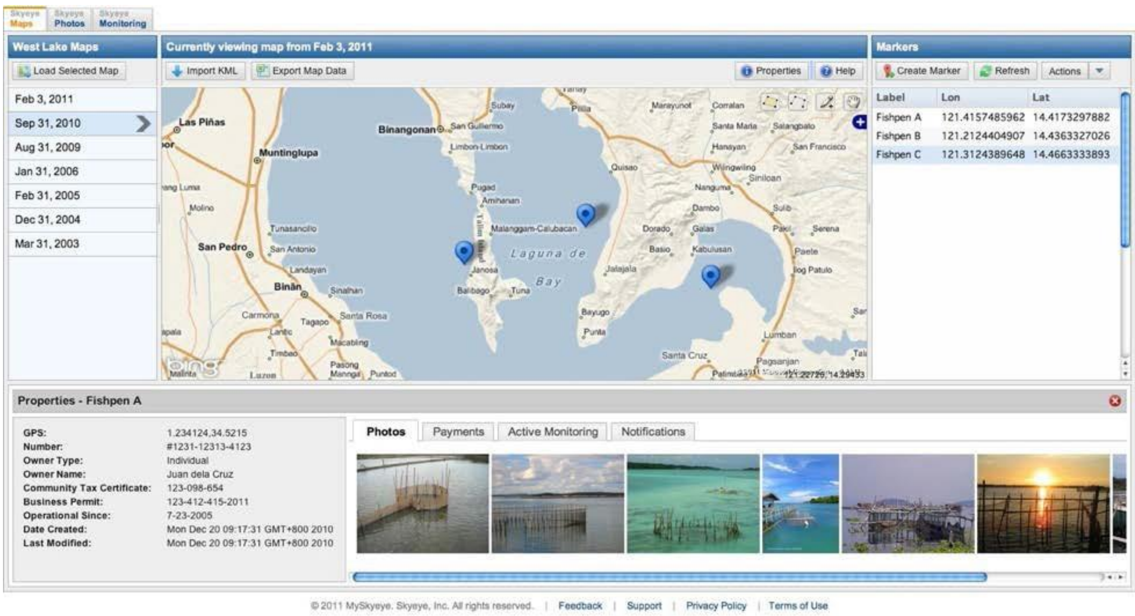


Figure 2-1-6: An information and knowledge base was developed from field servers data

2.1.6 Benefits of Introduction

Figure 2-1-7 shows a fishpond worker removing dead milkfish locally known as Bangus after thousands of them were found floating on Taal Lake in Batangas province, south of Manila, Philippines, recorded onSunday May 29th,2011. Losses from fishkill in northern Philippines are tremendous. Over 800 tonnes of fish die, and these losses from fish kill are estimated to be valued at P150 million. Our project is expected to help to stabilise aquaculture production and income for fisher folk through the Philippines, once standardized sensor systems are developed with full telemetry web information.

Figure 2-1-7:　800ton fish die in Taal Lake

2.1.7　Conclusion (Future Prospects)

A first cut network design has been completed. The sensor suite should include data on dissolved oxygen, conductivity, turbidity and temperature. First cut sub-system prototypes, the purpose of which would be to clarify design and implementation issues needed to be successfully deployed in such a system for the J3 Project Phase. After the project, AIC (Ateneo Innovation Center) continued the development of a newly developed system which has expanded the sensor system to include an aerator that pumps oxygen into the fish ponds, when they see the oxygen levels being really low, turn on aerator system by simply texting the field server.　All data appears on a website updated every 30 minutes.

2.2 e-Education Solution in Malaysia

-APT J2 in Malaysia: "Bridging the digital divide in Remote rural areas: a universal Playground for children"

-APT J3 in Malaysia : "Technology enhanced solutions for Remote rural communities in Malaysia to facilitate Development of Learning and Preservation of local knowledge and create health awareness and practice for healthy living"

2.2.1 Background of the Project

Bario is a remote rural location on the island of Borneo, close to the Malaysia-Indonesia border between Sarawak, Malaysia and Kalimantan, Indonesia. There are twelve longhouses in Bario which are homes to about 1,000 people. While there are many locations in Sarawak that can be categorized as remote rural, Bario was selected because of its isolated geographical location.

Before the Universiti Malaysia Sarawak's project commenced in 1999, Bario did not have 24-hour electricity supply and water was available only through gravity-fed systems. There was also no sophisticated telecommunication service available, and communication was largely conducted using radio calls, as well as by passing messages to departing passengers、 and getting messages from passengers arriving at the local airport.

In April 1999, UNIMAS started the e-Bario project with the general aim of bridging the digital divide between urban and rural communities. In order to achieve this, baseline data describing the technological needs and readiness of the Bario's community was obtained, and this was soon followed by the introduction of ICT to the community. The technologies deployed were VSAT (telecommunication system) which allowed the Internet connectivity to the Bario telecenter. Power is supplied by photo-voltaics (solar system) with computers there. Facilitated by UNIMAS e-Bario researchers, the people of Bario began connecting with the rest of the world using ICT, and this marked the first phase of the project implementation.

2.2.2 Objectives

This project proposed to implement a multifaceted approach to provide efficient technology-enhanced solutions for remote rural communities in Sarawak, Malaysia. Specifically, the objectives of the project are to establish a optical LAN infrastructure for two schools and a health clinic in Bario; to develop e-Education solution which serves as digital learning repository to complement formal teaching and learning experiences of the school community in Bario, Ba'kelalan, Long Lamai and Larapan Island; and to propose a sustainable health check system for use by community members in these identified remote rural communities in Sabah and Sarawak.

The optical LAN infrastructure is an important linkage that will enable the other two solutions (i.e. e-Education and e-Health) to be developed in these remote rural areas. The e-Education solution aims to design and develop a digital learning repository in five areas of interest: health sciences, ICT, communication, living skills, and indigenous knowledge and culture. The e-Health check system is to be introduced to children and young adults in the community, to raise awareness about regular health checks which need to be performed periodically to detect and monitor common illnesses.

Overall, the objectives of the project state that:

- Implement a multifaceted approach to provide efficient technology-enhanced solutions for remote rural communities in Sarawak, Malaysia
- Establish optical LAN infrastructure for schools and health clinic in Bario to enable

Develop an e-Education solution which serves as digital learning repository to complement formal teaching and learning experiences of the school community in Bario, Ba'kelalan, and Long Lamai in Sarawak and Larapan Island, Sabah

Develop an e-Health solution to provide a sustainable health check system for use by community members in these identified remote rural communities in Sarawak and Sabah.

Document the impact of e-Education and e-Health solutions on educational experiences and health awareness of the community members in these remote rural locations

2.2.3 Project Site

The project is mainly conducted at Universiti Malaysia Sarawak (UNIMAS) campus in Kota Samarahan, and Bario, the Kelabit Highlands. Figure 2-2-1 is a map of Sarawak indicating the locations of both venues

Figure 2-2-1: Location of Bario and Kuching on the Borneo map

Bario is a remote rural location on the island of Borneo, close to the Malaysia-Indonesia border between Sarawak, Malaysia and Kalimantan, Indonesia. The only practical way to get to Bario is a one-hour flight on a 19-seater Twin Otter airplane from Miri, Sarawak. At present, there are no gravel roads leading into Bario, and a land journey requires a river journey and a 14-day-long trek across forested mountains.

The majority of the people in Bario are Kelabits, one of the smallest ethnic groups in Sarawak. They are generally farmers, growing the famous organic, fragrant Bario rice, and the sweet highland pineapples. While there are many locations in Sarawak that can be categorised as remote rural, Bario was selected because of its isolated geographical location.

The Bario children go to the Bario Primary School which provides education from Primary 1 to Primary 6 or age 7-12. Bario Secondary School provides education from Form 1 to Form 3 (ages 13-15) only. When students finish school in Bario, they have a choice to either go to two nearby towns, Miri or Marudi, to continue their studies. Most students attending the primary and secondary schools in Bario stay at the school dormitories because their own homes are miles away from the location of the schools. Today, the schools have received a growing number of Penan (who practice nomadic values and way of living) and Sabans (who migrated from another remote rural area for socio-economic needs), and both of these ethnic groups are of minority ethnic in Sarawak, living within close proximity to the Bario Highlands.

2.2.4 Partner Organization

- Universiti Malaysia Sarawak (UNIMAS), Malaysia
- The Telecommunication Technology Committee (TTC), Japan
- NPO Pangaea, Japan
- Japan Advanced Institute of Science Technology (JAIST), Japan
- Nippon Telegraph And Telephone Corporation (NTT), Japan
- Mitsubishi Electric Corporation, Japan

2.2.5 System Configuration

2.2.5.1 Fibre Optic Network

Figure 2-2-2 shows the schematic view of optical fiber network in Bario. We installed optical fiber from telecenter (eBario) to primary and secondary school and from telecenter to New hospital and current clinic.

One fiber count optical drop cable was used for aerial and one fiber count indoor optical fiber cable with SC connector was used for indoor. The existing poles once built for an abandoned hydropower supply plan were utilized to lay on optical fibers, Optical splitter is located at the pole between primary and secondary school and the pole between new hospital and current clinic, respectively. Total fiber length is about 2.5 km from eBario to secondary school, about 2.3 km from eBario to primary school, about 500m from eBario to a new community clinic, and about 200m eBario to the existing clinic, respectively.

Bario Optical Fiber Network Configuration

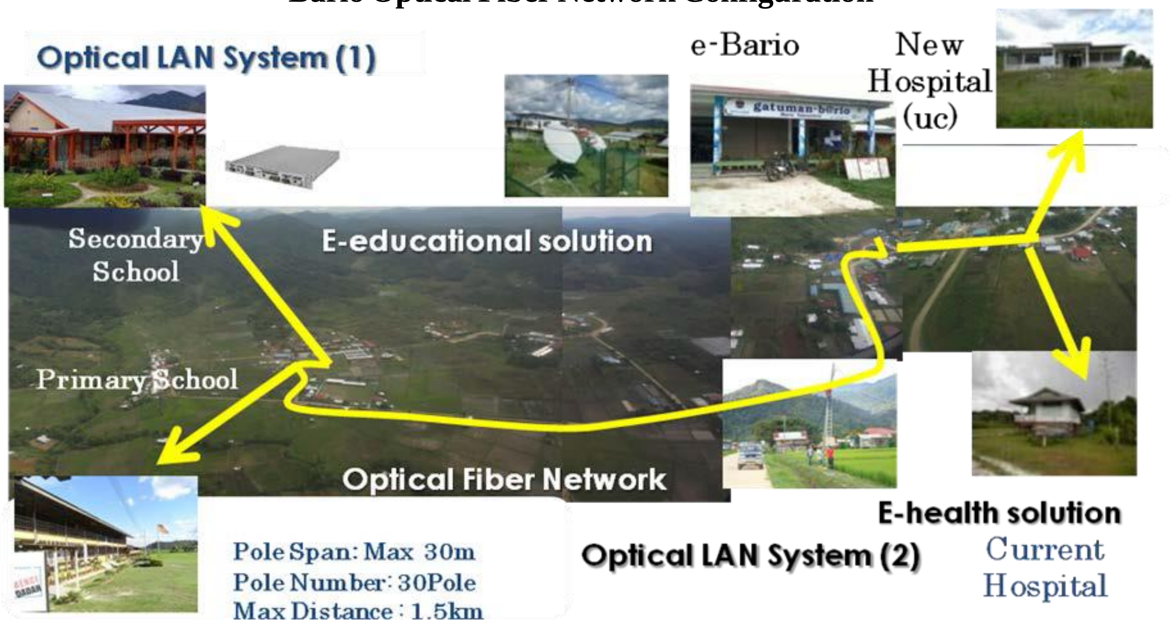


Figure 2-2-2: Optical LAN System

2.2.5.2 Optical Network System

Figure 2-2-3 shows the GE-PON network for APT J3 Malaysia Project at Bario. The GE-PON network is constructed over the optical fibers laid by Commuture in October, 2011. As shown in the figure, the GE-PON network consists of the following two PON lines:

Line A from TeleCenter to the Primary School and the Secondary School, and Line B from TeleCenter to the Current Clinic and the New Hospital.

Both Line A and Line B are terminated at the local telecenter by the OLT (Optical Line Terminal). The OLT relays packets over Line A or Line B to a server or a router via a L2 switch. The other ends of Line A and Line B are terminated by ONUs. An ONU has a LAN port to accommodate a PC, an L2 switch, or a WiFi BTS.

