SitkaNet: Low Cost, Open-Source System for Landslide Monitoring and Study

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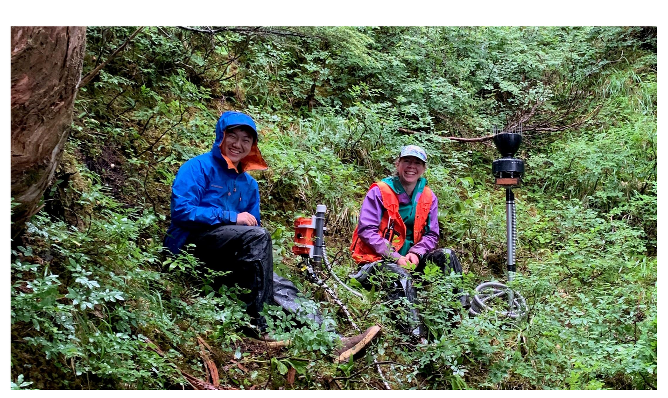
Abstract

Landslides cause billions of dollars and dozens of casualties annually in the US. Situated up against the steep mountains and along the cost of Baranof Island, Sitka, Alaska annually sustains economic and occasional human losses from landslides, spurring city and government initiatives to measure environmental predictors of landslide risk to inform officials where to allocate resources and intervention measures. Efforts have been made to study the soil conditions leading up to and during a landslide, but are limited by cost and ability to instrument enough sites to capture a landslide in action. Traditional methods are expensive, bulky, and hard to install, limiting the number of slopes that can be studied. The SitkaNet project is a low-cost, customized, open-source alternative that allows for numerous sites to be studied. Using industry-proven sensors, each SitkaNet node can measure rainfall, soil moisture levels at 6 different depths, water table, atmospheric pressure, humidity, and temperature at each site. The cost of a node is roughly $1000 compared to over $10,000 for existing systems. The install process is also more streamlined, allowing for a node to be installed in less than a day. Combining LoRa wireless networking technology and Google cloud creates a robust system for accessing in-situ data from anywhere in the world in near real-time. The SitkaNet system relies on each node transmitting data wirelessly at five minute intervals to an internet hub located in the city, removing the cost of cellular or satellite networks.

Purpose

This project was motivated by a severe landslide-triggering storm in Sitka, Alaska in August of 2015. Heavy rainfall caused upwards of 40 landslides near Sitka, including one that caused 3 fatalities. The SitkaNet project was started to develop a low-cost, on-site, real time landslide monitoring system in order to better study and detect potentially landslide-triggering events. Each monitoring station, or node, uses monitoring instruments to track soil moisture, rainfall, and atmospheric conditions on prone hillslopes.



Max Chu (left) and Annette Patton (right) after the installation of a monitoring node in Sitka

Installed node outside of Sitka

Once long-term data collection has been established, the SitkaNet system will be used as a part of a landslide warning and detection system in Sitka. The goal of the SitkaNet project is to create an effective warning and monitoring system that could be used not only in Sitka, but throughout Southeast Alaska and other remote communities that are impacted by landslide-causing events and hazardous weather conditions.

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(http://www.open-sensing.org/)

Scan Me to go to the OPEnS Lab Site!

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Hardware Design

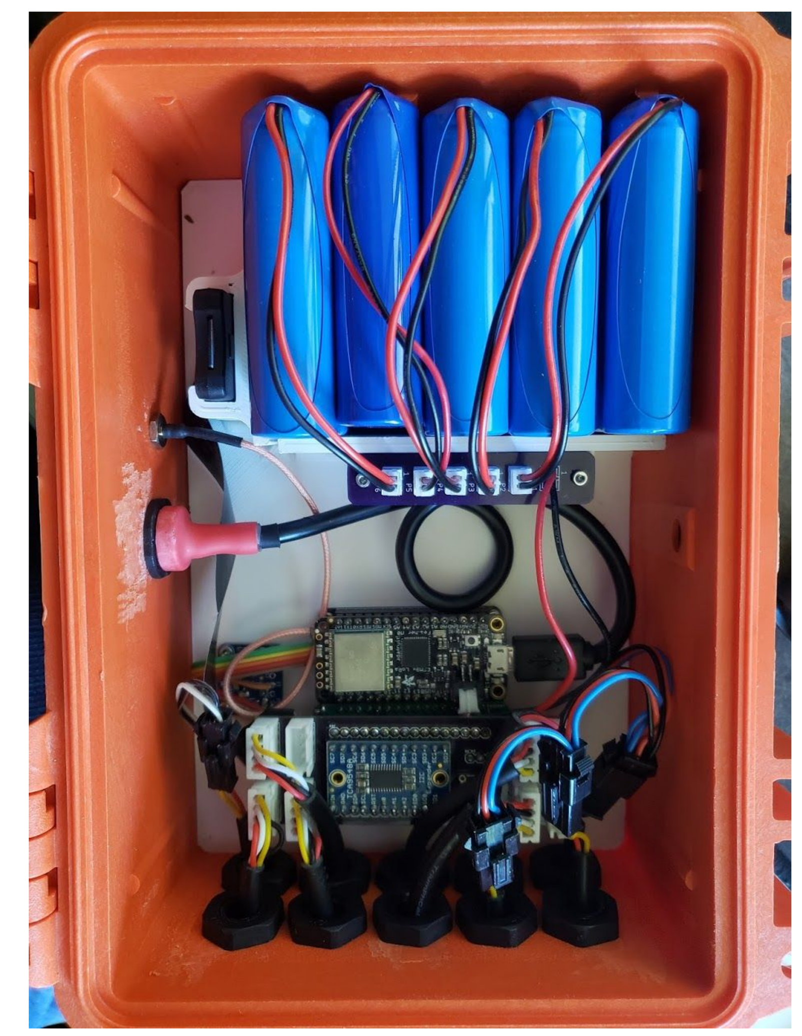
Each node in the SitkaNet system contains the following sensors:

