

Wireless Networking and Filed Server in the high Himalayas

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Abstract

Nepal Research and Education Network (NREN) in collaboration with Asia Pacific Advanced Network (APAN) Japan, National Agricultural Research Center Japan (NARC), Keio University Japan, e-Lab Japan and other Japanese teams installed Filed Server and its Wireless network in the high altitude Everest region of Nepal. NREN team used combination of WiFi radios and proprietary Motorola Radio in ISM bands of 2.4 and 5.7 GHz. The networking project was done to monitor the environmental information (e-Environment) like temperature, humidity near the Imja Glacial Lake situated at 5200meter, Mt Everest Region. This scientific research has been conducted to monitor on glacial lakes and melting glaciers, consisting of detailed field investigations to study the climate change impacts on the glaciers, glacial lakes and risk posed on GLOF hazard by potential dangerous lakes. We're also conducting research on both sides-performances testing for extreme weather for both wireless networking and field server.

The NREN team formed two relay stations at approximately 5200meter situated about 25 KM apart and one relay station in 3700meter for network redundancy. The relay stations in turn were connected by wireless radio to the V-SAT station in one end, and the monitoring field server at the other end. The bandwidth throughput was approximately 5Mbps over the network.

Keywords: Wireless Network, Field Server, Sensors, Glacial Lake, Outburst Flood, Climate Change, Global Warming, Early Warning System, GPS measurement, Water Level.

Introduction

Glacial lake outburst flood (GLOF) is technically a sudden and often catastrophic flood that occurs during a volcanic eruption, but is also used to describe other sorts of glacial flooding, can occur when a lake contained by a glacier or a terminal moraine dam fails. This can happen due to erosion, a buildup of water pressure, an avalanche of rock or heavy snow, an earthquake or cryoseism or if a large enough portion of a glacier breaks off and massively displaces the waters in a glacial lake at its base. The global climatic change during the first half of the twentieth century has brought a tremendous impact on the high mountainous glacial environment. Many of the big glaciers melted rapidly and gave birth to the origin of a large number of glacier lakes. The faster rate of ice and snow melting, possibly caused by the global warming, the accumulation of water in these lakes has been increasing rapidly and resulting sudden discharge of large volumes of water and debris and causing flooding in the downstream.

Out of 20 potentially dangerous glacial lakes in Nepal, 12 lie in this Khumbu, Mt. Everest Region. GLOF causes disasters to life and property along the downstream, results serious death tolls and destruction of valuable forests, farms and costly mountain infrastructure. The recent catastrophic GLOF event in the Nepal known as the Dig Tsho GLOF in 1985 has destroyed the Namche small hydro project, big amount of physical infrastructure and human lives. Accurate and timely information on the spatial locations and regular monitoring of the glacier lakes behavior is needed to prevent and monitor the GLOF hazards and assess the damages to be occurred in the near future.

Therefore, modern information tools such as Field Server with integration of wireless technology, Remote Sensing and GIS could play a lead role in identifying potential risk lakes and monitoring the GLOF events in near real time. Field server has been played an effective equipment to gather potential information for the scientific prediction of GLOF. Early warning system is a potential safety method to reduce the impact of ongoing disaster. It provides information earlier than the disaster happen.

The highest risk from climate change is the increasing risk of Glacial Lake Outburst Flood (GLOF):

Impacts mountain eco-system

Displaces downstream villages

Further south, huge damage to crops and other livelihoods

There are many new glacial lakes being formed in the high Himalayas in Nepal.



Imja Glacial Lake

The Everest region is one of the hotspots of glacial melting in the Nepal Himalayas. Out of 20 potentially dangerous glacial lakes in Nepal, Ima Glacial Lake is in most danger lake for Glacial Lake Outburst Flood (GLOF). A study conducted recently by the KIEO University Japan and International Centre for Integrated Mountain Development (ICIMOD), states that Imja is the fastest-retreating glacier in the entire Himalayas. Imja Lake, located at an altitude of 5200meter in the Mount Everest region is expanding at an alarming rate. It is growing by 74 meters a year. Spotted as a group of small masses of snow in 1962, it has now turned into a one-square-kilometer lake.