Bario Network System Configuration

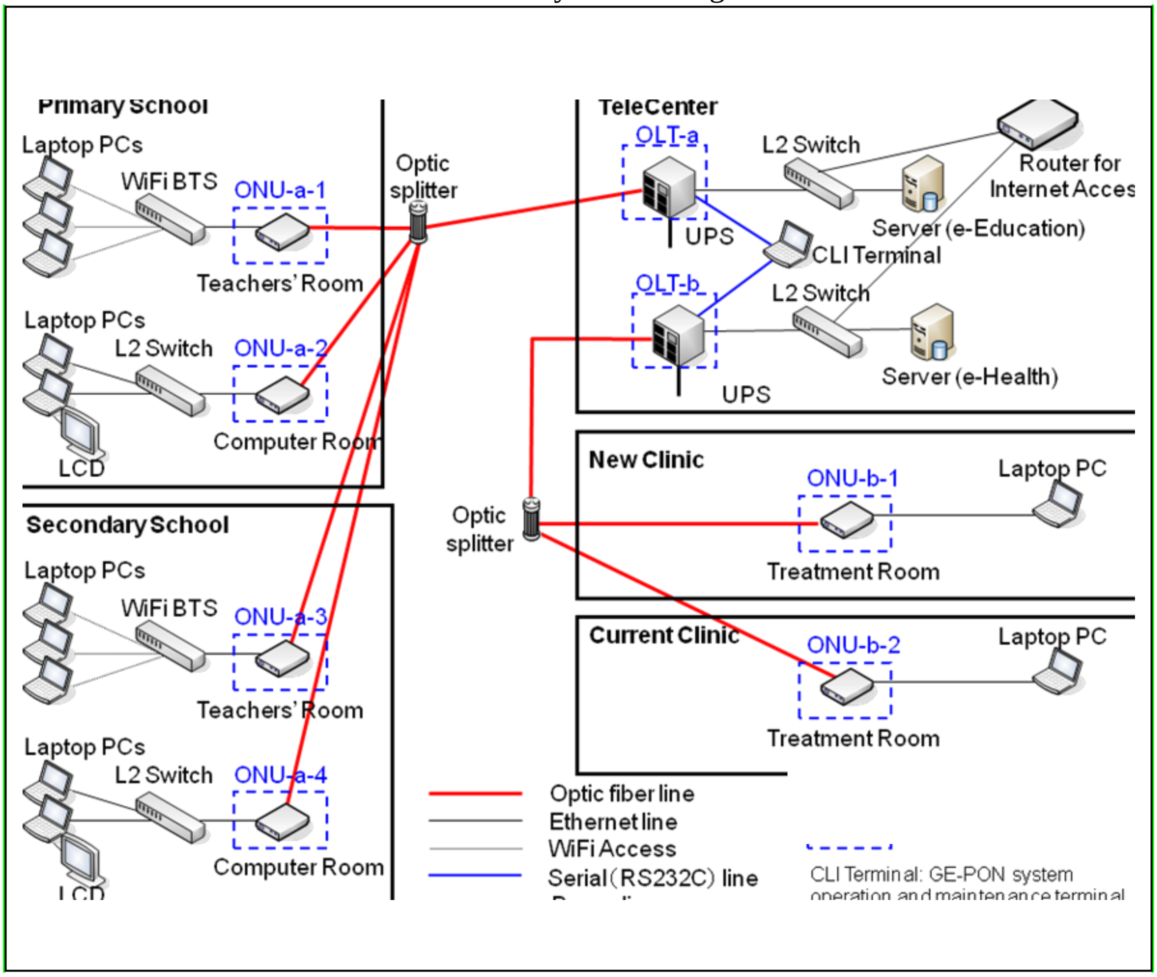


Figure 2-2-3: Bario Network System Configuration

2.2.5.3 WiFi Implementation

At the ONU termination in the two schools, the network connection was further extended to the common student activity areas via WiFi access point. The tablets required WiFi connection to the network as that is the only means to connect. WiFi access point allowed multiple tablets to connect to the GE-PON network concurrently. The WiFi access points deployedwere compliant to the IEEE802.11n standard for supporting maximum data rate to take advantage of the higher performance GE-PON system installed. The WiFi coverage was within 50 meters from the WiFi access point.

2.2.5.4 Server Implementation

There was a total of four servers being deployed in the e-Bario telecentre for various applications provision over the GE-PON network. The application servers are as follow.

a) e-Health Database Server

b) Viscuit Application server

c) Education Moodle Server

d) Backup Server for e-Health Database

Among the deployed servers, the e-Health Database server is a standard desktop computer comes complete with a monitor display, keyboard and mouse. The server is running on Ubuntu platform.

The Viscuit Application server is a notebook computer that hosts all the proprietary Viscuit application services. Viscuit enables users who is not familiar with computers to create graphical animation by utilizing drawing tools. The advantage of using Viscuit is to teach users the fundamental concepts of basic programming.

The E-Education server runs on a Windows platform. The server hardware utilizes the green computing concept or known as green server in that it is able to utilize energy, either from the telecentre, or from its own dedicated solar panel and battery system. The green server is a highly power optimized computer system built from Intel Atom processors and other power optimized system components such as solid state drive etc. Its power supply system is designed for native solar power input to take advantage of minimizing the power conversion loss throughout. The power of Green Computing System is supplied through a customized portable solar charging system with battery that can be installed almost instantly anywhere due to is small in size (battery and controller box dimension is around 10" x 12" x 7" and solar panel size is around 4' x 2.5').

The backup server for e-Health solution is a replica of the e-Health database server where its hardware is similar to that used by the E-Education server, which adopts the Green Computing System.

2.2.5.5 Solar Power Implementation

A separate solar power system was designed and deployed as additional electrical power input for the e-Bario telecentre. Figure 2-2-4 shows the solar panel, which is installed on the telecentre's rooftop. The size of this solar power system is 1.3kW. The main purpose of the system is to provide power specifically for the network equipment such as the GE-PON, switches, routers and servers deployed for the project. This solar power system is separated from the main telecentre solar power system in order to prevent single point power outage in the telecentre that maycause power blackouts to the critical network equipment. Hence, connectivity reliability can be further improved.

Figure 2-2-4: Solar panel installation on bario telecentre's rooftop

2.2.6 Outline of the Solution

2.2.6.1 e-Education system

There are several outputs identified for this aspect of the Digital Learning Repository (DLR). These are the features available on the E-Education system:

a) Creating an Android application which will be the primary input tool for the children to capture data and content

b) Creating a customized access and interface to an open source Learning Management system, which will be used to assemble and further develop the data and content captured by the children

c) Creating a user-friendly localized version of Viscuit, an open source application for children which teaches them to learn about basic computer programming using drawing tools

To best understand the process of data collection and processing between users and stakeholders in the project, an illustration of the scope of work for this project is presented in Figure 2-2-5.

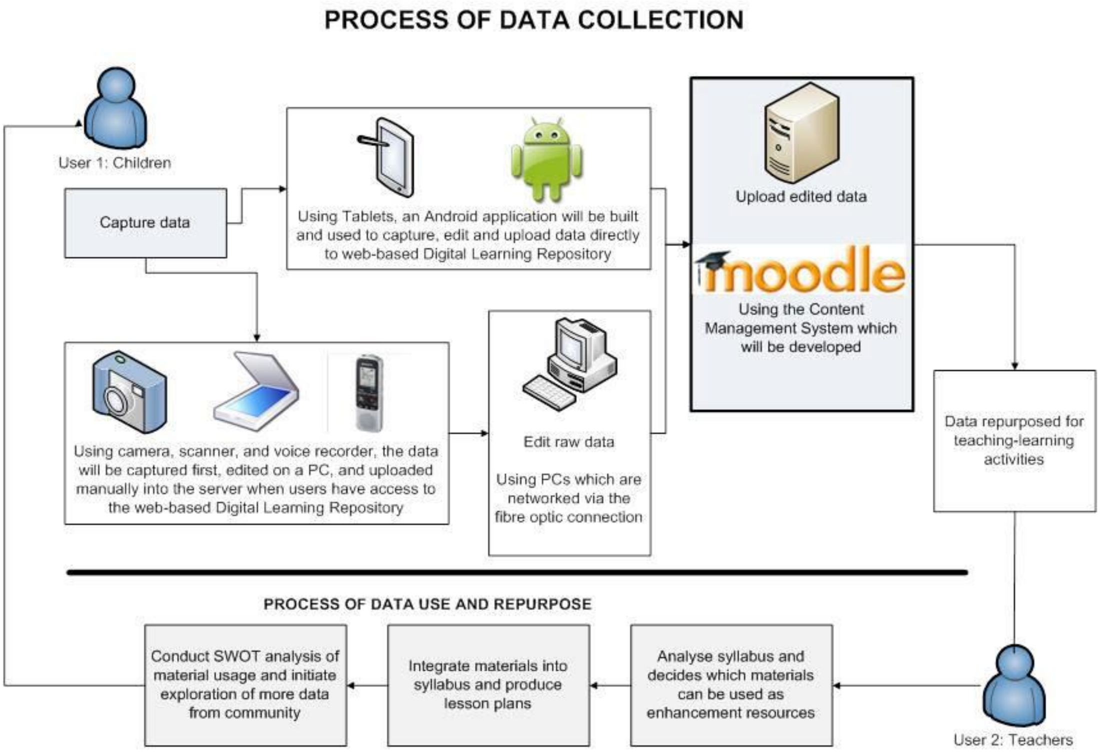


Figure 2-2-5: Process of Data collection

2.2.6.2 e-Health Check system

The e-Health check system for this project is designed to record basic health data (height, weight and blood pressure) of the local population. The system is developed by researchers in JAIST, and it was introduced to children and young adults in the community to raise awareness about regular health checks which need to be performed periodically to detect and monitor common illnesses.

During the installation of the system, community members from a village called Ulong Padang in Bario learned how to use all the health equipments packaged in the E-Health Check system. They were also taught how to create a health check database, which records individual weight, height and blood pressure measurements of people in the local community. Using the fiber optic network, the data collected from users could be transmitted to the local health clinic, and the medical officers could be alerted if there was any anomaly in the data. With a systematic database of information available, dissemination of important health information and interventions can be deployed in a more strategic and sustainable manner.

2.2.7 Benefits of Introduction

2.2.7.1 e-Education

The project enabled the children of a remote rural community in Bario to utilise technology to preserve elements of their culture, language, traditional songs, local myths and living legends into a digital form. The children are able to complement what they learn in school by adding on knowledge from their own local values and culture. The fibre network connection connected the children from their schools to the local telecentre, which opened new ways for them to connect with the rest of the world.

Their teachers at the schools also benefited from the availability of the mobile tools and applications and internet connection as well, because they are now able to use digital resources to strengthen the contents of their lessons. With the children’s activities using the mobile technology tools, the teachers are also able to tap into the children's digital products and integrate the contents with topics they teach in the classroom.

Children and teachers in Bario are encouraged to use the mobile tools as much as possible, and they are not confined to only activities designed for the programme, in order to maximise the potential of mobile learning for learning and teaching.

2.2.7.2 e-Health

The introduction of E-Health Check system which includes patient monitoring system, intends to promote health awareness among the communities in Bario. Since the elderly make up the majority of the local population, plus the lack of professional health personnel on a permanent basis in Bario, health monitoring is a key concern for Bario residents.

The Health Check system was designed by researchers in Japan, and it was deployed earlier at Tanah Datar province in West Sumatera, Indonesia. The same set was introduced in Bario, to enable the local community to conduct and manage their own health checks at their convenience. The Bario community has one health clinic established at the heart of Bario, and medical officers are flown in every two weeks to conduct physical checks on those in need.

With the introduction of the E-Health Check System, the community was excited to know about their health status. They were pleased that they were able to conduct their own checks, and data from the checks were transmitted to the Health Check database located at the local clinic. It enabled a systematic record of health checks, making it easier for medical officers to obtain records about the health of people in Bario.

2.2.8 Conclusion

This pilot project was the first trial to introduce fiber optic network into rural areas in ASEAN countries and indicated its effectiveness. The research team continues to learn and to seek solutions using ICT to help extend the indigenous knowledge and culture of these communities to enable them to prosper and improve their lives and well-being even when living in remote rural locations. The focus remains on developing the ICT literacy skills and knowledge of children in remote rural areas, because these children are the hopes of their unique communities to propel their social, economic , cultural and intellectual developments into the future.

2.3 e-Environment Solution in Indonesia

-APT J2 in Indonesia: "Exploration of ICT's Potential in Peatland Environmental Conservation to Address Climate Change"

-APT J3 in Indonesia: "Promotion of e-environmental community with ICT solution in Central Kalimantan, Indonesia"

2.3.1 Background of the Project

In the later half of 1990's the development of peatland in Central Kalimantan, Indonesian Government planned and executed Mega Rice Project (MRP) as a measure in tackling poverty issue. However, it caused environmental destruction of peatland that entailed the social issue of the restoration and conservation of peatland.

Failure of the MRP was caused by unrealistic dimensions of channels, ignoring local knowledge and culture, and it has consequently affected peatland to become very dry in dry season and very susceptible to peat fire, which subsequently produced a large amount of CO2 every year. Thus, deforestation and the degradation of peatland have been the main causes for Indonesia being one of the world's largest emitter of greenhouse gases. Air pollution by peat fire smoke has been threatened human health of neighboring countries.

As the counter-measure to restore the peatland, University of Palangka Raya, through the Center for International Cooperation in Sustainable Management of Tropical Peatland (CIMTROP), has been working for the restoration of the peatland around the university premises for more than 15 years. One of its main activities is to construct the simplified dams on the canals to maintain the water level of the peat land to avoid peat fire from occurring.

However, researchers must personally attain access to the dam sites for observation and information or data gathering, whilst the sites are rigorously challenging to gain access to, and the effort is time consuming.

Thus, it is considered essential to establish a remote monitoring system using ICT technologies, which will make the process of the operations quicker, more efficient, and a set of data series could be recorded.

2.3.2 Objectives

To establish a remote monitoring system for dams and the peatland using ICT technologies, CIMTROP, KOMINFO (Ministry of Communication and Information Technology), and TTC performed APT J2 project APT J3 project.

The projects aims:

1) To conduct a feasibility study towards the establishment of the ICT remote monitoring system at rural area. The ICT remote monitoring system is to monitor a simplified dam and peatland so that the researchers can see the visual image of the dam and get the information of the water level remotely at the new data center where the research team of University of Palangka Raya has the facilities for his activities.

2) To encourage young researchers to become familiar with the remote monitoring system and also to enhance and improve their understanding, knowledge, and skills about ICT technologies

3) To integrate soil sensors at a new monitoring point and to make a test of a new firefighting agent that is expected to act as a preventive measure as well as a counter measure for peat fire.

4) To establish a telecenter where the students and residents will be educated on knowledge about

ICT, for instance, the various uses of the Internet and the use of technology for environmental conservation.

5) To share the data collected from the system with joint researchers in the Asian countries.

2.3.3 Project Site

Figure 2-3-1: Location of the Project in Perspective to Larger Indonesian Map

The basic operation of this project is conducted at the site of University of Palangka Raya, in close proximity to Palangka Raya city, the capital city of Central Kalimantan Province, as shown in Figure 1. It takes around 1.5 hours by plane from Jakarta to Palangka Raya. Based on 2010 population census, the population of the municipality stood at 220,223.

As shown in Figure 2-3-2, the project site is located between the two big rivers; Kahayan River and Sabangau River, and canals that were made to drain the water to those rivers from the peatlands that were designated to be developed into rice field as stated on Mega Rice Project objective. Therefore, the peat became dry and consequently it became susceptible to fire.

Figure 2-3-2: Map of Palangka Raya and Pulang Pisau Regencies

2.3.4 Partner Organization

・University of Palangka Raya (UNPAR)

・A center for international research collaboration for tropical peatland (CIMTROP).

