

Sensor Service Grid (SSG) and Wireless Networks for Monitoring Climate Change in Himalayan Regions

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Nepal Wireless Project

Sensor Networks are Growing

- Ubiquitous Networks
 - Internet/ Network Availability/ IPv6
- Sensors are/ will become cheaper
 - IC Technology
 - Moore's Law
- Wide ranging applications in any monitoring

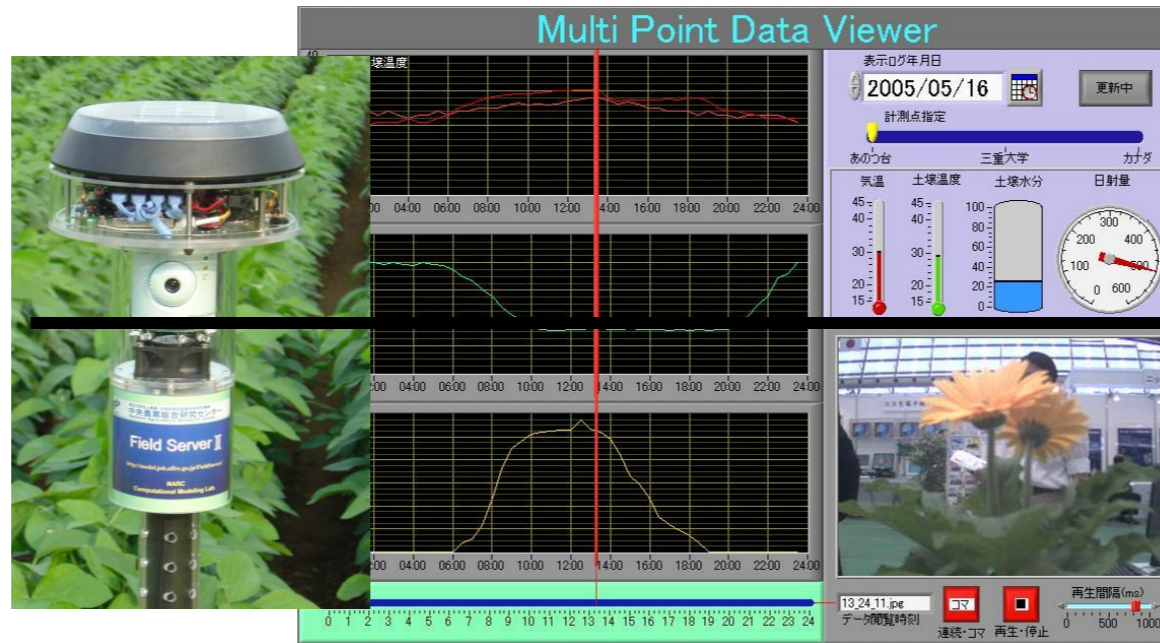
Fieldserver

- Consists of:
 - CPU
 - Embedded Webserver
 - Analog to Digital Converter
 - Multiple Sensors
 - Network IP Camera
 - Wireless + Ethernet Interface

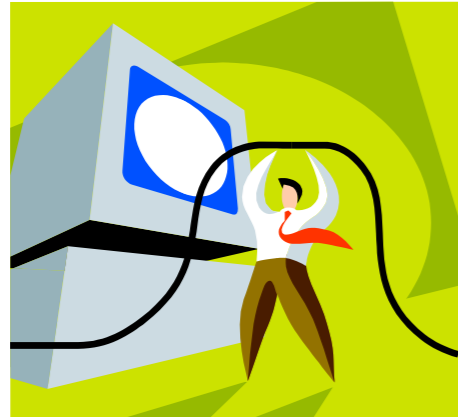


Introduction to SSG

R&D
Manual Setup
Knowledge on
Network,
Database....



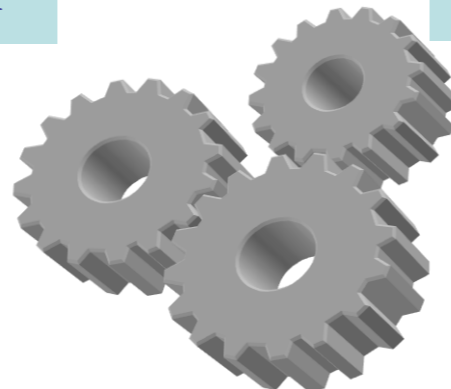
Real Application
Automatic Setup
Sensor Plug&Play



FS Specialist
Computer / Network Engineer



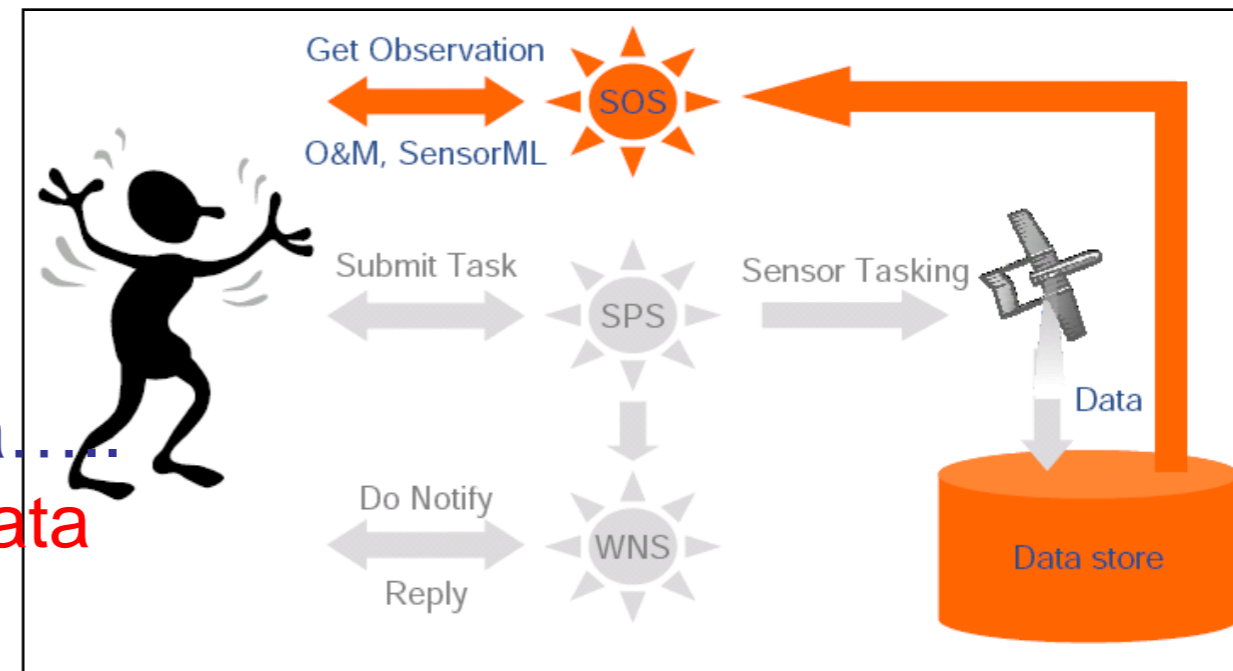
Farmer, Application Engineer,
Kids interested in Environment