Field Server

A Field Server (FS) is a sensor node which can create a wireless sensor network and simultaneously serve as Wi-Fi hotspots in open fields. Since 2001, NARC have been working on Environment, Glacial Lake Outburst Flood Monitoring and Early Warning System Research and Development projects to develop field server technology and its applications. So far, three generations of field servers have been developed and are in use in more than a dozen countries for collaborative research and educational applications such as a global sensor network for Earth observation, Environment, food safety/IT-agriculture, advanced sensor technology in fields and image monitoring for urban areas.

FS with integration of wireless technology to access data through Internet is a very good initiation to monitor the glacial lake, implemented in Imja Lake, Mt. Everest Region, Nepal.

FS as a distributed sensing device consists of web-server, multi-sensors, web-camera, wireless LAN module, high intensity LED lighting for environmental measurement, plant/animal monitoring, farm observation at fields or facilities in the long term for good initiation for disaster management.

Implementation

Regular monitoring based on scientific data and information of the lake is crucial. To initiate an early warning system; a wireless LAN setup has been established using innovative geo-ICT tools and technologies to connect different field monitoring devices for real time monitoring and early warning for potential GLOF.

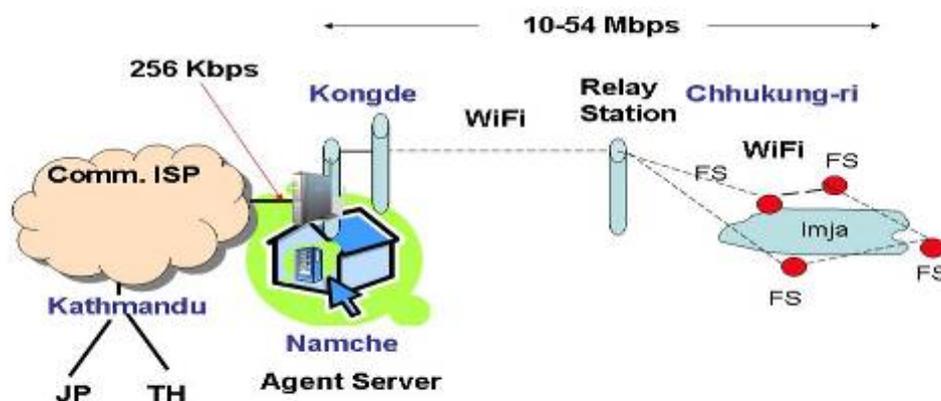
Real Time Monitoring and Early warning system has diverse area of application such as flood monitoring, volcanic monitoring, earthquake and landslide monitoring etc. FS plays an effective tool to provide proper information within a sudden time period. A fast-swelling glacial lake, is putting the entire Khumbu region in peril. When Imja Lake is burst, it will create a vertical tsunami tearing villages, mountain lodges, bridges, mountain paths, hydro electric plants, world heritage woodlands, animal habitats, wildlife, livestock and most importantly innocent lives- from the slopes leading to Mt. Everest.

Nepal Research and Education Network MoU with NARCC Japan and AP, KEIO University Japan MoU with and the Department of National Park and Wildlife conservation, APAN Japan, e-Lab Japan and other Japanese teams have given joint efforts for the establishment of early warning system in Imja Lake. FS integration with Wi-Fi mesh is a self monitoring device, powered by solar cells and capable of collecting a wide range of data on

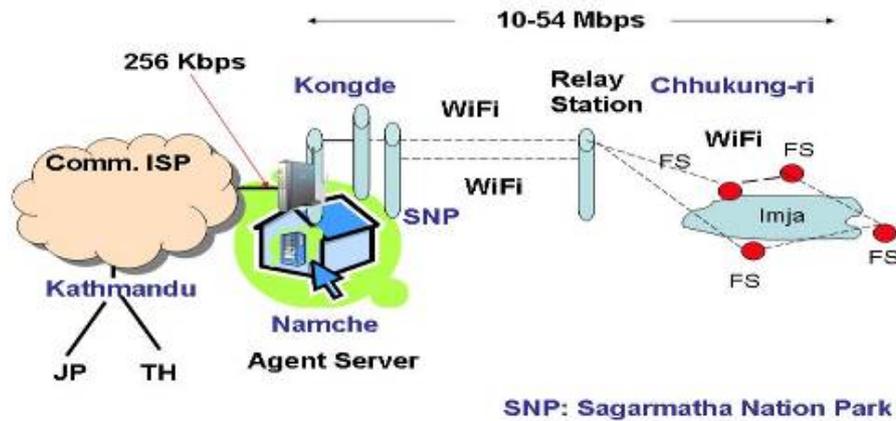
FS transmitted the data and picture through this wireless networks which is connected on VSAT at Namche. The FS started capturing images and several types of meteorological data that has been transferred real-time to a server located in Japan at <http://fsds.dc.affrc.go.jp/data4/Himalayan>.