・Ministry of Communication and Information Technology (KOMINFO)

・The University of Kitakyushu, Japan

・The Telecommunication Technology Committee (TTC), Japan

・Nippon Telegraph and Telephone Corporation (NTT), Japan

・NEC Corporation, Japan

2.3.5 System Configuration

The ICT Network configuration is shown in Figure 2-3-3. In the 2010 APT-J2 project, one Data Center and three monitoring points, A, B, and C have been constructed. The Data Center was established specifically with a data server to compile the data sent from the towers. Four 25m Towers were erected, one at the Data Center and three at the designated measuring point A, B and C to establish radio link.

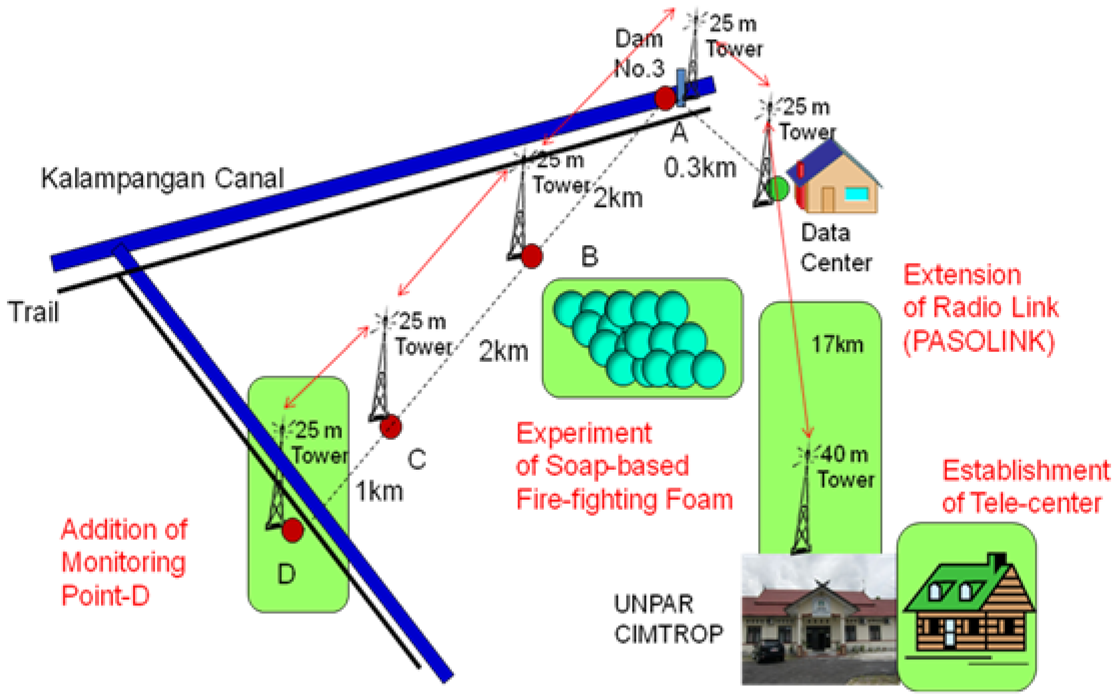


Figure 2-3-3. Network Configuration of Remote Monitoring System

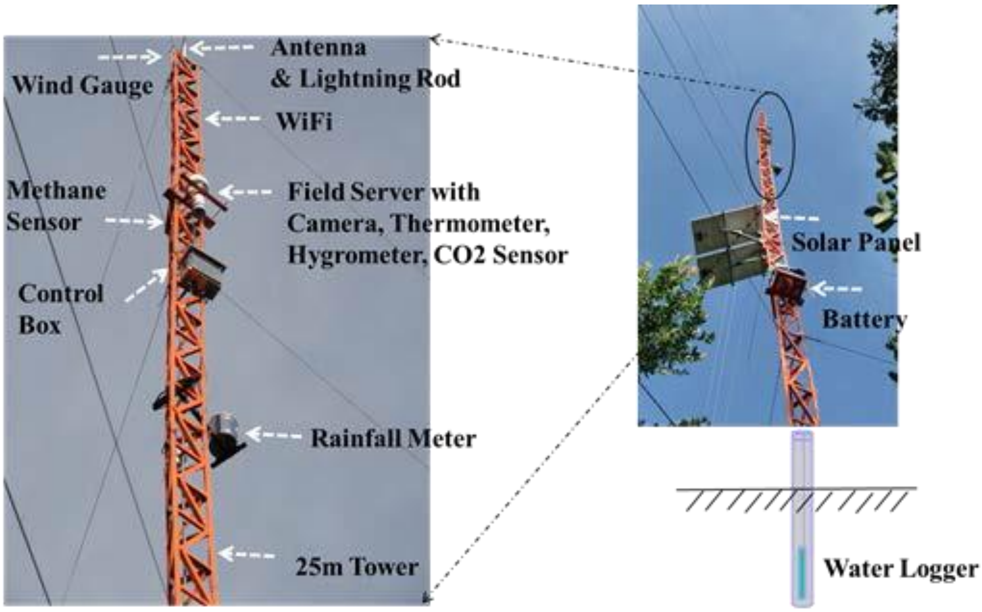


Figure 2-3-4:　Tower at Measuring Point A,B and C

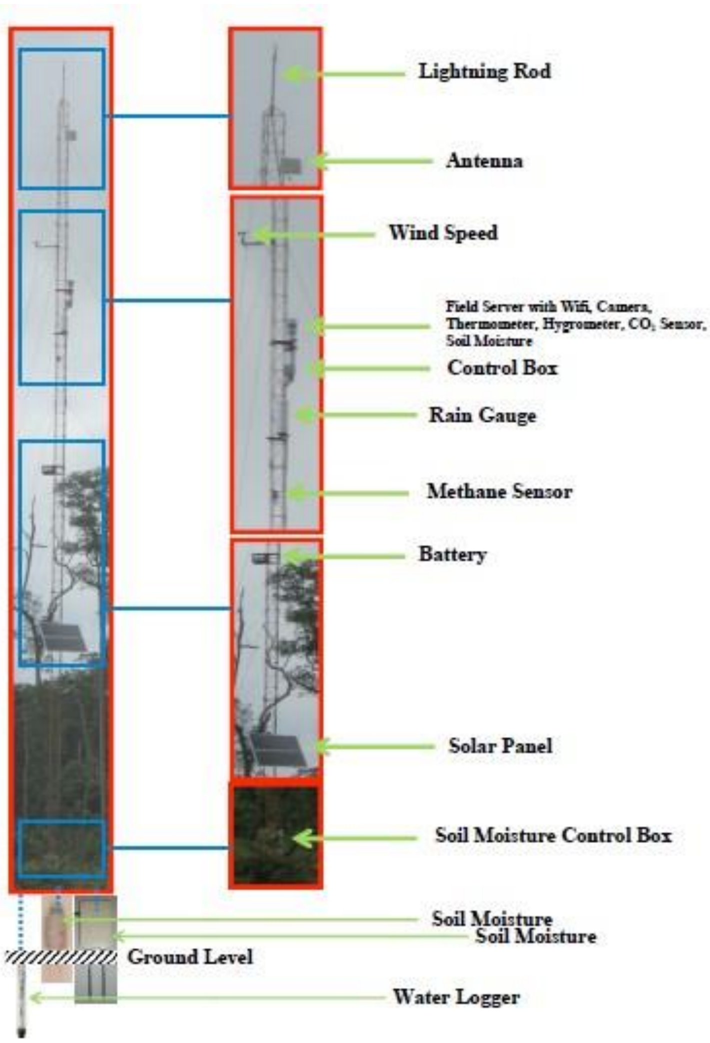


Figure 2-3-5 Tower at Measuring Point D

The equipment was mounted on each tower which consists of a water level sensor in the water, a field server, solar panels with battery, and WiFi equipment for radio system.

The field server is also equipped with WiFi interface and also consists of a thermometer, a hygrometer, a rain gauge, an anemometer, a CO2 sensor, a methane sensor.

In 2011APT-J3 project, Point D was newly provided, which lies on the extension of the straight line from Point A to C and is located in the natural forest near Taruna Canal. In order to evaluate the effect of the fire-fighting foam, the soil sensors were installed at Point D.

A high speed data link, which is called PASOLINK system, was installed to connect the Data Center and CIMTROP office, so that all the collected data at Data Center are transmitted to the data server in CIMTROP office.

The list of the equipment and materials provided in this system is shown in Table 1.

Table 2-3-1: Equipment and Materials List

No.	Item	Quantity
1. Field Server		
1.01	Field Server	4
1.02	Thermometer	4
1.03	Hygrometer	4
1.04	Rain Gauge	4
1.05	Anemometer	4
1.06	CO_2 Sensor	4
1.07	Methane Sensor	4
1.08	Solar Panel	4
1.09	Battery	4
1.10	Battery Charging Controller	4
1.11	WiFi Equipment	5
1.12	Software to Display the Collected Data	1
1.13	Accessories	1 lot
2. Hydrograph		
2.01	Water Level Sensor	4
2.02	Connecting Cable	4
2.03	RS232C-USB Conversion Cable & Software CD	1
3. Data Logger		
3.01	Data Logger	2
3.02	Soil Moisture Sensor	2
3.03	USB Adapter Cable	2
3.04	ECH2O Software CD	2
4. Data Server		
4.01	Laptop	2
5. 25 m Tower		
5.01	25 m Tower	4
5.02	40 m Tower	1
6. Soil Sensors		
6.01	Thermocouple Thermometer	3
6.02	Exchanger	3
6.03	Transmitter	3
6.04	50 m cable	2
6.05	Soil Moisture Sensor	3
6.06	25 m cable	4
6.07	5 m cable	3
6.08	Basic Logger	1
6.09	TDR Soil Moisture Sensor	1
6.10	Logger Net-software	1
6.11	Case	1
6.12	USB-RS232C Exchange Cable	1
6.13	Accessories	1

6.14	Nozzle for Fire Hose	1
6.15	Computer for Data Analysis	1
6.16	Magnetic Stirrer	1
6.17	Ultracold Freezer	1
6.18	pH Electrode	1
7. PASOLINK Subsystem		
7.01	Indoor Unit	2
7.02	Antenna High Performance Single Pole	2
7.03	ODU-IDU IF Cable	2
7.04	Rectifier Unit	2
7.05	Installation Materials	1
8. Data Server & Software for Telecenter		
8.01	Desktop PC as Data Server	1
8.02	Desktop PC as Data Server for Telecenter	1
8.03	Desktop for Telecenter	1
8.04	Contents Development, Equipment, and Consultation	1

2.3.6 Outline of the Solution

a) Through the APT J2 project and J3 project, a remote monitoring system that gets data from all measuring points without having to access the actual site was developed. The following components were completed in the J2 project.

- A new Data Center Building
- Five units of painted towers (25 m) with fence at the Data Center, with four measurement points at Point A, B, C, and D
- Four data loggers for water level measurements at Point A, B, C, and D
- The sensors for the measurement of temperature, humidity, wind speed, rainfall, methane amount, and CO_2 amount at Point A, B, C, and D
- Video camera at Point A, B C, and D; wireless equipment at each tower

b) The following components were monitored at each point and transmitted through WiFi radio link to the data server installed at the Data Center.

- Water level of the canal (at Point A) and of the peatland (at Point B, C and D)
- Rainfall, external temperature, humidity, wind speed, and CO_2 and methane amounts
- Soil temperature and water content (at Point D)

Table 2-3-2: Typical Data of Measured Components [temperature, humidity, wind speed, methane and rainfall]

Time	CH1	CH2	CH3	CH4	CH5	CH6	CH7
	Temp.	Humidity	Wind Speed	CH4	CO2	Rainfall	Water Level
	(℃)	*(RH%)*	*(m/s)*	*(ppm)*	*(ppm)*	*(mm)*	*(mm)*
28/12/2012 6:44	30.31	22.05	3.29	0.54	998.9	1215	167.58
28/12/2012 7:43	29.49	20.37	0	0.55	998.9	1215	176.97
28/12/2012 8:43	31.62	20.45	63.13	0.54	728.1	1215	185.03

28/12/2012 9:15	28.99	20.02	62.79	0.53	672.6	1215	179.46
28/12/2012 10:15	31.74	19.65	62.65	0.52	512.4	1215	188.61
28/12/2012 11:15	34.31	20.75	0	0.48	514.5	1215	203.95
28/12/2012 12:15	30.91	18.86	0.85	0.47	610	1215	189.99
28/12/2012 13:15	27.58	19.7	1	0.55	804.5	1215	173.36
28/12/2012 14:15	28.74	19.92	0	0.55	927.7	1215	175.73
28/12/2012 15:15	30.33	19.38	63.52	0.54	660	1215	185.5

Note: #Rainfall data is cumulative. The same rainfall value means there was no rain.
#Water level data is the depth from underneath the canal to the water surface.