Sensor Service GRID (SSG)
Sensor Observation Service

SOS: Sensor Observation Service

- OGC: Open Geo-Spatial Consortium Standards on SWE
 - SOS (Sensor Observation Service)
 - SPS (Sensor Planning Service)
 - WNS (Web Notification Service)
- Obtain Sensor Information
 - Standard Query and Answer
 - O&M Documents (xml)
 - Sensor Name, Location, Spec, Data.....
- Provide standard interface to sensor data
- Limitations
 - Not field oriented
 - Gap to physical sensor setup
 - Sensor configuration
 - Security
 - Public Service



SOS Station

Communicate via Standard Protocol Returns
Standard O&M Document



Fieldserver

+



Linux Box

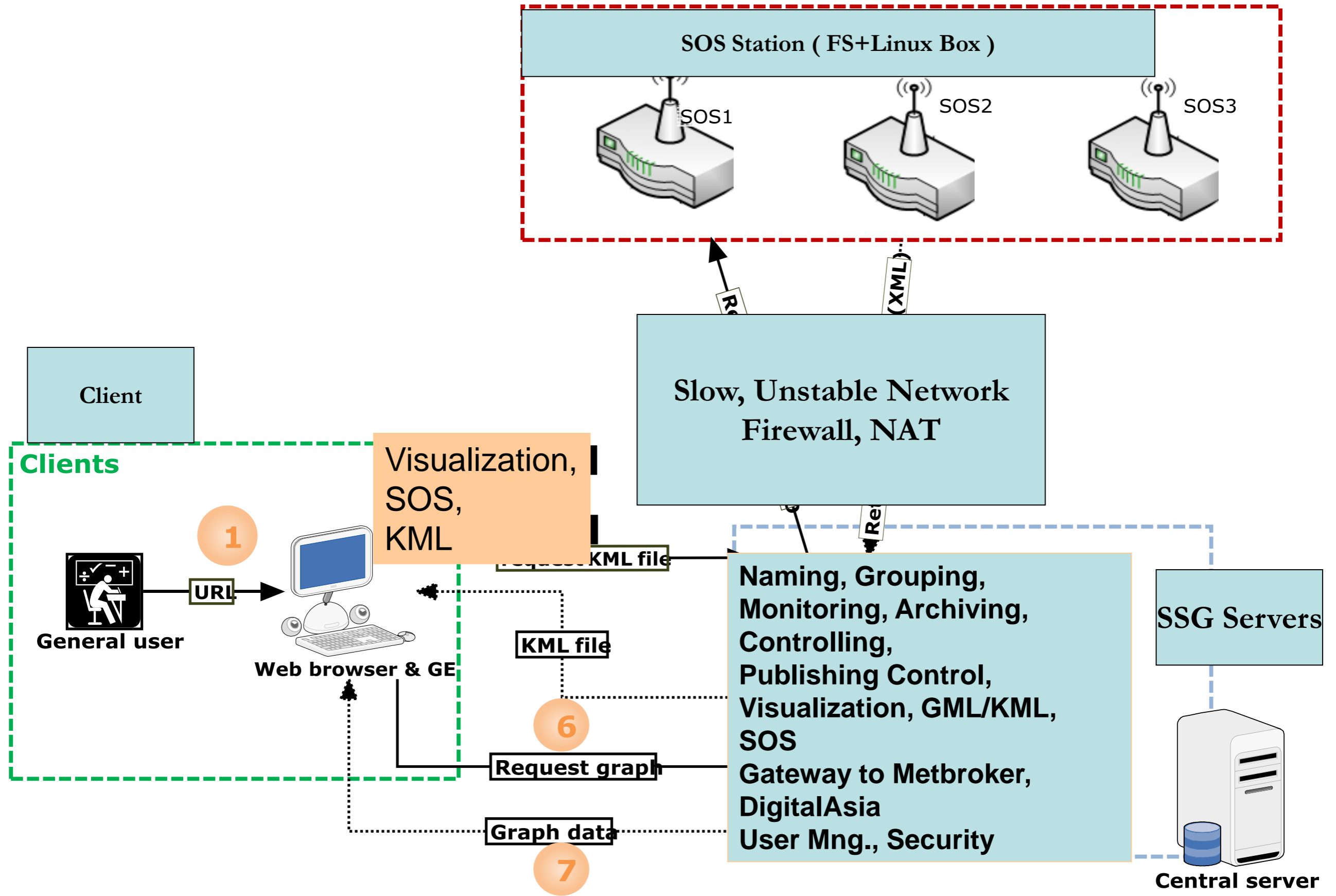
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SOS Station