This research project outline objectives are:

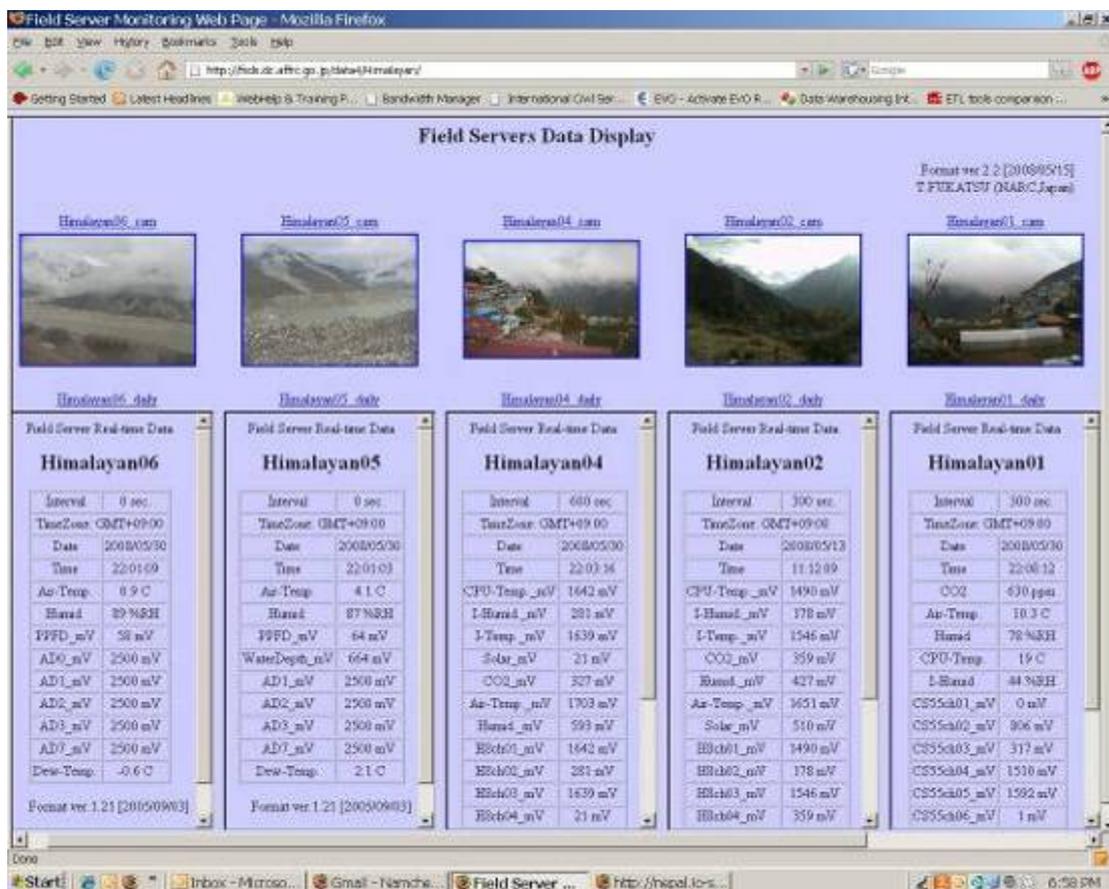
1. Install field server near high camp of island peak and ridge of the lake
2. connect downstream villages with networking facilities for early warning system
3. GLOF monitoring and enhance networking
4. GPS and Water level measurement



First phase of this project research activity has started from two FS in November 2007. One in Namche Bazar and another one in Imja Lake, FS took pictures and data of environment in that region and lake every 10 minutes and all data were updated through wireless network and forwarded through Internet to NARC lab for recorded on a website.