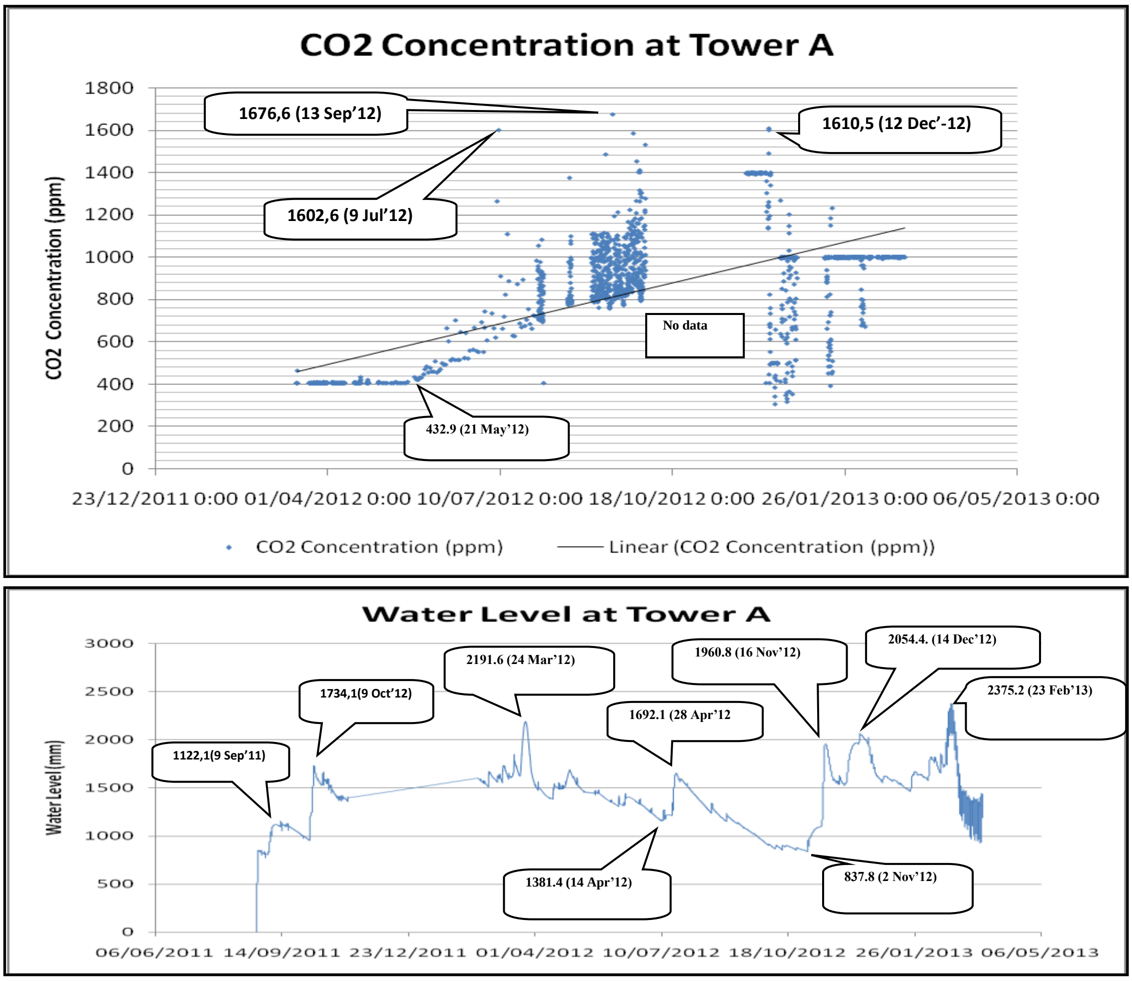


Figure 2-3-6: CO_2 Concentration and Water Level Fluctuation at Tower A

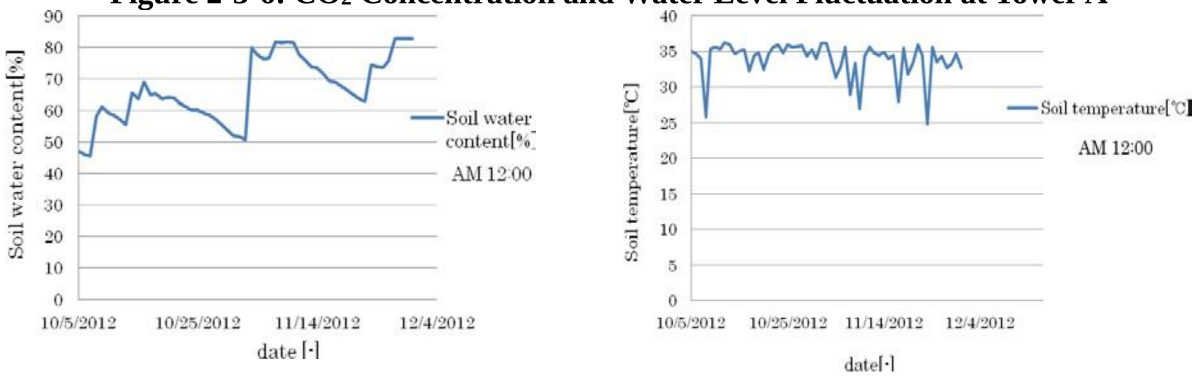


Figure 2-3-7: Soil Water Content and Temperature at Point D

Visual Image at Tower A

Visual Image at Tower B

Visual Image at Tower C

Visual Image at Tower D

Figure 2-3-8: Visual Image from the Tower at Each Measurement Point

c) A high speed data link, which is called the PASOLINK system, was established to connect the Data Center to the CIMTROP office so that all the data collected at measurement points A, B, C, and D may be monitored at the CIMTROP office in University Palangka Raya.

d) To test a new firefighting method, an experiment using soap-based firefighting foam was conducted on the peatland. The soap-based fire-fighting foam was newly developed in Japan and is expected to prevent and extinguish peat fire. The effect of the fire-fighting foam is monitored by the soil sensors installed at Measurement Point D.

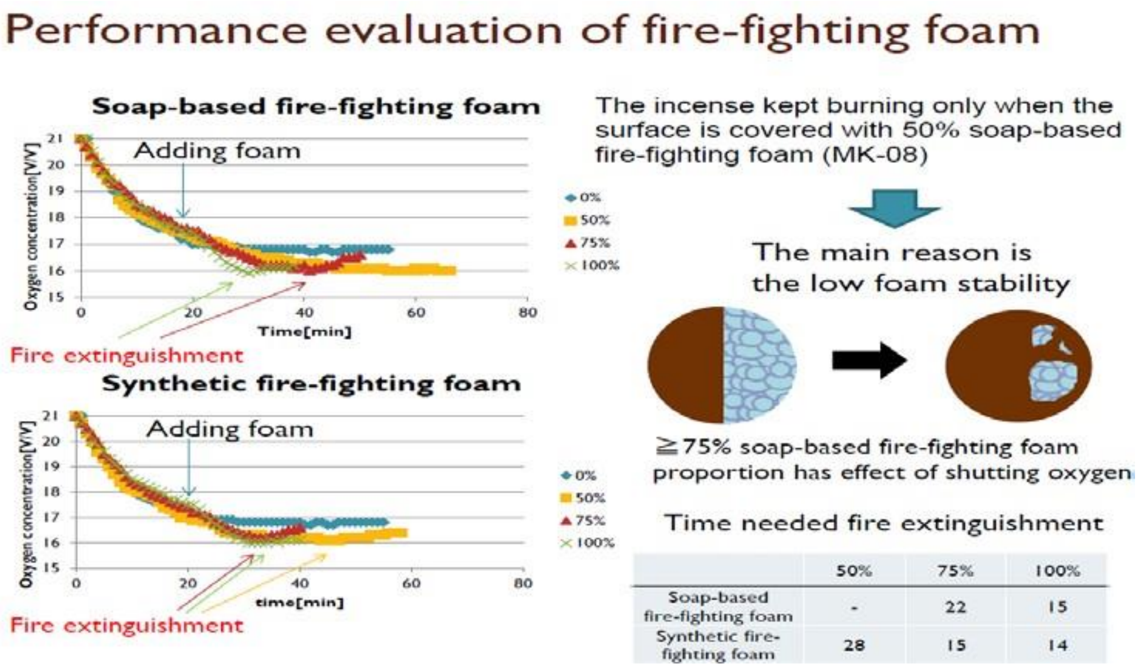


Figure 2-3-9: Performance Evaluation Between Soap and Synthetic Firefighting Foam

e) A Telecenter was established in the building next to the CIMTROP office to provide e-Education services to the residents who live near the peatland.

Participants from Senior High School

Residents from the Villages

Figure 2-3-10: e-Education Services for the Residents

2.3.7 Benefits of Introduction

a) Using the ICT remote monitoring system, the researchers can see the visual image of the dam and get the data collected by various sensors for the measurement of water level, temperature, humidity, wind speed, rainfall, methane amount, CO_2 amount, soil temperature, and soil moisture without having to go to the peat land site.

b) The monitored data from each measurement point will be useful in designing the dam and blocking the canal to restore the hydrological status of the damaged peatland.

c) The project team conducted a feasibility study towards the establishment of an ICT remote monitoring system in a rural area. The team could also make young researchers and scholars of the University of Palangka Raya to be familiar to the remote monitoring system. The system provides them opportunities to enhance their understanding, knowledge, and skills about ICT technologies and to implement ICT technologies for environmental monitoring.

d) At the Telecenter, e-Education services were provided to the residents who live near the peatland. We have conducted classes for farmers, students in elementary school, students in high school, and college students. They were taught introduction to the internet and basic knowledge on e-Education, and also to understand the environment and the importance of peatland conservation.

e) Based on the experiment using soap-based firefighting foam, it was proven that the firefighting foam shuts off oxygen and radiant heat so that the surface fire can be extinguished, but the soil underground was still smoldering. Based on the analysis of the collected data, we will continue to improve its efficiency and conduct more experiments using firefighting foam in the peatland.

2.3.8 Future Prospects

a) Utilizing the results of the APT-J2/J3 project activities, it is expected that in the future, the Indonesian Government (Central and Local) through the University of Palangka Raya would establish a wide-area remote monitoring system for the restoration of the peatland.

b) These activities could demonstrate the successful promotion of an e-Environment community with ICT solutions that will be recognized as a best practice to be replicated and scaled-up in rural areas in Indonesia and other APT members' countries to bridge the digital divide in remote and rural communities.

c) In considering who will be responsible for the maintenance of the regionally and globally important monitoring systems established, we should consider how we can work and contribute together so that this facility will continue to work and collect data so that we do not lose the investment.

2.4 e-Healthcare Solution in Indonesia

- APT J3 in Indonesia: "Promotion of e-local community with ICT solution in Indonesia" ICT Development Programme for Supporting ICT Pilot Projects in Rural Areas 2008 [J3]

2.4.1 Background of the Project

The TTC Promotion Committee is engaged in providing system solutions to the challenges of the modern society, such as digital divide and economic disparity in rural areas of Southeast Asia, through the SHARE concept.

This Project studied methods to improve healthcare services in Tanah Datar, West Sumatra, Indonesia, where 350, 000 people are living but with only one hospital and some small local clinics. The number of doctors is about 50 and they work without any PCs or databases connected to the network. All departments in the hospital and clinics operate independently from one another and all medical documentation processing was handled manually.

This Project established the "Health Checkup Service" that allows automatic collection of the height, weight, and blood pressure data from measuring instruments and puts them into a database, as well as the "Healthcare Contents Distribution Services" that provides prevention of epidemic diseases such as Pandemic Influenza, dengue fever, etc.

2.4.2 Objectives

The overall objective of this project is to demonstrate the successful promotion of e-local community with ICT solutions that will be recognized as a best practice to be replicated and scaled-up in rural areas in Indonesia and APT member countries to bridge the digital divide in remote rural communities.

The project aims:

1) To develop and implement a community-based wide area network by connecting a hospital, a healthcare center, a telecenter, a university, high schools, and junior high schools with a broadband access system to utilize e-healthcare, e-education, and e-agriculture solutions by providing the internet accessibility to rural communities.

2) To evaluate the effectiveness, efficiency, and sustainability of this community-based broadband telecenter and try to propose the best practice of the telecenter to be replicated and scaled up in the other rural communities in Indonesia and other APT member countries.

3) To enhance and improve implementation and maintenance skills among prefectural government staff to successfully establish and sustain ICT infrastructure and applications.

2.4.3 Project Site

Tanah Datar Regency, West Sumatra Province, the Republic of Indonesia has been chosen as the project site for the "Promotion of e-local community with ICT solution in Indonesia".

Tanah Datar, located at the heart of West Sumatra Province, is the smallest of the 19 regions in this province. Fig 2-4-1 shows the geographical location of the Regency.

General information on Tanah Datar Regency:

a. Regency government office location: Batusangkar

b. Administrative units: 14 Sub-districts, 75 Villages, 395 Small Villages

c. Population: 343, 993

d. No. of households: 86, 424

e. Area: 1333.3 sq km

f. Average temperature: 20~25 degrees Celsius (Highlands)

g. Main industry: Agriculture (70% of the population)

h. Regency's GDP: IDR 3.39 Trillion (2006)