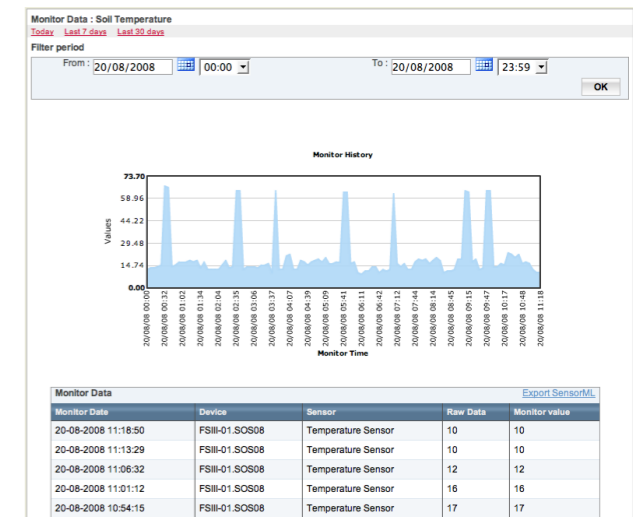
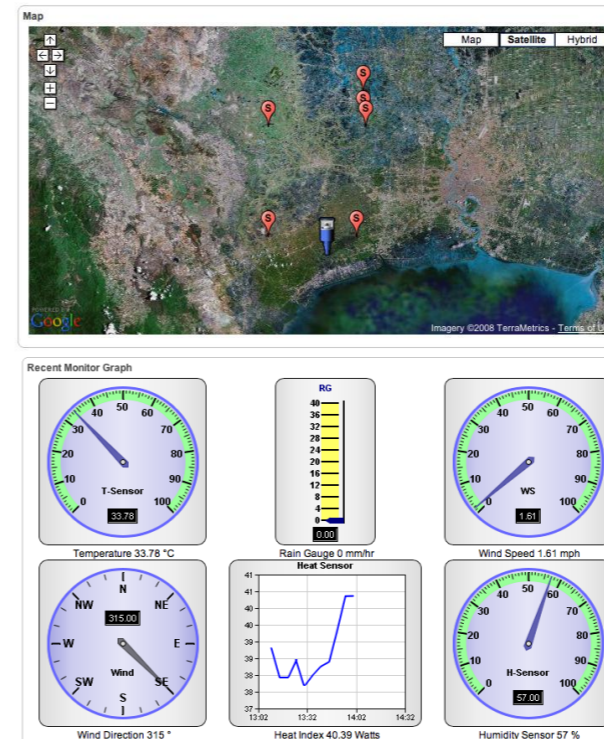
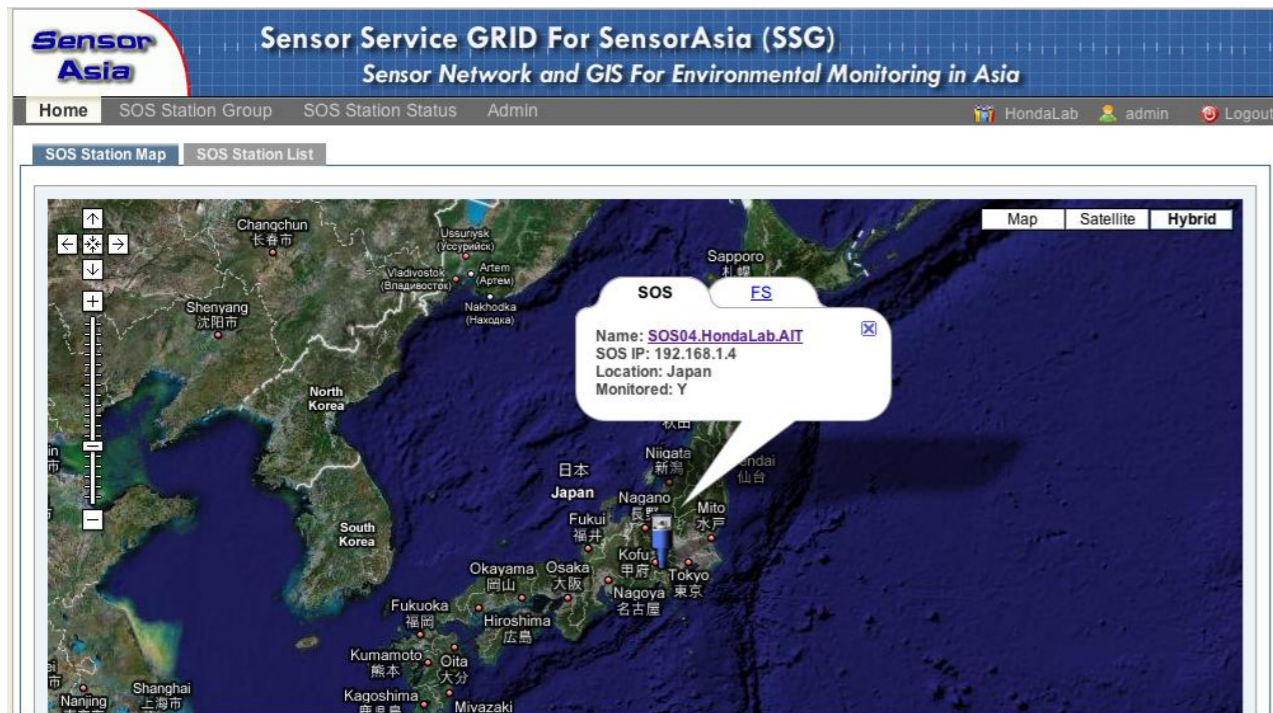
SOS Implementation

Overview of Sensor Service GRID



SSG

GIS & visualization interface



- SSG provides a user-friendly GIS visualization interface
- Shows locations of Fieldservers on web-maps
- Shows the data from various kinds of sensors and weather-stations in easy-to-understand graphs and dials.

http://ssg.sensor-asia.net/ViewMonitorHistory.jsp?sosId=91&deviceid=165&sensorid=581

Monitor Data : K30 CO2 Concentration Sensor

[Today](#) [Last 7 days](#) [Last 30 days](#)