Second phase of this project research started on mid April 2008, Install new three FS, One in Sagarmatha National Park and another two FS near to high camp of Island peak ridge, which easily inspected the overall activities of the lake. The FS setup was undertaken under extremely difficult and adverse weather conditions. The FS started capturing images and several types of meteorological data that has been transferred real-time to a server located in Japan. The field server at different places forwarded the metrological data which included humidity, temperature, pressure, Co2, Images of lake, water level.



Other Activities of this Research Project are:

GPS measurement on Chukkung-ri and surrounding of Lake

Geographical positioning system was measured in Chukkung ri near by relay station and surrounding area of the Imja lake. It gave general information for measuring center access point of particular location.

Corner reflector installed.

The new Corner reflector was installed on south part of Imja, for measuring satellite picture of the lake. One corner reflector had already installed there on the ridge of west part.

Water level sensor installed.

Water level sensor was installed on the west ridge of the lake. Water level sensor regular monitoring the water surface of the lake. It plays a big effort to analysis the threats of glacier burst or some kind of potential hazards.

Measurement of outlet pond depth.

Imja was semi-frozen when the team planning to measure the centre depth of the lake. It was difficult to measure the centre depth with the help of boating so the surrounding outlet pond depth had been measured by the research team.

Assessment of the status of end moraine.

The research team had observed the end moraine status with the help of some scientific tools. It was found that there is not a big threat for few years.

Technology Lessons Learned:

Wireless Network can be made to work in remotest areas

Low power self sufficient devices embedded with appropriate sensors are needed to avoid big impact on fragile ecosystem

Power storing technology still needs more work for remotest areas

Even if you have solar panels, without long lasting battery storage - you can't benefit much.

The major problem is power in this location.

- ICT technologies can help in monitoring and documenting changes. It will also help in taking preventive measures.
- ICT can also increase the awareness in local communities about potential hazards
- A public private partnership between local communities, government, service providers and scientific researchers can only get the work done.

Two more Field Server donated by NARC to NREN and that FS will be using as follows:

Adaptation to climate change: The effect of climate change in the form of increase in temperature, change in monsoon cycle, heavy rainfall, floods and droughts have adverse effect in the limited livelihood options of the rural poor. The vulnerable communities need strategies to cope and adapt with this changing environment. Information system with implementation of FS enables community to develop strategies to cope and adapt the changing environment efficiently and this will also help top-level decision makers to identify the vulnerable

communities and developing different strategies to cope and adopt the changing environment due to climate change.

• ***Community based system for monitoring climate change***

It is a monitoring system to monitor the key parameters such as temperature, rainfall, etc. to monitor the climate change in the local level. Local community monitors the changes using different sensor and maintain the database locally and provided information to central database using telephone. This system enables community to know the trend in local level which will help in developing various coping strategy in local level. Database maintained in the center will help to develop different strategies for prioritizing, planning and implementing the programs with regard to climate change. Field server with implementation of wireless network can be a good approach of developing monitoring system for climate change.

• ***Weather forecasting system***

Forecasting system with implementation of Satellite weather forecast for gathering information and communication technologies such as Radio, CDMA, Mobile, land telephone, etc. for disseminating information as disaster management forecasting system similar to one mentioned above.

• ***Community based GIS information system for vulnerable of areas***

This system maintains the GIS database of vulnerable communities which will help in developing different types of strategies to cope and adapt the changing environment.

• ***Knowledgebase to cope the effect of climate change***

ICT based knowledgebase that enables targeted communities to exchange various knowledge required to cope the effect of climate change such as natural resource management for reducing effect of climate change; local knowledge and practices of coping the effect; best practices to adopt the changing farming systems; livelihood options for affected community; etc.

• ***Communication systems for interaction***

Two way audio-visual communications to interact with experts to get advice on copying the effect of climate change. Integrated system of CDMA or mobile or land telephone and Radio / TV could be an appropriate technology for this system.

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