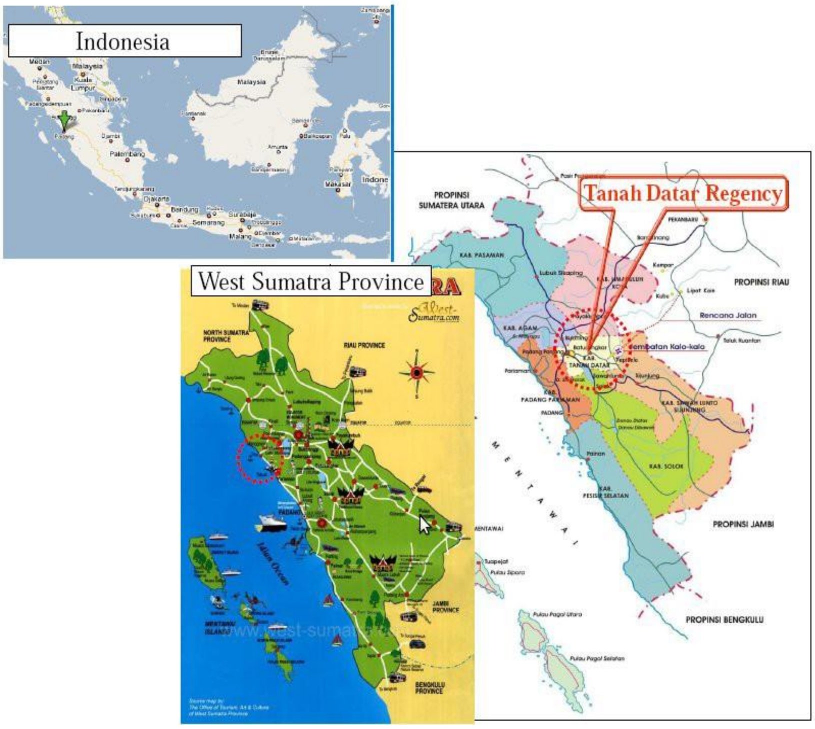


Figure 2-4-1: Location of Project, Tanah Datar Regency, West Sumatra, Indonesia

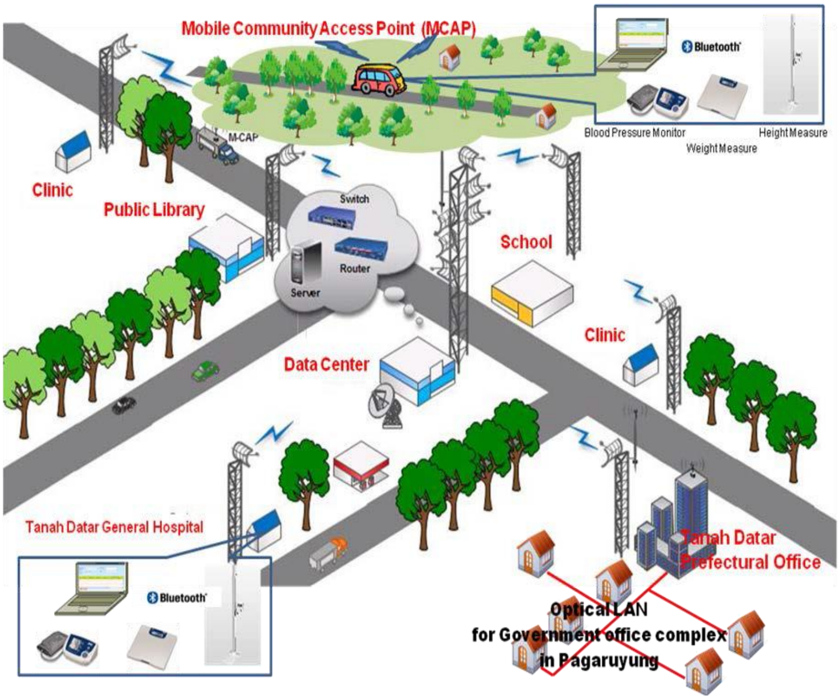
2.4.4 Partner Organization

- Ministry of Communication and Information Technology (KOMINFO)
- The Telecommunication Technology Committee (TTC)
- Oki Electric Industry Co., Ltd. (OF Networks Co., Ltd.)
- Fujikura Ltd.
- Dinas Hub, KOMINFO (ICT Management Division) of local government in Tanah Datar Regency
- Dinas Kesehatan (Health Agency) of local government in Tanah Datar Regency
- PT Jaring Lawah Cyber (PT. JL Cyber)
- PT. Fujitsu Indonesia
- International Office, Nippon Telegraph and Telephone East Corporation (NTT-EAST)
- The National Institute of Informatics (NII)

2.4.5 System Configuration and Installation Sites

The project provides a very basic health check-up system in remote rural areas for the trial of a centralized health data management system with simple health consultancy and disease information services, which is also the public information service for the local community.

Wi-Fi system is adopted as an access network for this pilot project in Batusangkar, Tanah Datar, and optical LAN system is installed by using FTTH technology at Tanah Datar Prefectural Office and Government Office Complex in Pagaruyung. System configuration and the sites of installation are as shown in Fig 2-4-2.



Antenna Unit Installation

Antenna Tower at Data Center

Preparation of Tower Installation

Equipment Installation

Figure 2-4-2: System Configuration and the Sites of Installation

The system specification, network equipment, and construction period of the Wi-Fi system and optical LAN are as shown in Table 2-4-1.

Table 2-4-1: System Specification, Network Equipment, and Construction Period of the Wi-Fi System and Optical LAN

	System specification	Network Equipment		Construction Period
Wi-Fi System	Maximum Distance: 4500 m Transport speed: 27 Mbps, Best Effort	- Wireless Tower - Lightning protection - Wireless Radio Access Point - 5.8 GHz Antenna - 2.4 GHz Access Point - 2.4 GHz Antenna		40 days
Optical LAN	Total Distance: 4.1 km 1st construction: 1.3km 2nd construction: 2.8km Transport speed: 100 Mbps, Best Effort	Optical Outside Plant	- Telephone Pole - Single mode optical cable for aerial installation - 1:8 Optical Splitter	1st Construction: 14 days 2nd Construction: 14 days
		Network Equipment	- 19” Rack system - GE-PON OLT - GE-PON ONU - Layer 2 Switch	1st Construction: 3 days 2nd Construction: 2 days
Server system		- 19” Rack system - GENSET 5000 Watt for Data Center - UPS 3000VA for Data Center - Computer Server for Data Center - Router Management for Data Center - Switch for Data Center		

One of the reasons that made it easier to successfully implement both Wi-Fi system and optical LAN is that a single agency is responsible for issuing permissions or licenses for both Wi-Fi system and optical LAN.

2.4.6 Outline of the Solution

2.4.6.1 Health Checkup Application

The measuring instruments for health checkup service consist of blood pressure meters, weight scales, and height scales. These pieces of equipment have the Bluetooth communication capability (Class 1, Version 1.2). Measured data are sent automatically to a local PC via Bluetooth and stored in a local database of the PC and also copied to an integrated healthcare database at Data Center. Bluetooth connectivity can lessen the burden to local workers of coping with new and additional tasks for medical checkup and facilitate the familiarization process with the operating instructions. The application was optimally customized and developed for data analyses and to assist the progress of the local people.

The health checkup operation procedure is composed of the following 3 steps:

Step1: Registration of patient
Step2: Measurement

Step3: Measured data entry

According to the evaluation results of this procedure, it typically takes 3 minutes to complete the procedure for revisiting patients and 7 minutes for first visits.

2.4.6.2 Administrative Cloud Service

By utilizing the network infrastructure consisting of Wi-Fi network and optical LAN, Tanah Datar Regency installed the Financial Information System (SIMDA) developed and provided by KOMINFO as an administrative cloud service to improve the work efficiency of associated workers in every regency.

The objectives of “SIMDA” are to support the realization of good governance and a clean government in the regional economic administration especially in financial implementations, and to realize professional, transparent, and responsible regional government facilities connected with the optical LAN infrastructure established by the project. Associated workers have been able to use this networked “SIMDA” on an online basis.

The functions of ‘SIMDA’ include compiling financial reports as part of financial management accountability using budget credit balance reports, cash flow reports, and notes to the financial statement according to the government regulations on standard government accounting; and producing other comprehensive financial reports such as statements of regional financial position, financial performance and regional government accountability on regional financial management, and the Internal Affairs Minister Regulation on regional government management guideline.

The Health Checkup Application Used on Clinics

2.4.7 Benefits of Introduction

Throughout the project, clinics, schools, and governmental agencies in Tanah Datar Regency are networked and connected to each other over Wi-Fi system and optical LAN. As a result of the implementation of the applications described in Section 2.4.6, improvement of administrative services was observed and recognized among residents and local government agencies.

a) Establishment of fundamental computerization for local community with ICT solutions

b) Introduction of necessary infrastructure for expansion of health or medical services

c) Improvement and upgrading of work efficiency at local government, and introduction for expansion or upgrading of administrative services to be provided to local community

2.4.8 Conclusion

APT J3 project in Tanah Datar was successfully handed over and its report was completed and submitted to the APT Secretary.

In the Tanah Datar case, the local governor conducted this project as one of the most important policies and formed a special team for the project. This team has been making great efforts to maintain the infrastructure and applications working normally. Two years after the completion of the APT-J3 project, the local government decided to expand the optical LAN and it was implemented successfully with the project members’ support.

Throughout this project, Indonesia's 1st implementation of a municipality-based solution model, Health Checkup and Administrative cloud service is achieved.

Regarding its future prospects, Tanah Datar Regency plans to keep working together in cooperation with TTC in utilizing ICT development in the region.

2.5 e-Disaster Risk Management in Philippines

-APT J2 in Philippines: "Broadband wireless for disaster operations: resilient networks and reconfigurable information systems for rapidly deployable disaster response" 2012 APT J2

2.5.1 Background of the Project

In 2013 alone, natural disasters in the Philippines included Typhoon Haiyan, known locally as typhoon Yolanda, the deadliest Philippine typhoon on record, and a magnitude 7.2 earthquake that caused great destruction in Bohol province. In response, DOST-ICTO and the Ateneo de Manila University spent a considerable time looking for various ways to address communication problems resulting from damaged communication networks caused by natural disasters. In times of calamities, there is a need for immediate communication of information in order to minimize damage and loss of human life, and to provide evacuation updates and other vital information to those concerned.

2.5.2 Objectives

We envisage the design of a BBW (broadband wireless) network that is very resilient and rapidly deployable for quick end to end information flow from affected areas right up to the war room. The system has to be able to carry effective broadband content, to prepare communities, especially persons with disabilities (PWDs), during the critical pre-disaster planning and preparation periods, and for effective response immediately upon the onset of disasters and over the long term recovery effort. There is a critical need for systems designs that offer broadband access solutions to disaster risk management, assessment, rescue, medical treatment, survivor
support system, resource allocation, and long term recovery.

2.5.3 Project Site

This project was planned and conducted in the laboratory in Ateneo de Manila University, Philippines.

2.5.4 Partner Organization

・ ICT Office, Dept. of Science and Technology-DOST, Philippines

・ Philippine Long Distance Telephone Company (PLDT), Philippines

・ Ateneo Innovation Center (AIC) and ECCE Department, Ateneo de Manila University, Philippines

・ Advanced Science and Technology Institute (ASTI), DOST, Philippines

・ Vastnet Inc., Philippines

・ Ionics Inc., Philippines

・ Keio University, Japan

・ Oki Electric Industry Co., Ltd, Japan

・ Mitsubishi Electric, Japan

Other partners that were gained over the course of the project include:

- Daisy Consortium; Assistive Technology Development Office (ATDO), Japan
- National Council for Disability Affairs (NCDA); National Library of the Philippines (NLP)

- RBI - Resources for the Blind; Physicians for Peace, Philippines

2.5.5 System Configuration

Figure 2-5-1 shows a future system architecture for a possible Phase II(*) implementation, highlighting the different components of an information network suitable for disaster risk reduction and management. In this architecture, War rooms are the disaster information sources and have the function of delivering such information to disaster sites and other sites. War room can be constructed by IPTV headend equipment and/or ISDB-T narrow band broadcasting system (shortly, ISDB-T Narrowcast). The disaster related information to the disaster sites includes timely critical information for evacuation and short searchable video of survivors. ISDB-T narrowcast may broadcast several channels as survivors, rescue, relief, and so on.

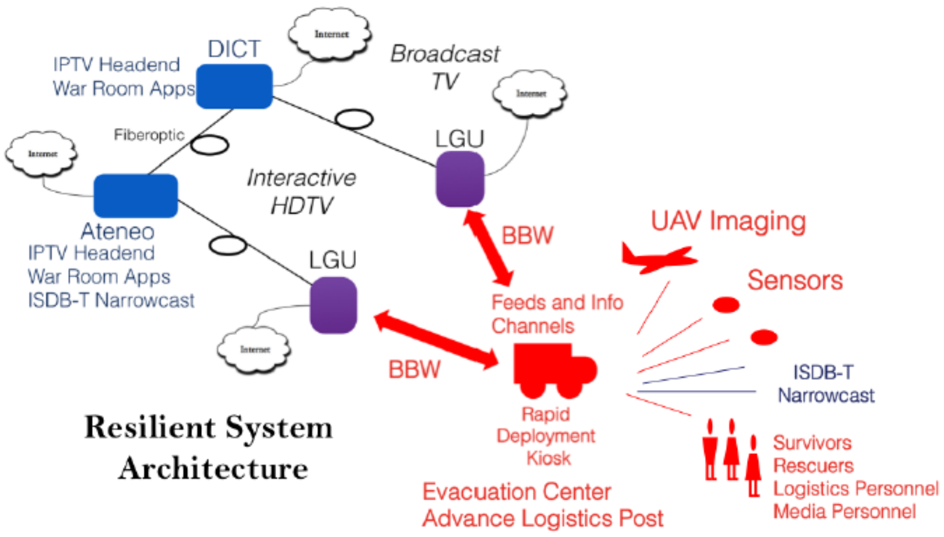


Figure 2-5-1: Future Wireless System for Pre-Disaster Preparation and Post Disaster Rescue and Recovery

NOTE - Phase I means this project. Phase II is the successor of Phase I. There is not any concrete plan as of February 2015.

Figure 2-5-2 details the sub-systems necessary for an end-to-end information delivery system that incorporates in a hybrid manner many key wireless and broadband technology components that can prove critical for our application: one set communications, IPTV standards based content delivery, WiFi and other wireless (such as TV white space), as well as headend technologies that include realtime encoding, web streaming, rapidly deployable mobile media servers and transcoders. Rapidly deployable components such as laptop based media servers (instead of rack mounted technologies), mobile transcoders, and one segment receivers.

Figure 2-5-3 shows the terminal devices that received Wi-Fi and ISDB-T narrow band broadcasting in Figure 2-5-2.

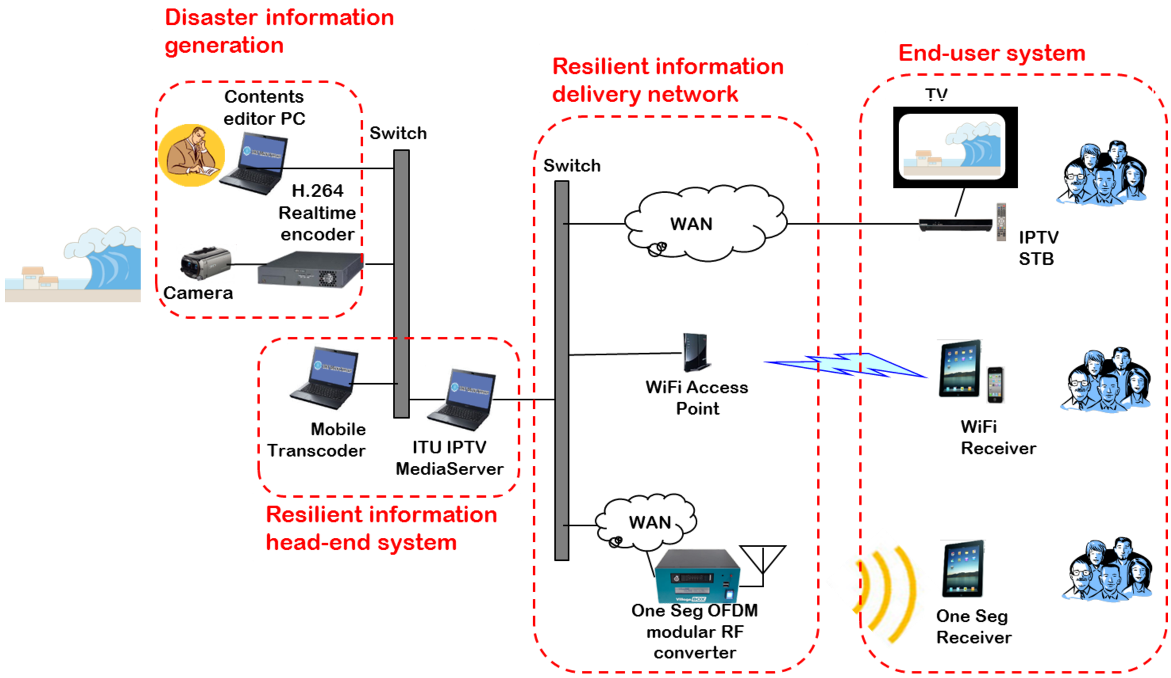


Figure 2-5-2: Proposed Experimental System for Test Deployment at the Ateneo de Manila University Testbed Site

Figure 2-5-3: Mobile Terminals That Receive ISDB-T Narrow Broadcast and IPTV streaming Over Wi-Fi in the Testbed Site.