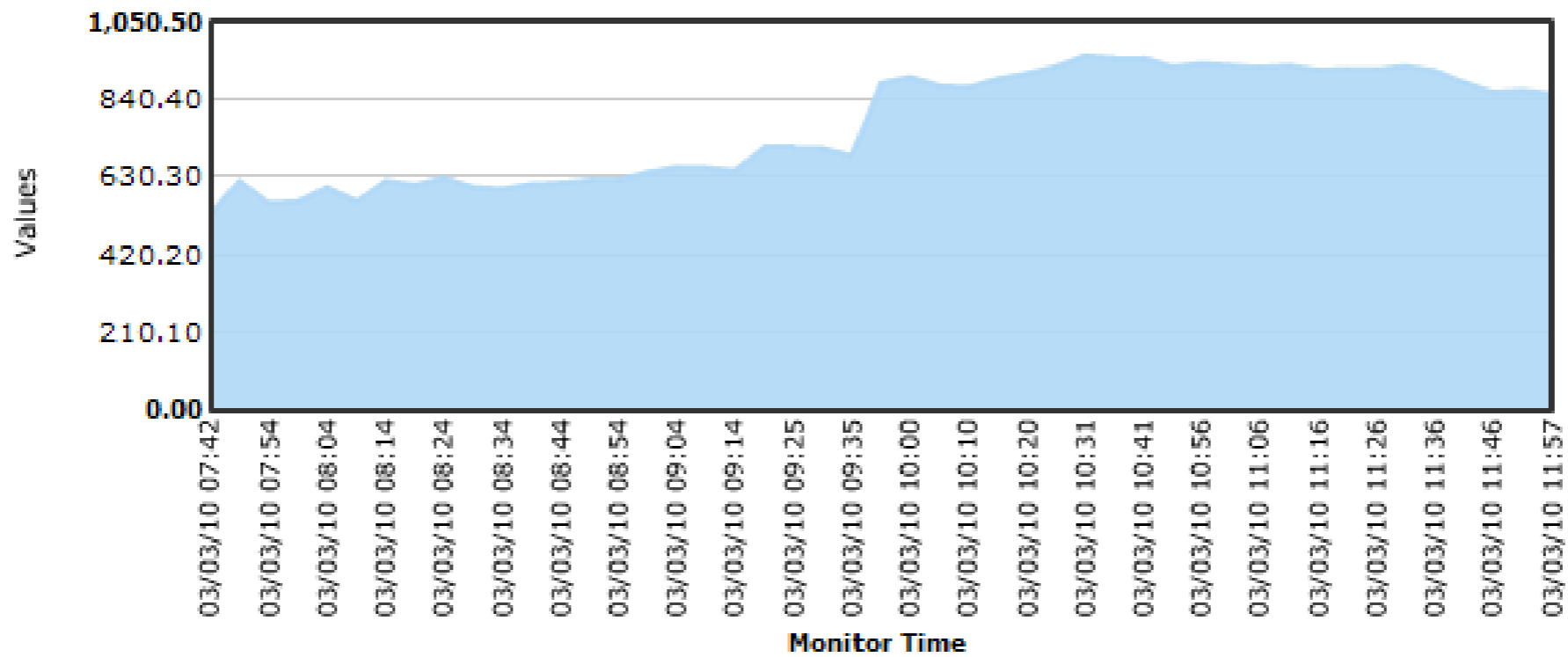
Filter period

From : 03/03/2010 00:00

To : 03/03/2010 23:59

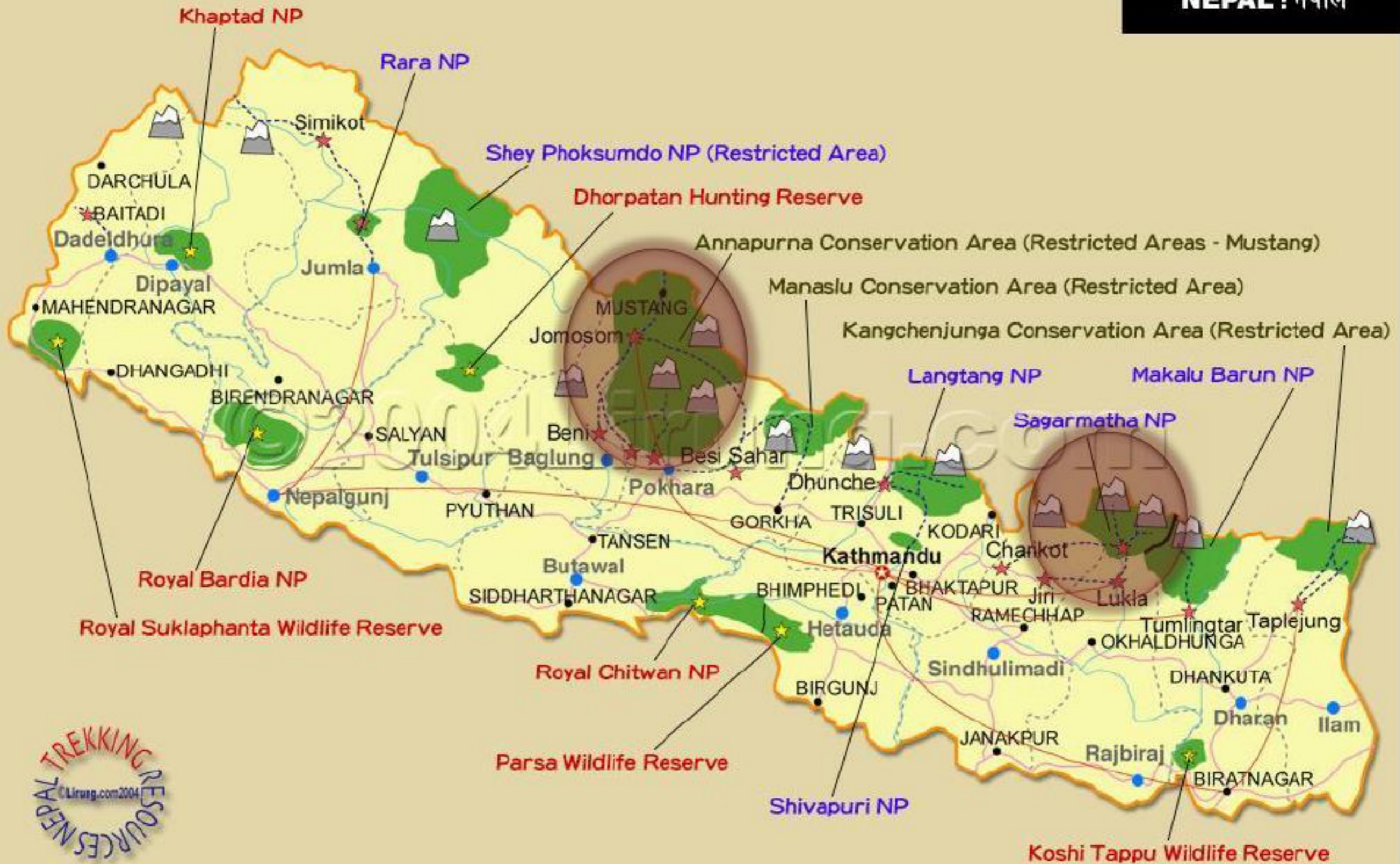
OK

Monitor History



Two applications in Nepal

- **Glacier Lake Monitoring, Everest Region**
- **Weather Monitoring, Annapurna Region**



Glacier Lake Monitoring, Everest Region

What are Galciers?

A glacier is a large, slow moving river of ice



Unknown Glacier, near The Pyramid, Lobuche

Glacier Lake

- A **glacier lake** is a lake with origins in a melted glacier.



Imja Lake (Imja Tso), 5000m, Everest Region

Imja Glacier Retreat and Growing Lake

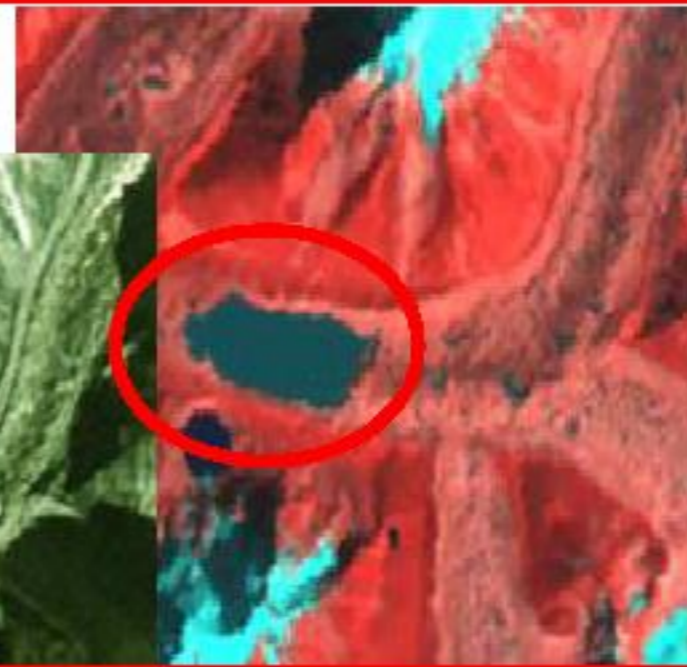
Source: ICIMOD



•CORONA
15 DEC 1962



•SPACE SHUTTLE
DEC 1983



•LANDSAT TM
1992



•IRS ID PAN 19
MAR 2001



•ENVISAT, ASAR, 18 October 2007



Quickbird Jan. 2006



•IRS LISS3 2005

Imja Glacier Lake Monitoring

- Joint Work with
 - Keio University, Japan
 - Nepal Wireless Networking Project
 - Nepal Research and Education Network (NREN)
 - Asian Institute of Technology
 - ICIMOD, Nepal
 - Sagarmatha National Park, Nepal
- Initial Survey – September, 2007
- Primary Setup – November, 2007
- Maintenance Trip – April, 2008

Deployment in the Himalayas

- Deployment at:
- Imja Lake (5000m)
 - A glacier lake in the Everest Region.
 - In Danger of bursting and turning into GLOF at any time soon
 - There are many villages, bridges and small hydroelectric generators in the lower areas
 - Many tourists also visiting



Nepal

Gandaki

Kathmandu

Ruler

Line Path

Length: 137.09 Kilometers

Mouse Navigation Clear

Image © 2007 DigitalGlobe
© 2007 Europa Technologies

Image © 2007 TerraMetrics

© 2007 Google



Gorakshep, 5171m

Imja Lake, 5015m

Chukkungri, 5134m

Chukkung, 4773m

Pyramid, 5000m

Dengboche, 4365m

Thukla, 4627m Pheriche, 4269m

Shomare, 4052m

Pangboche, 3960m

Phortse, 3808m

Khumjung, 3735m

Namche, 3386m

Monjo, 2821m

Phakding, 2640m

Lukla, 2847m

Airport

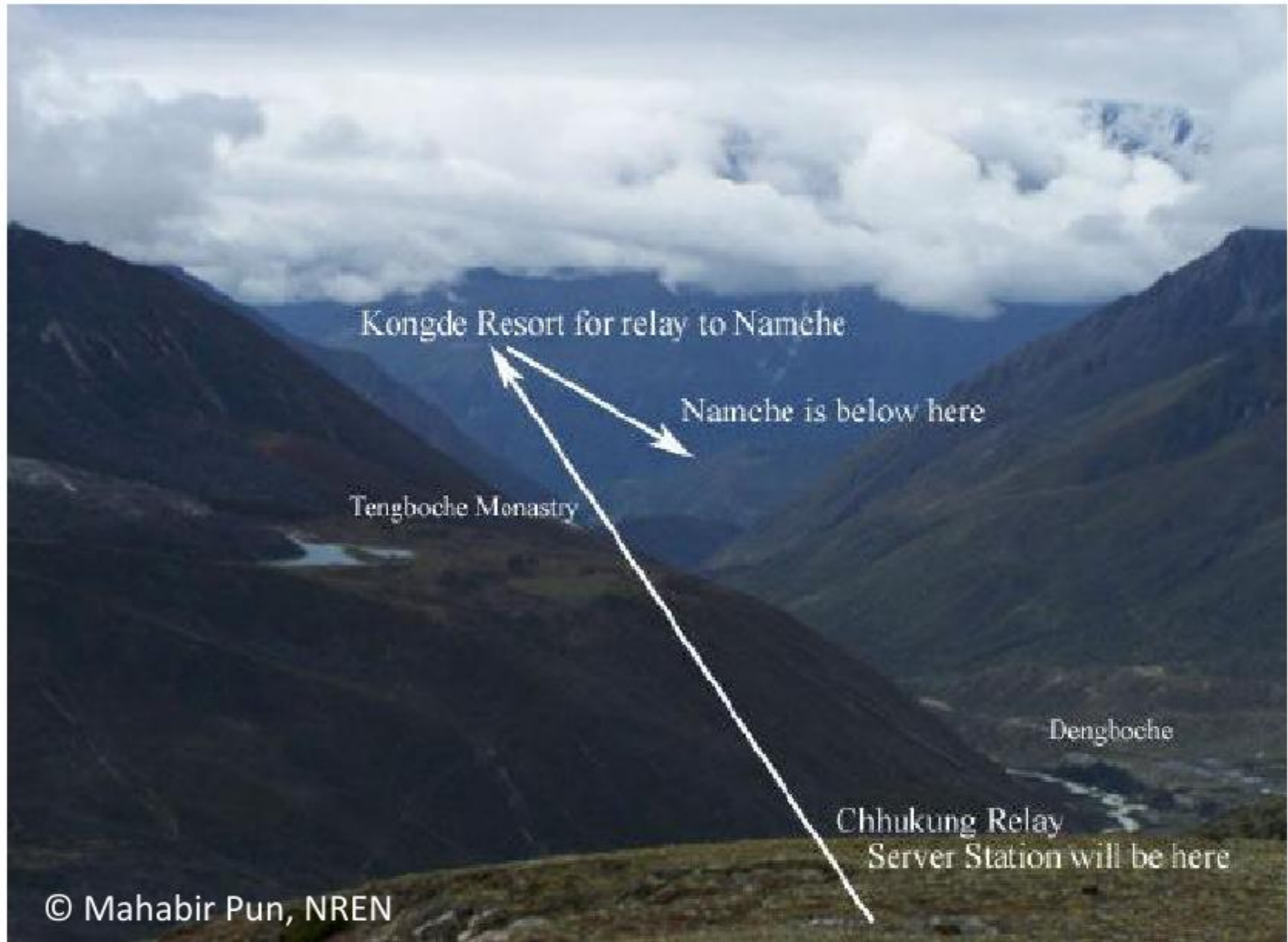
Image © 2007 DigitalGlobe
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Imja Glacial Lake Monitoring Network



Implementation Outline



Implementation Outline



Chhukung Relay at 5,143 m



Field Server at Imja Lake 5000 m



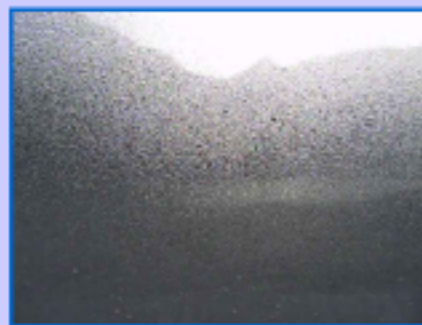
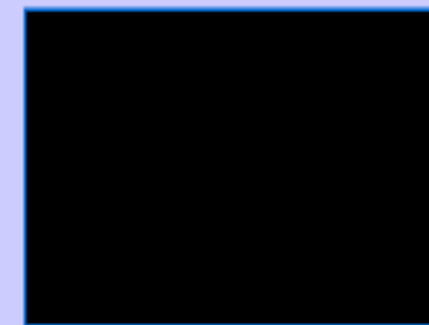
Field Server Monitoring Agent

Format ver.2.2 (T.FUKATSU)

[DataViewer](#) | [ImageViewer](#) | [aboutFieldServer](#)

 select FieldServer
[all data](#) / [round cam](#)
 fs Cam

Field Server

[Himalayan06 \(e-Lab FS4, Imja ridge\)](#)
[Himalayan05 \(e-Lab FS4, Imja Lake\)](#)
[Himalayan04 \(EOS version\)](#)
[Himalayan02 \(2008 Standard version\)](#)
[Himalayan01 \(demo version\)](#)
[Kathmandu03 \(Toshiba-cam version\)](#)
[Himalayan05 cam](#)[Himalayan04 cam](#)[Himalayan02 cam](#)[Himalayan01 cam](#)[Himalayan05 daily](#)

Field Server Real-time Data

Himalayan05

Interval	0 sec.
TimeZone:	GMT+09:00
Date	2008/06/04
Time	12:01:57
Air-Temp.	10.5 C
Humid.	65 %RH
PPFD_mV	996 mV

[Himalayan04 daily](#)

Field Server Real-time Data

Himalayan04

Interval	600 sec.
TimeZone:	GMT+09:00
Date	2009/10/23
Time	00:00:32
Air-Temp.	11.8 C
Humid.	49 %RH
CPU-Temp.	16.6 C

[Himalayan02 daily](#)

Field Server Real-time Data

Himalayan02

Interval	300 sec.
TimeZone:	GMT+09:00
Date	2009/10/23
Time	00:15:22
Air-Temp.	5.1 C
Humid.	91 %RH
CPU-Temp.	18.1 C