For the system architecture, the following key components have been identified:

(1) End to end standards based system software and hardware

(2) Rapidly deployable and transportable components

(3) Low power content appliances at the deployment site

(4) Ability to provide necessary content even in low bandwidth environments

(5) Inclusive content design and delivery, PWDs are a critical part of the community addressed

2.5.7 Benefits of Introduction

To meet these design goals, we have put together a series of proof of concept sub-systems that have the necessary capabilities and concluded the project with the following accomplishments:

1. Standards based (ITU) IPTV platform head-end architecture

2. Near-cloud edge architecture
3. TV White space non-commercial-frequency wireless platforms
4. A hybrid approach that marries current technologies and standards based approaches in a mission critical capable content streaming platform: iptv.ateneo.edu.
5. A successfully concluded consultation and needs analysis process culminating in an international conference.

The IPTV platform was architected to function either as a head end or as a rapidly deployable node, utilizing ISDB-T standard and portable components. At the edge of the deployment, small form factor low power (<10 Watt) near cloud capable network appliances with full-up computer capabilities deliver and gather information at full bandwidth while updating metadata via the narrowband pipes often available in remote rural areas or in post disaster recovery sites. With the lead of the ICT Office of DOST, a test deployment using TV White Space frequencies, a developing standard, was implemented in post-earthquake areas in Bohol Island. While all this design and development work was ongoing, we configured a publicly accessible streaming capability via the iptv.ateneo.edu site to test new content and engage the DRRM community. In parallel we started a consultation process with multiple stakeholders, such as post disaster camp managers and the PWD community, which culminated in a UN ESCAP Sendai International Conference which was participated in by the PWD Community with remote online participation in panel discussions by the Manila Group, convened by this APT Project Team.

2.5.8 Conclusion (Future Prospects)

APT J2 project in Philippines was successfully handed over and its report was completed and submitted to the APT Secretary.

In this Philippines case, an Academia, Ateneo de Manila University, and a government organization, DOST, conducted this project as one of the most important topics regarding disaster information delivery. The project installed a prototype system of RESILIENT NETWORKS AND RECONFIGURABLE INFORMATION SYSTEMS based on an international standard based IPTV system and ISDB-T narrow band broadcasting system.

Throughout this project, the team identified design goals and we have put together a series of proof of concept sub-systems that have the necessary capabilities and concluded the project with the accomplishments.

Regarding its future prospects, the project members plan to keep working together and to consider utilizing ICT development in the region, such as e-learning for hospitals based on IPTV (patient safety topics), and so on.

2.6 Shrimp Water Quality Monitoring in Vietnam

-APT J2 in Vietnam: "Heterogeneous Wireless Sensor Network Monitoring Water Condition for Strengthening Aquaculture Industry in Vietnam" 2014 APT J2

2.6.1 Background of the Project

Monitoring water condition by ICT technology is very important in aquaculture industry. Basically, the methodology of monitoring system is similar. However, the implementation depends on the requirement of a specific application. Therefore, it may incur much effort in terms of hardware and software developments for various applications. Currently, each existing system for monitoring water is designed for a specific application. There are no systems that can support vast of applications. It causes the following problems regarding water condition monitoring:

1) It is difficult for the government to have overall view.
2) It is difficult for companies to manage business.
3) It is difficult for farmers to share knowledge.

2.6.2 Objectives

The aim of this project is to strengthen Vietnam aquaculture industry by applying ICT technology in monitoring aquaculture water and in sharing experimental knowledge. This project proposes a system dealing two issues:

・ Real-time water monitoring system lets farmers know what happening in their farms.

・ Knowledge sharing system for increasing farmers' technology capability

2.6.3 Project Site

The project was planned and conducted at Faculty of Computer Science and Engineering, Ho Chi Minh City University of Technology. Additionally, the system was planned to deploy for testing in several areas in the south of Vietnam.

2.6.4 Partner Organization

・ Ho Chi Minh City University of Technology (HCMUT), Vietnam

・ Department of International Cooperation, Ministry of Information and Communications, Vietnam

・ The Telecommunication Technology Committee (TTC), Japan

・ Nippon Telegraph And Telephone Corporation (NTT), Japan

・ The University of Electro-Communication (UEC), Japan

2.6.5 System Configuration

Figure 2-6-1 shows the overall architecture of our proposed system that consists of three parts. The first part of proposed system is **monitoring devices**. The system supports different monitoring devices with different network capabilities. Each device class appropriates for a specific application requirement. They are classified into three classes, as below.

・ High speed monitoring class (HSMC): devices belong to this class have a high-computing capacity and high-speed WiFi. HSMC devices are suitable for applications requiring high data rate such as audio, video monitoring. One application example is looking for operating of sea lobster cave underwater. These devices require much energy, high cost, and complex in deployment. They always require power line connection for long-time operating and often need a wired internet access which is not always available everywhere.

- Mobile-over monitoring class (MMC): devices belong to this class use mobile network services such as short message service (SMS), general packet radio service (GPRS), 3-G communication infrastructure. In addition, MMC devices require less power and has lower data rate than HSMC devices. Medium-size batteries provide enough energy for a device. In addition, mobile network is pre-deployed almost everywhere in Vietnam. Therefore, MMC devices are suitable for application require medium data rate such as monitoring water parameters. Drawbacks of MMC devices are long latency and not reliable communication so that they cannot be used in applications need fast reaction to changing of water condition.
- Energy-harvesting monitoring class (EHMC): devices belong to this class use low-power, short-distance, low data rate 6LowPAN to form a multi-nodes local wireless network. A local mesh network provides high data reliable and low latency. The power consumption is also very small such that a small solar energy harvester is enough. These features make EHMC devices suitable for monitoring application requiring real-time, high-reliable and fast response such as shrimp farm monitoring. Drawback of EHMC devices is that they cannot provide data remotely. An EHMC network often combines with one MMC device to allow remote data access.

The second part of the proposed system is the **data center server**. All monitoring data are collected to a server for remote accessing and knowledge sharing. The server has a data management system to organize data, manage user privacy and data access policy. Informative analysis is also provided. An integrated framework allows users watch monitoring data each other, ask questions, give advices, discuss issues, and find solution, etc. New farmers quickly catch modern technology, growing process, and experiential knowledge. Farmers not only monitor their farm but also learn to apply new technology into their work with supporting from the proposed system.

The third part of the proposed system is **the user-friendly application on smart phone**. There are large number of Vietnamese still cannot use internet. They do not know how to use a personal computer as well as open or interact with a website. Smart phone with touch interface is much easier to learn and more interested to them.

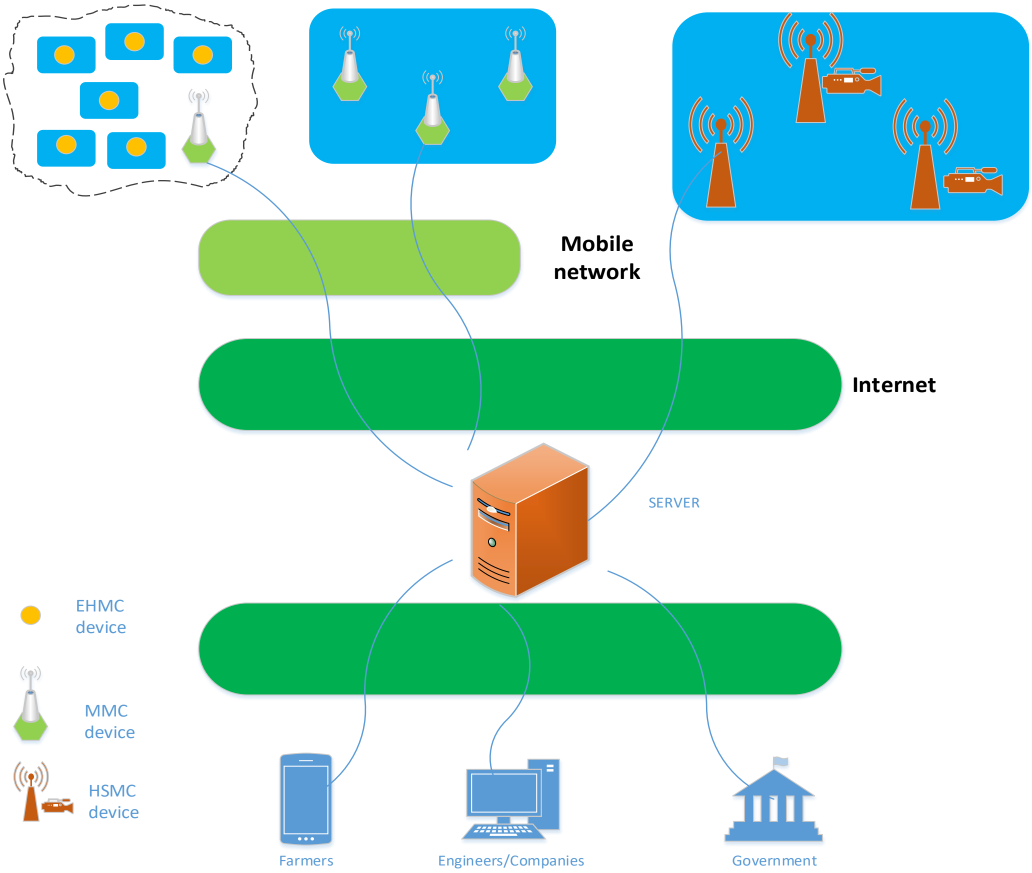


Figure 2-6-1: Overall architecture of proposed system

The implementation results including hardware devices (EHMC, MMC, Web and Mobile Application) of the proposed system are shown as snapshots in Figure 2-6-2, 2-6-3, 2-6-4, and 2-6-5.

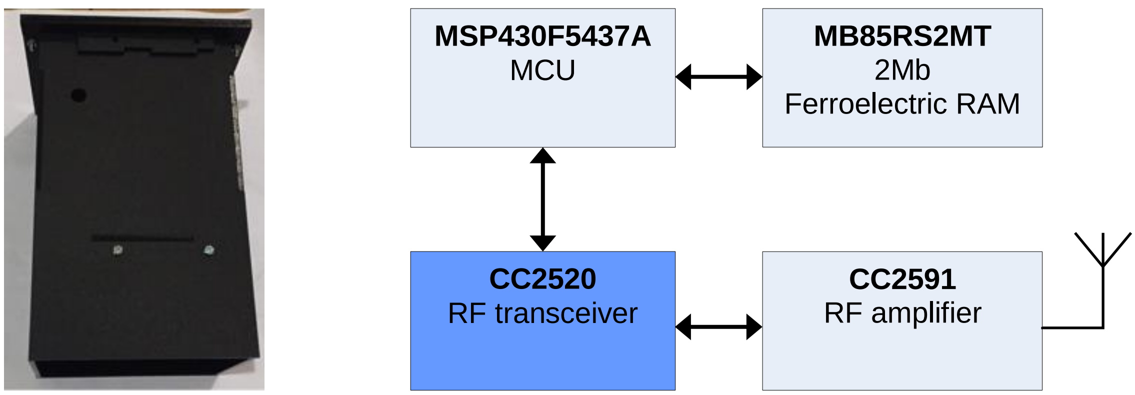


Figure 2-6-2: Block diagram of the processing components inside an EHMC device

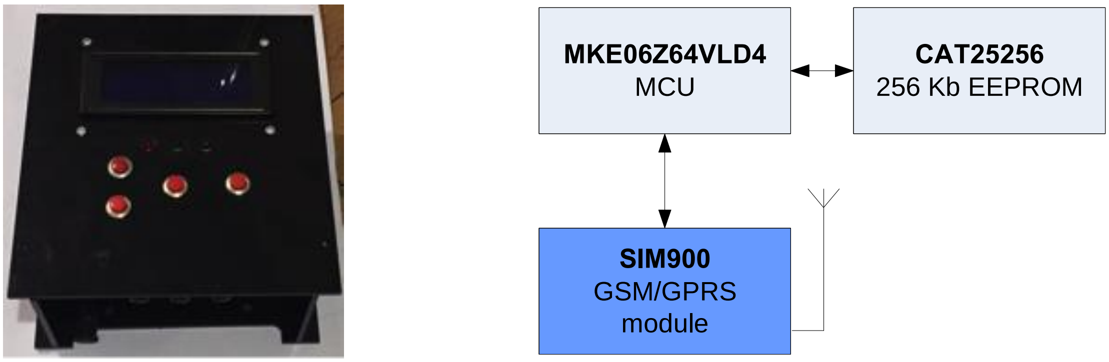
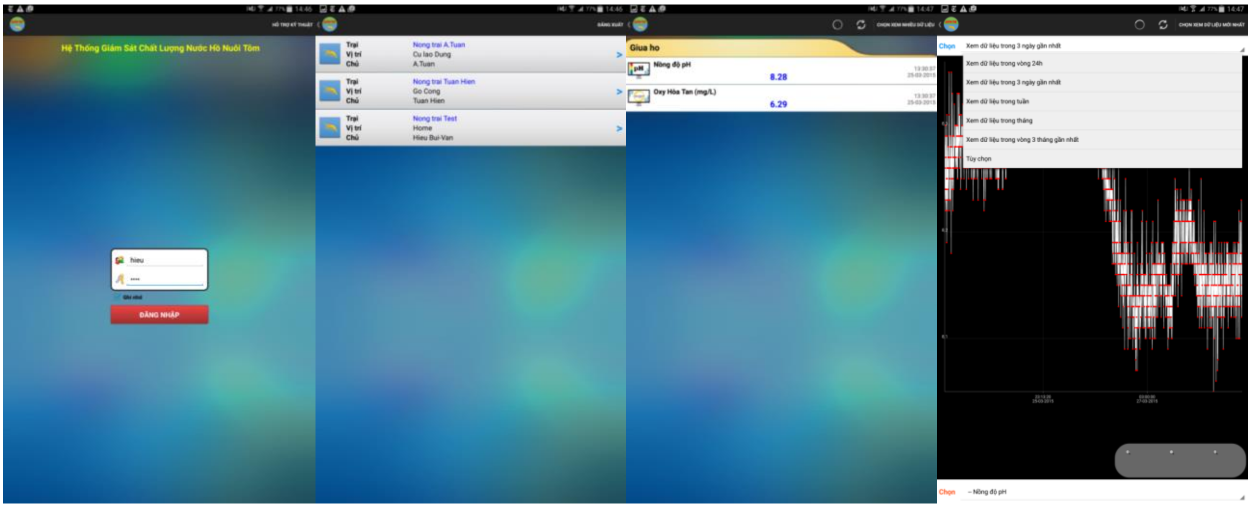