[Himalayan01 daily](#)

Field Server Real-time Data

Himalayan01

Interval	300 sec.
TimeZone:	GMT+09:00
Date	2009/10/06
Time	20:36:16
CO2	696 ppm
Air-Temp.	10.8 C
Humid.	73 %RH

Effects at High Altitudes

- Very Low Temperatures
- Low Atmospheric Pressure
- Many Electronic Devices do not work well.
- Embedded systems
- Special Computer
- No moving parts/fans
- Compact Flash instead of Hard Drive

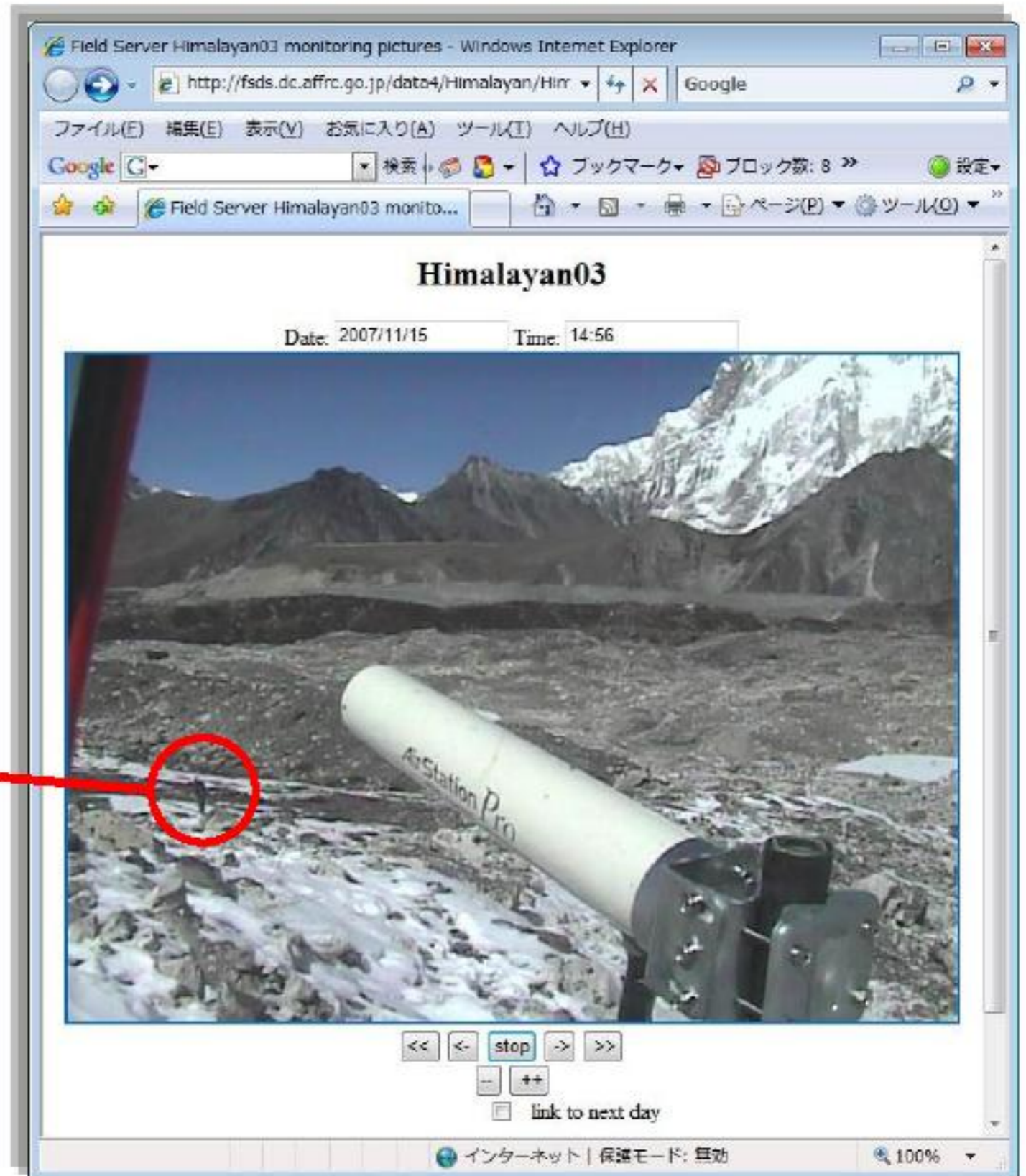


Yeti

- Mythical Creature of the Himalayas