Figure 2-6-3: Block diagram of the processing components inside a MMC device



(a) User Login | (b) Farm and Pond Information | (c) Latesting Monitoring Data | (d) Graphical Display of Monitoring Data

Figure 2-6-4: Monitoring on Mobile Application (Android)

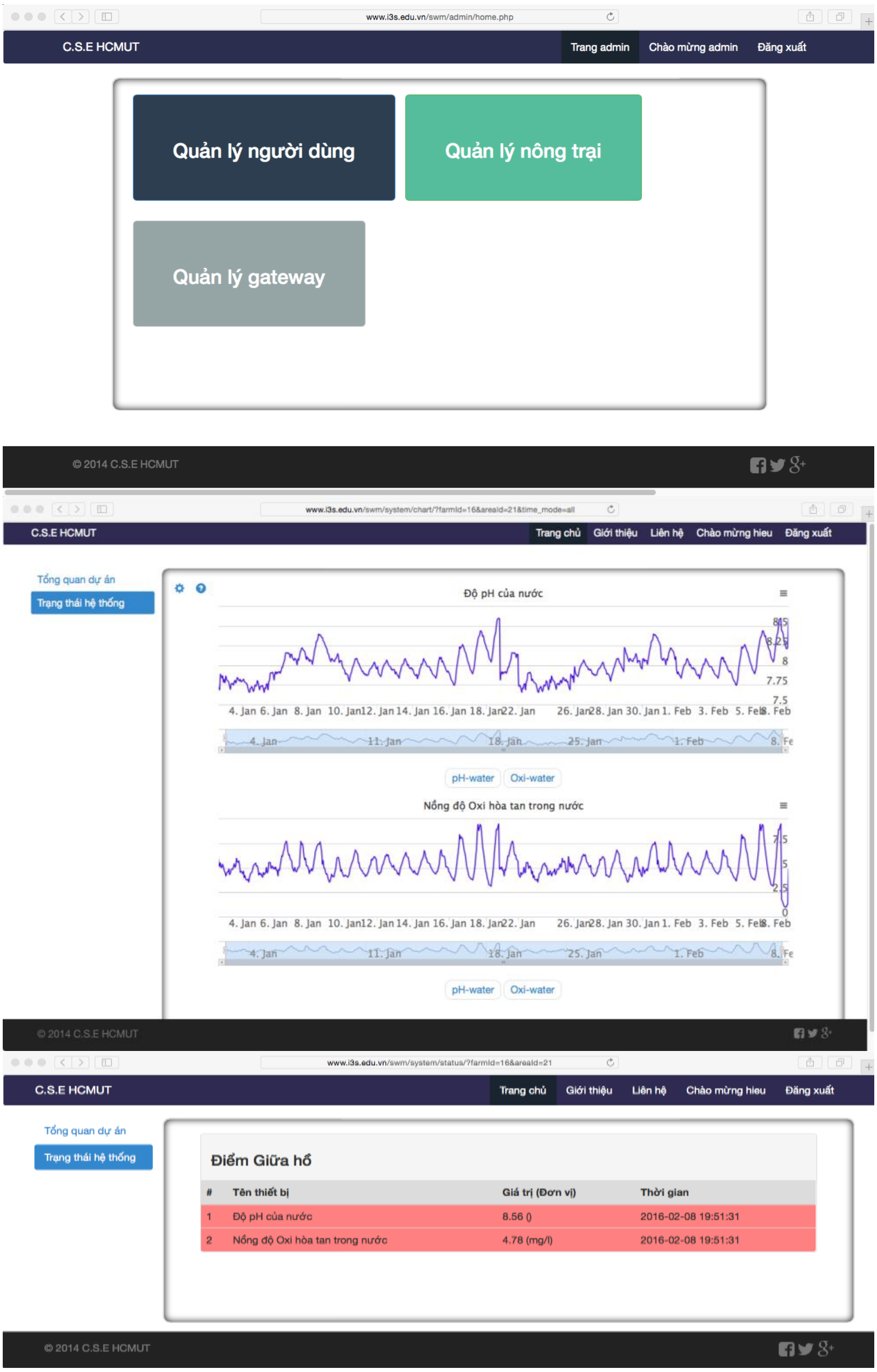


Figure 2-6-5: Web-based Application and Management

2.6.7 Benefits of Introduction

The proposed system has potential to reduce cost including electricity cost and food cost directly, processing chemical indirectly which helps in increasing income for farmers. Basically, the cost of growing shrimp is shown as Figure 2-6-6 where food is the most cost (consume 50% total cost), while shrimp seed and processing chemical are the next costly (17% and 16% respectively). Next costly is electricity which consumes 7% total cost.

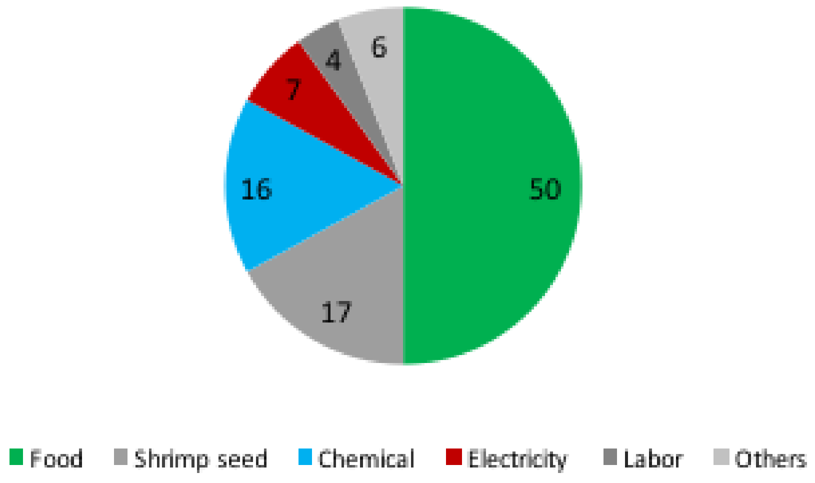


Figure 2-6-6: Cost consuming for growing shrimp

With deployment evaluating result, farmers can reduce working time of rotators. Without the system, farmers often turn on all rotators almost 24 hours a day. Using information from the system, farmers can turn off rotators when dissolved oxygen is in good condition. Hence, working time of rotators is reduced approximately to 18 hours/day. Figure 2-6-7 shows electricity cost of one pond during one season crop by million VND (22.000VND / 1 USD). The light color is amount of saving cost when applying the system. The electricity billing can be reduced up to 14.6 million VND for one 6-rotator pond (from the peak 58.3 to 34.0) or 33% in best case. Consequently, our system directly reduces total cost 2.31%.

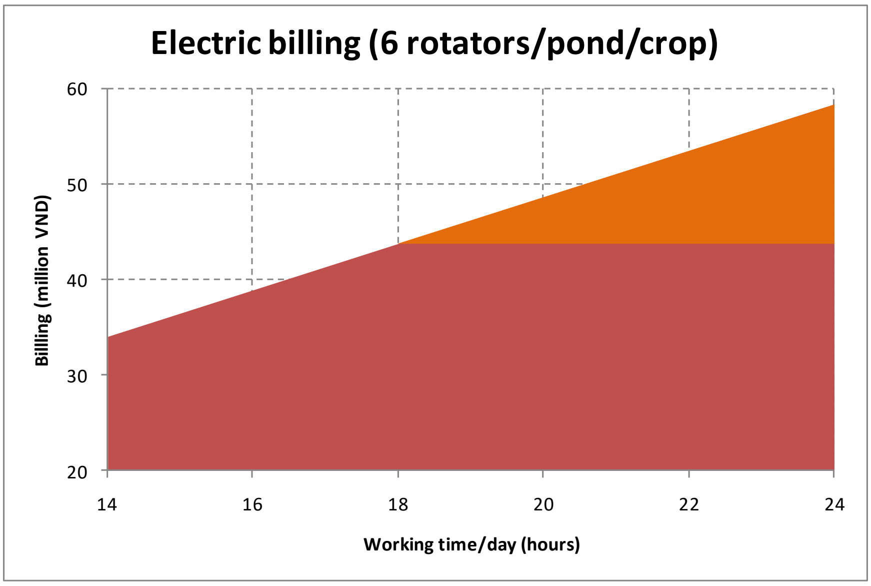


Figure 2-6-7: Electric billing reduction for one pond using 6 rotators

In normal condition, shrimp eating mostly depends on environment temperature and dissolved oxygen. Farmers often feed more than shrimp need. With feedback from our system, farmers adjust fed food suitable so that all food are used which reduce most costly. In addition to direct affection, indirect cost reduction processing chemical can be utilized from our system. Because farmers do not overwhelm food, toxic contaminant such as NH3, H2S do not be generated. The growing environment becomes fresh so that less processing chemical need. Shrimp also become stronger, no more chemical need. In addition, shrimp quality is better which increasing income.

2.5.8 Conclusion (Future Prospects)

This project has proposed a uniform system that integrating different device types to monitor water quality for all different requirements of aquaculture industry. All monitoring data are collected remotely to a data center in real-time manner. Different user agents such as farmers, engineers, companies, government access monitoring data in different views depending on privilege policy. An easy-to-use mobile application is developed for farmers to view monitoring data. The system has been deployed and evaluated in different testing sites. It has worked as expected.

The result shows that electricity billing can be reduced up to 33%. Food and processing chemical can be reduced as well. More research needs to evaluate how much food and chemical cost can be reduced. The remaining issues are to improve dirty deployment environment and high maintenance complexity. They increase system reliability and reduce working time.

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3. Summary of ICT Solutions

CATEGORY	SUB CAREGORY	e-Aquaculture (1) PHL	e-Aquaculture (2) VNM	e-Education	e-Environment	e-Healthcare	e-Disaster Risk Management
1. Overview of the solution		e-Aquaculture systems is a remote environment monitoring system using M2M sensor network at the fish pond in order to suspend the fish kill due to lack of oxygen. 1) M2M sensor network M2M network was built with sensors measuring water temperature, pH, dissolved oxygen (DO), turbidity and conductivity around the lakeshore. 2) Improved the lack of oxygen in the water A water circulation system could be provided to improve the lack of the oxygen in the water. 3) Distribute information system Information distributed to fish folk through a portal site created by an expert. Distributed information includes water parameter, disaster information, market price and cooking information etc.	The aim of this project is to strengthen Vietnam aquaculture industry by applying ICT technology in monitoring aquaculture water and in sharing experimental knowledge. This project proposes a system dealing two issues: 1)) Real-time water monitoring system Real-time water monitoring system lets farmers know what happening in their farms. 2) Knowledge sharing system Knowledge sharing system is useful for increasing farmers' technology capability.	e-Education provides a wide variety of functions according to the target area situation and requirement. 1) Introduction of ICT technologies into schools: Introducing internet access environment, school internal network (LAN), PCs and other networked display and operation devices, electronic whiteboards and education-related application systems etc. 2) e-Education materials Multimedia education materials which are delivered via video and still image database, interactive tools and digital playground concept. 3) e-Learning system Self-study systems provided through servers and communication networks, which allows students to study by themselves, remotely and at any time if necessary, using e-Education materials. 4) Remote communication Realizing remote communication environment among children and students, or with teachers, through networks and display devices.	e-Environment is a remote environment monitoring system using M2M sensor network in the peatland. 1) It is also effective for dam designs and area maintenance, prediction of fire occurrence, and protection of the peatland. 2) By designing and constructing the monitoring system, the local young ICT engineers have the opportunity to enhance their technical skills on ICT technologies. 3) Using the ICT system, the e-Education service can provide the local residents a venue to understand the importance of peatland conservation and introduction to internet operations.	e-Healthcare system provides healthcare –related information, services, and products to patients using the Internet and other relevant networks. The following are cases of e-Healthcare services in rural area. 1) Health checkup service It allows the automatic collection of height, weight, and blood pressure from the scales and puts them into a database. 2) Healthcare Contents Distribution Services It provides opportunity to raise awareness against epidemics such as Pandemic Influenza, dengue fever, etc. by using the e-learning system application contents.	e-Disaster risk management system provides a broadband wireless network that is very resilient and rapidly deployable for quick end to end information flow from affected areas right up to the war room.. 1) Resilient network Resilient network consists of the different component of information network such as broadband and wireless network. 2) Disaster information Disaster information includes pre-disaster planning, preparation periods, disaster situation and recovery information. 3) Head-end system IPTV head-end for broadband and ISDB-T system for wireless are included in the system.
2. Analysis of	a) Purpose and	A series of surveys are	A series of surveys are	A series of surveys are	A series of surveys are	A series of surveys are	A series of surveys are