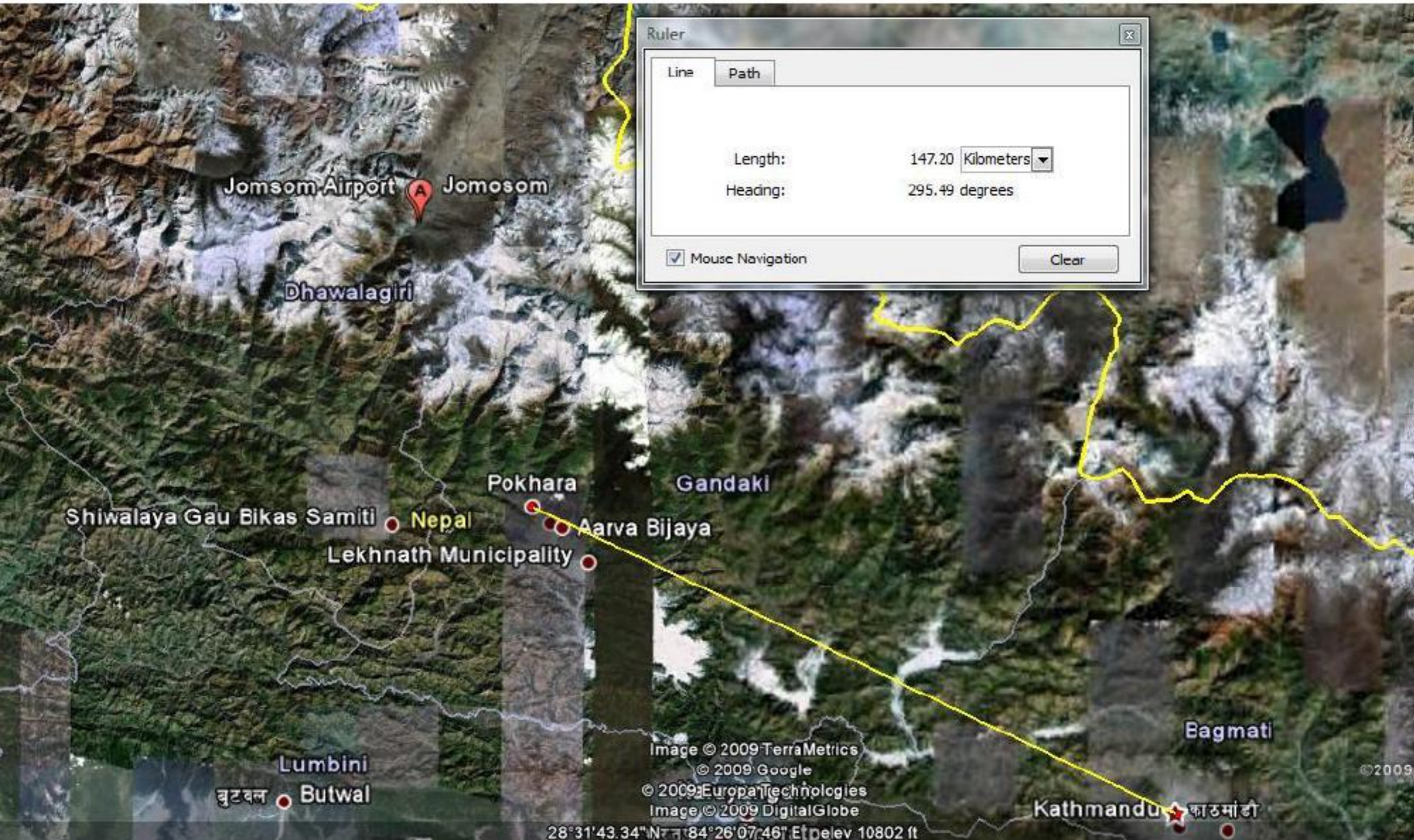


Yeti?



2007.11.15 14:56 JST

Weather Monitoring, Annapurna Region



Ruler

Line Path

Length: 147.20 Kilometers

Heading: 295.49 degrees

Mouse Navigation

Clear

Jomsom Airport Jomosom

Dhawalagiri

Pokhara Gandaki

Shivalaya Gau Bikas Samiti Nepal
Aarva Bijaya
Lekhnath Municipality

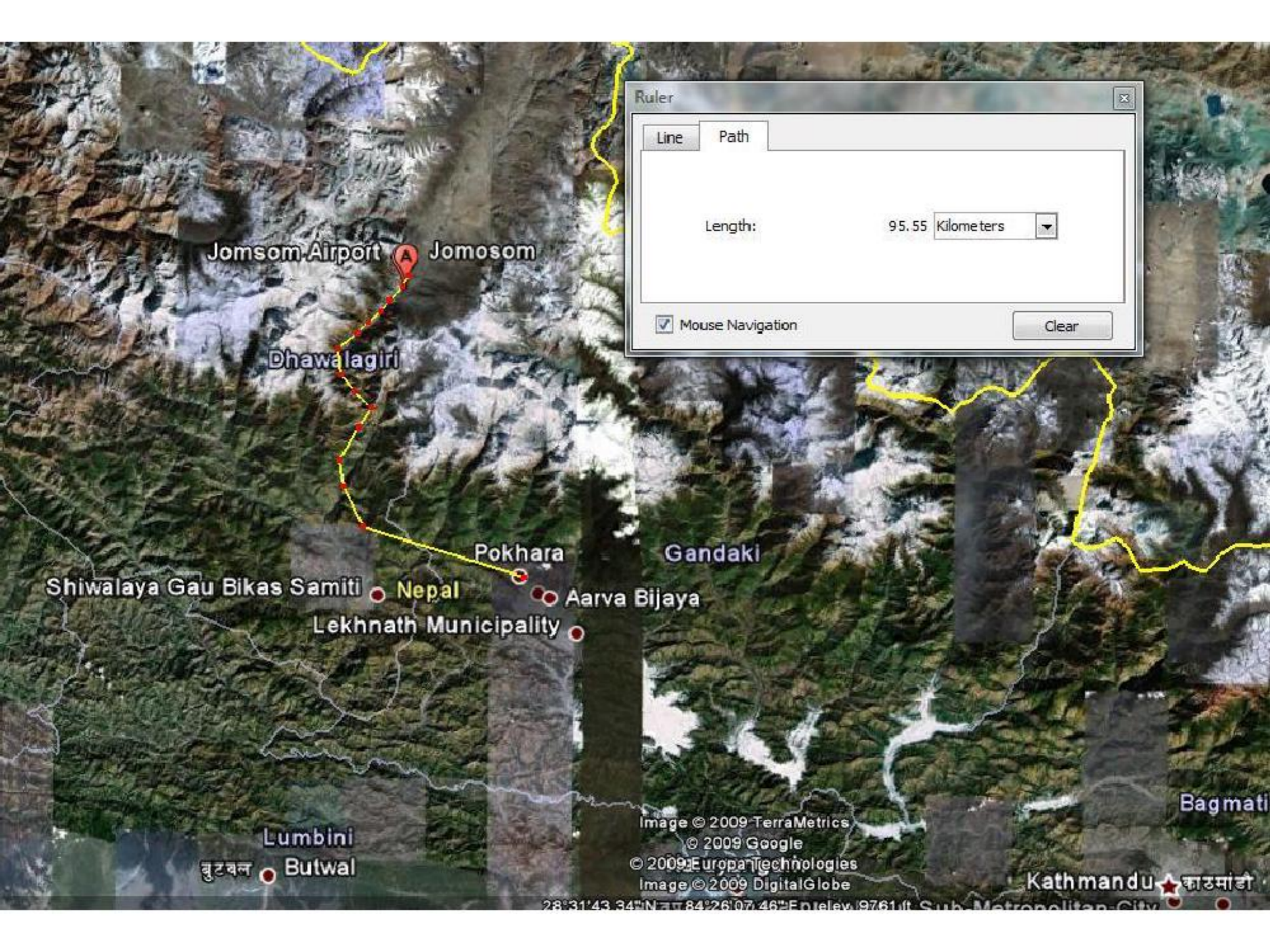
Bagmati

Lumbini
बुटवल Butwal

Kathmandu काठमांडौ

Image © 2009 TerraMetrics
© 2009 Google
© 2009 Europa Technologies
Image © 2009 DigitalGlobe