the situation and status	Environment	conducted to analyze contextual conditions, which will be instrumental in deciding requirements for e-Aquaculture system - main reason of fish kill - which kind of sensor is needed (water temperature, pH, DO etc.) - location of monitoring Survey existing ICT system such as communication networks and PC equipment	conducted to analyze contextual conditions, which will be instrumental in deciding requirements for water quality monitoring system - Main reasons of shrimp kill - What ICT and aquaculture technology that farmers know - Which kinds of sensors are needed (water temperature, pH, DO, salinity, turbidity, conductivity, H2S, NH3, NO2, etc.) - Locations of monitoring - Which kinds of sensor networks communication networks are needed - Which kinds of power supplies are needed	conducted to analyze contextual conditions, which will be instrumental in deciding requirements for e-Education systems. - Existence of Internet environment or ICT penetration level in the target area - Analysis of rate of child labor - Analysis of school attendance rate (necessary to determine readiness for self-study, and the current rate of truancy due to child day- time labor or local economic situation, etc.) - The number of teachers per capita (necessary to determine readiness for self-study, from the perspective of teachers) - Scope of geographical area where one school should cover (necessary to determine readiness for remote/distance learning) - Number of children or students in the area (necessary to determine communication environment among children across a distance) - Social surroundings like existence of zoological or botanical gardens (providing alternate education materials for children without such study environments)	conducted to analyze contextual conditions, which will be instrumental in deciding requirements for e-Environment system - Construction area - Water level in the canal / peatland - CO_2 / methane concentration - Rainfall - Temperature and humidity - Wind speed - Local environment setup Survey existing ICT system such as communication networks and PC equipment	conducted to analyze contextual conditions, which will be instrumental in deciding requirements for e-Healthcare system. - Presence of local Internet access services, and Internet penetration rate - Demographic composition by age, literacy rate etc. - Ratio of medical institutions (hospitals and clinics) per household and area coverage per medical institution (hospitals and clinics) (to determine the need for remote healthcare services) - Availability of regular health checkup services and checkup consultation rate - Availability of health insurance schemes - Availability of medical office automation - Identification of most common diseases, and records on presence of endemic diseases	conducted to analyze contextual conditions, which will be instrumental in deciding requirements for e-Disaster risk management system. - Existence of broadband access for IPTV services - Existence of digital broadcasting for wireless services - Frequency of natural disaster in the target area (country) - Availability of mobile terminal devices such as smart phone to receive ISDB-T. - Availability of IPTV terminal devices such as STB and TV with IPTV functions
	b) Measures and	Based on the above survey,	Based on the above survey,	Based on baseline data,	Based on the above survey,	Based on baseline	Based on baseline

effect	decide what kind of sensor system is suitable and necessary. - Number of fish kill using the system. - Improving the income of fish folk.	decide what kind of monitoring system is suitable and necessary. - Real-time and easy-to-use water monitoring system lets farmers know what happening in their farms - Experiments and information sharing - Improving the income of shrimp owner based on the collected and analyzed data.	decisions are made to determine the type of e-Education solution which best fit the contextual needs and challenges identified. . Relevant reference indices are determined to indicate the quantitative effect or impact of the project goal.	decide what kind of systems is suitable and necessary. In case of its application to the peatland - Effective for prediction of fire and its protection - Use of the canal dam design for recovering water supply Also set up some reference indexes and consider the quantitative effect.	environmental survey, decisions are made to determine the type of e-Healthcare systems or services needed. In addition, selection of specific targets to perform a quantitative review of the results of the implementation.	environmental survey, decisions are made to determine the type of e-Disaster risk management system or services needed. In addition, selection of specific targets to perform a quantitative review of the results of the implementation.
c) Business Model	Survey relevant conditions including the following items to generate and assess a business model for e-Aquaculture services. - Considering the purpose of deployment, necessary system and benefits to be expected should be clarified. - How much fish harvest was improved using the system and solution. - Reduction of manpower costs by saving the time in measuring environmental data - Benefits to enhance technical skills of local young ICT engineers and to provide e-Education service to the local residents - Costs of system deployment, operation, and maintenance - Financial support: who will operate and maintain the system.	Survey relevant conditions including the following items to generate and assess a business model for water quality monitoring services. - Considering the purpose of deployment, necessary system and benefits to be expected should be clarified. - How much income of farmers was improved using the system and solution. - Reduction of power and labor costs by saving time in measuring water quality parameters - Benefits of sharing experiments and information to improve the shrimp harvest as well as ICT and aquaculture knowledge of the farmers - Costs of system deployment, operation, and maintenance - Financial support: who will operate and maintain the system.	Survey relevant conditions including the following items to generate and assess a business model for e-Education services. - At this stage, it is necessary to determine the economic situation of local government or schools, i.e. whether they are able to keep up with the cost of system introduction and run it as local government or school services sustainably. - If it is determined that difficulty is predicted in sustaining and managing the project, it is necessary to identify potential financial support from the central government, grants, or other countries.	Survey relevant conditions including the following items to generate and assess a business model for e-Environment services. - Reduction of manpower cost by saving time in measuring environmental data - Benefits of getting useful data on a timely basis (ex. the data for dam design, fire prediction, and rapid fire-fighting for environment conservation). - Benefits of enhancing the technical skills of local young ICT engineers and to provide e-Education service to the local residents - Costs of system deployment, operation, and maintenance - Economic strength of local governments in the region - Financial support of the central government or other countries	Survey relevant conditions including the following items to generate and assess a business model for e-Healthcare service. - Economic readiness of the local residents (whether service fees could be collected from local residents will be sufficient to cover costs for system implementation, operation, and maintenance, etc. As such, it is to be determined if private commercial businesses ran by medical institutions are feasible operators to sustain the e-Healthcare services in the future). - Economic readiness of local municipalities and medical institutions (whether the system deployment, operation, and maintenance costs can be covered by municipalities if fees collected from the local residents are insufficient; whether municipalities are capable of the continuous management of the system). - Availability of central government or foreign	Survey relevant conditions including the following items to generate and assess a business model for e-Disaster risk management service. - Availability of ISDB-T including head-end system and terminals to deliver emergency information when disasters happens - Availability of IPTV services (broadband, head-end and terminals) to deliver emergency information when disasters happens

						financial aids (whether financial support could be obtained from the central government or other governments if both service fees and municipalities cannot cover the costs).	
	d) Cost estimation	Survey electricity in the environment (existence or possibility of a power supply, quality of electricity)					
		Survey existing communication network environment (existence and reliability of wired or wireless broadband access)					
		Survey and compare the damage of fish kill and the investment for system implementation, operation, and maintenance.	Survey and compare the damage of shrimp kill and the investment for system implementation, operation, and maintenance.	Survey conditions and estimate the cost of introduction, operation, and maintenance of e-Education systems. - Required type of systems and services to be introduced, and necessary facilities such as servers and buildings for them; communication network equipment, terminal devices, education materials, and so on. - Coverage of area size, population density and distribution - Readiness of available teachers or education expert resources in the target area - Challenges to establish maintenance system for ICT and e-Education systems	Survey conditions and estimate the cost of introduction, operation, and maintenance of e-Environment system.- Presence (or supply potential) of the power supply and power quality - Necessary ICT system (center building, communication equipment / terminal equipment) - Coverage area and construction difficulty of ICT equipment maintenance system	Survey relevant conditions including the following items to estimate costs associated with e- Healthcare system implementation, operation, and maintenance. - General description of required system (service details), facilities (center building, telecom facilities, terminal equipment, instruction materials, etc.) - Coverage of area size, population density and distribution - Readiness of local community members to sustain the e-Healthcare system after deployment - Challenges to establish maintenance system for ICT and e-Healthcare systems	Survey relevant conditions including the following items to estimate costs associated with e- Disaster risk management system implementation, operation, and maintenance - War room specification that delivers the emergency information and also collects the personal and disaster area information. - Coverage of area size, population density and distribution. - Readiness to regulate a small broadcasting system to broadcast disaster information to specific areas.
3. Target data, Collection and Analysis		Collection of the following data. - Water temperature - pH - Dissolved oxygen (DO) - Turbidity and conductivity around the lakeshore. - Water circulation - Ecology of fish and water	Collection of the following data. - Water temperature - pH - Dissolved oxygen (DO) - Turbidity and conductivity of shrimp farms. - Water circulation - Ecology of shrimp and	Collection of the following data - Academic performance of students in local schools - Rate of basic literacy and arithmetic knowledge - Knowledge about local culture - Ability in creative thinking skills	1) Collection of the following data. - Climatic conditions, carbon dioxide / methane (CH4) concentration - Rainfall, temperature, humidity and wind speed - Local environment appearance (in case of the application	Collection of the following data - height - weight - body fat percentage - temperature - blood pressure - pulse rate, and so forth.	Collection of the following data - Disaster area (potentially dangerous area) - Disaster type - Disaster date, time - Route to Evacuation - Number of dead people, their names and other

		pollution	water pollution	- General student satisfaction rate about learning within the target context	to peatland) - Canal construction area - Water level in the canal and peatland - Fire generation and frequency 2) Storage technology for the above data and appropriate analysis skills		personal information
4. Appropriate technology	a)Communication Technologies	Between fisherman household (Telecenter) and fishing community center or university (knowledge center). Needed broadband capacity	GPRS, 3-G communication infrastructure low data rate 6LowPAN, Contiki MAC protocol high-speed WiFi	Select the communication technologies by considering the cost of introduction and usage of each technologies, taking into account the environmental conditions, existing facilities, and possibility of shared usage with other appropriate services, etc. At this juncture, relevant system s are decided to meet the required performance in a cost-sensitive way, not necessarily with regard to leading edge technology. < Area and long distance > - Optical fiber and PON*1 system, metal, microwave and WiFi *1 PON: Passive Optical Network - Satellite communication - Mobile phone data communication service < School connection requirements > - Wired LAN or WiFi - Cable system for broadcast	Communication tool (Wi-Fi and millimeter wave technology)	<Regional/wider geographic area> - Optical fiber/metal cable/microwave + wireless LAN - Satellite communication - Mobile phone (data communication) services <Situational customer-based premise> - Wired/wireless LAN - Broadcasting system	ISDB-T, WiFi and IPTV
	b) Sensor network Technologies	1) Sensor and measuring equipment (Dissolve oxygen, air & water temperature, pH, humidity, and imagery,	1) Sensor and measuring equipment (Dissolve oxygen, water temperature, pH, oxygen, salinity, turbidity,	(Normally not applicable)	1) Sensors and measuring equipment (Water level, CO_2 / methane concentration, rainfall, temperature,	1) Measuring equipment to provide health checkup service (height scale/ weight and body fat scale/ thermometer/	N/A

		etc.) 2) Radio wave (such as WiFi) technology 3) Power equipment (solar panel and battery)	conductivity, and imagery, etc.) 2) A low-power wireless communication protocol (Contiki MAC protocol) for strict power constraint; and high speed WiFi technology 3) Power equipment (solar panel, super capacitor and battery)		humidity, wind speed, etc.) 2) Radio wave (such as WiFi) technology 3) Power equipment (solar panel and battery)	blood-pressure gauge/ pulse counter) 2) Short range wireless communication technology (Bluetooth) for the data collection of health checkup service.	
	c) Center Facility	1) Server technology for storage of collected data 2) Internet server capability to respond to remote area	1) Server technology for storage of collected and analyzed data 2) Web server capability to respond to remote area	1) Data server and storage machines 2) Broadcast server or head-end 3) e-Learning systems (application systems and contents) 4) Relevant multimedia educational materials including pictures, video, sounds, text, etc., interactive tools and digital playground space, etc.	1) Server technology for storage of collected data 2) Internet server capability to respond to remote area	1) Data server and storage machine 2) Multimedia electric learning materials database 3) e-Learning systems (application systems and contents)	1) Data survey and storage machine 2) ISDB-T and IPTV head-end system to deliver information
	d) Terminal devices	Personal computers and smart device including GPS function.	Personal computers, and smart devices.	1) Personal or shared computers (desktop, laptop or tablets, smart phones, etc.) 2) School devices (displays, sound systems, electronic whiteboards, etc.)	Personal computers (desk top type)	1) Personal or shared computers (desktop, laptop or tablet, smart phones, etc.) 2) Facilities of medical institutes and administrative institutes (visual displays, audio equipment)	ISDB-T terminal WiFi terminal IPTV terminal
5. Human resource		Personnel who operate ICT system (Refer to the category 4 - Appropriate technology)					
		Personnel who maintain ICT system (Refer to the category 4 - Appropriate technology)					
		In order to realize sustainable implementation of e-Aquaculture system, the following human resource should be ensured and cultivated.	In order to realize sustainable implementation of shrimp farm water monitoring system, the following human resource should be ensured and cultivated.	In order to realize sustainable implementation of e-Education systems, the following human resource should be ensured and cultivated. 1) Teachers or education expert	In order to realize sustainable implementation of e-Environmental system, the following human resource should be ensured and cultivated.	In order to realize sustainable implementation of e-Healthcare systems, the following human resource should be ensured and cultivated.	In order to realize sustainable implementation of e-Disaster risk management systems, the following human resource should be ensured and

		- Experts for design and construction of M2M monitoring system - Maintenance personnel of e-Aquaculture system; experts for data analysis - Teachers or education experts for ICT training and environment education of local ICT engineers and residents	- Experts for design and construction of shrimp monitoring system - Maintenance personnel of the system; experts for data analysis - Experts for ICT, aquaculture and environment training	resources 2) Maintenance personnel for e-Education systems	1) Experts for design and construction of M2M monitoring system 2) Maintenance personnel of e-Environment system ; experts for data analysis 3) Teachers or education experts for ICT training and environment education of local ICT engineers and residents	1) Medical doctor or professional health services resources 2) Maintenance personnel for managing medical facility and services (remote medical checkup services)	cultivated. 1) Maintenance personnel for IPTV and ISDB-T equipment to deliver disaster information 2) Maintenance personnel for creating effective disaster information to government and persons in disaster areas