28°31'43.34"N 84°26'07.46"E elev 10802 ft



Ruler

Line Path

Length: 95.55 Kilometers

Mouse Navigation

Clear

Jomsom Airport A Jomsom

Dhawalagiri

Pokhara

Gandaki

Shivalaya Gau Bikas Samiti Nepal

Aarva Bijaya

Lekhnath Municipality

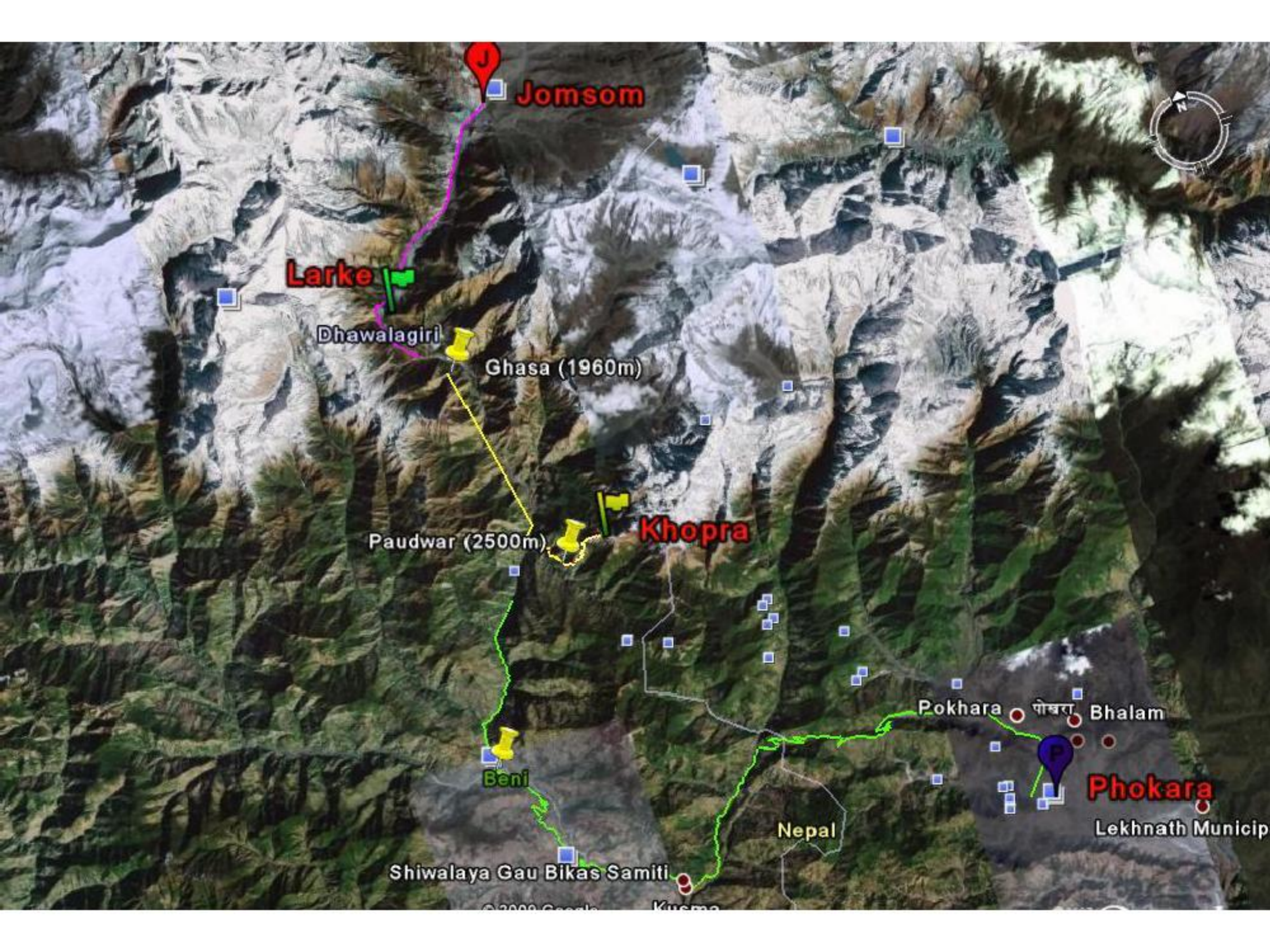
Lumbini

बुटवल Butwal

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 © 2009 Google
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Kathmandu काठमांडौ

28°31'43.34"N 84°26'07.46"E elev. 9761ft Sub-Metropolitan City



J

Jomsom

Larke

Dhawalagiri

Ghasa (1960m)

Paudwar (2500m)

Khopra

Beni

Pokhara

पोखरा

Bhalam

Phokara

Lekhnath Municipality

Nepal

Shivalaya Gau Bikas Samiti

© 2009 Google





Khopra, 3600m, Annapurna Region

Khopra Weather Station 3,600 m



Khopra Network Camera for Aviation 3,600 m





Installation Work: October 2009

Air Traffic Monitoring System at Khopra 3,600 m

Browser tabs: AIT, Pathumthani Weat..., Gmail - Inbox (2) - aadi..., Windows Live Hotmail, Sensor Service GRID fo..., http://esm.sensor-asia...
Address bar: http://esm.sensor-asia.net/services/invoke/com/cherry/app/Home/image_page
Suggested Sites: [Type in Nepali], OpenWrt / What is th..., Endeavour Awards, "PRNG is not seeded"..., iwlist parser (network..., Other bookmarks

[Home](#) | [Cloud & Visibility](#) | [Vaisala Weather Information](#) | [Pre-flight Decision](#) | [Contact Us](#)

Station Name : SSG Khopra Station , Current Server Time : Wed Oct 14 11:38:45 +0700 2009

Howdy, guest | [Logout](#)
Powered by Hondalab



Auto Update

--:--



Panasonic BB-HCM581

Visibility

	5 min	10 min	15 min
3 miles			
5 miles			
7 miles			

Cloud & Visibility information

Time
Start 2009-10-14 11:22:11.642
End 2009-10-14 11:24:05.646

--:--

Cloud cover (%)	Sky conditions
10 - 20	Few
20 - 40	Scattered
40 - 80	Broken
80 - 100	Overcast

Real time Weather Information from Khopra (3,600m)

Myagdi,Nepal Weather - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.hondalab.rsgis.ait.ac.th/weather/KhopraStation/

Most Visited Getting Started Latest Headlines Index of /downloads

Current Progress Myagdi,Nepal Weather

Barometer:	1026.4 mb +
Wind:	S at 10 Km/h
High Wind:	27 Km/h at 09:13
Recent Avg Wind:	10 Km/h
Recent Beaufort Scale:	Light Breeze
Today's Rain:	0.0 mm
Rain Rate:	0.0 mm/hr
High Rain Rate:	0.0 mm/hr at —
Storm Total:	0.0 mm
Monthly Rain:	5.6 mm
Yearly Rain (JAN):	94.5 mm
Air Density:	1.290 kg/m ³
Est. Cumulus Base:	154 m
High Temperature:	7.1 C at 12:25
Low Temperature:	2.7 C at 06:43
High Heat Index:	7.1 C at 12:25
Low Wind Chill:	-1.3 C at 18:56
High Humidity:	97 % at 14:32
Low Humidity:	57 % at 08:30
High Dewpoint:	4.4 C at 17:16
Low Dewpoint:	-3.1 C at 08:11
High Barometer:	1026.4 mb at 19:14
Low Barometer:	1020.8 mb at 12:25

Temperature Dewpoint degrees

14/10/2009 19:20

Wind Chill Heat Index degrees

14/10/2009 19:20

Temp C

3.3
0.9

Wind

09
27

Humidity

92

Precip Day

0.0 mm

Precip Month

5.6 mm

Precip Year

94.5 mm

Syang Muktinath
Member Jomsom

Links to the Remote Monitoring Systems

- <http://fsds.dc.affrc.go.jp/data4/Himalayan/>
(For Imja Glacial Lake Monitoring)
- <http://www.hondalab.rsgis.ait.ac.th/weather/KhopraStation/> (For Khopra Ridge Weather Monitoring, Nepal)
- <http://esm.sensor-asia.net/> (login and password: guest and guest)
- <http://ssg.sensor-asia.net/Login.jsp>
Customer Code: NepalAirRoute, User: guest, Password: guest

Thank you
Any Questions?