- 3 METER Group Teros 11 Soil Moisture Sensors
- 3 Adafruit STEMMA Soil Moisture Sensors
- 2 TE Connectivity MS5803-02ba Pressure and Temperature Sensors
- 1 Adafruit SHT-30 Humidity Sensor
- 1 Adafruit MMA4851 Accelerometer
- 1 Davis Instruments Aerocone Rainfall Tipping Bucket

The nodes and hubs utilize the Arduino compatible Adafruit Feather M0 microprocessor and communicate using the LoRa radio network.

In total, the approximate cost is $940 per node and $165 per hub.

For more information, see the SitkaNet project page via the QR code in the bottom left corner of the poster



Inside of a completed node

Communication and Software

The SitkaNet system is comprised of monitoring nodes that communicate with receiving hubs. Stable, frequent communication between node and hub is key for real time data collection and analysis. The LoRa radio network allows the node to communicate data to the hub on standard time intervals. The hub then sends this data to a Google spreadsheet where it can then be interpreted by the project team. A custom printed Hypnos circuit board is utilized within the node, allowing for accurate timestamps and the powering off of sensors between data sends. Data can also be collected manually via a microSD card within the node.

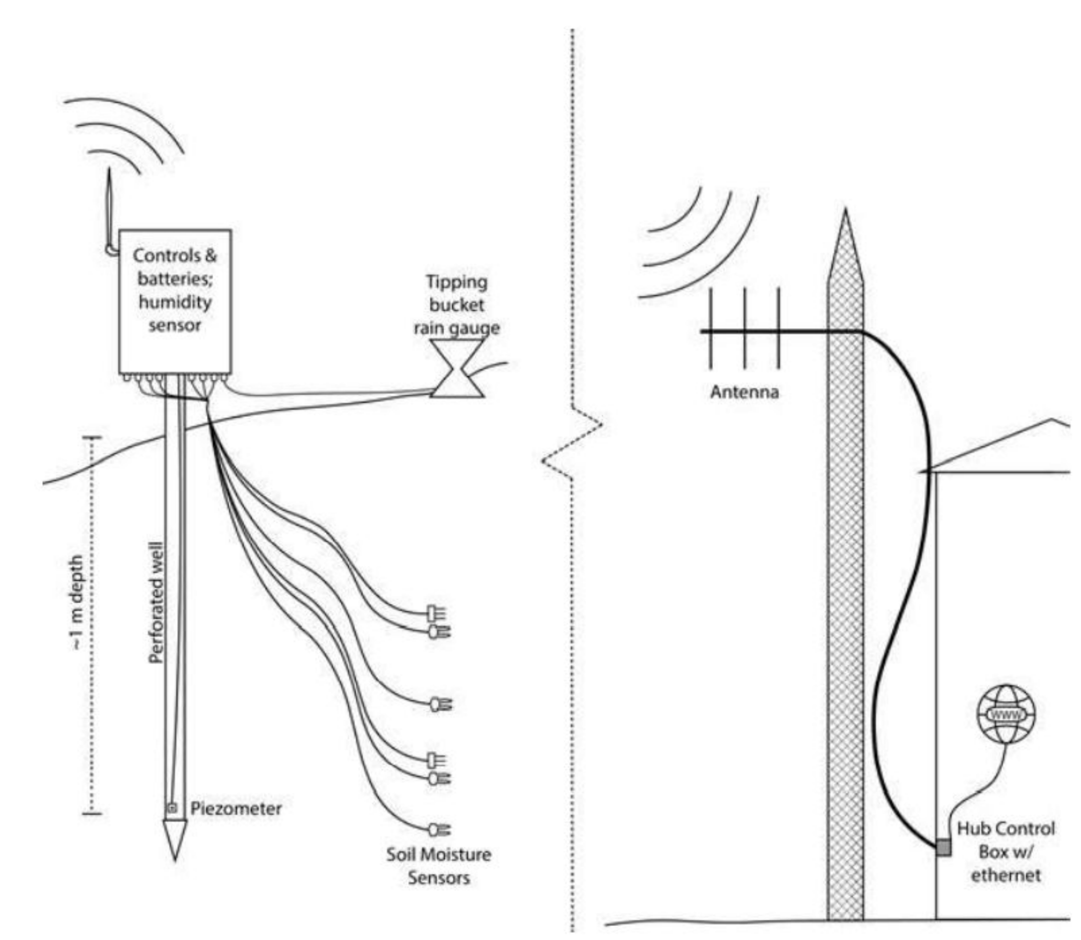
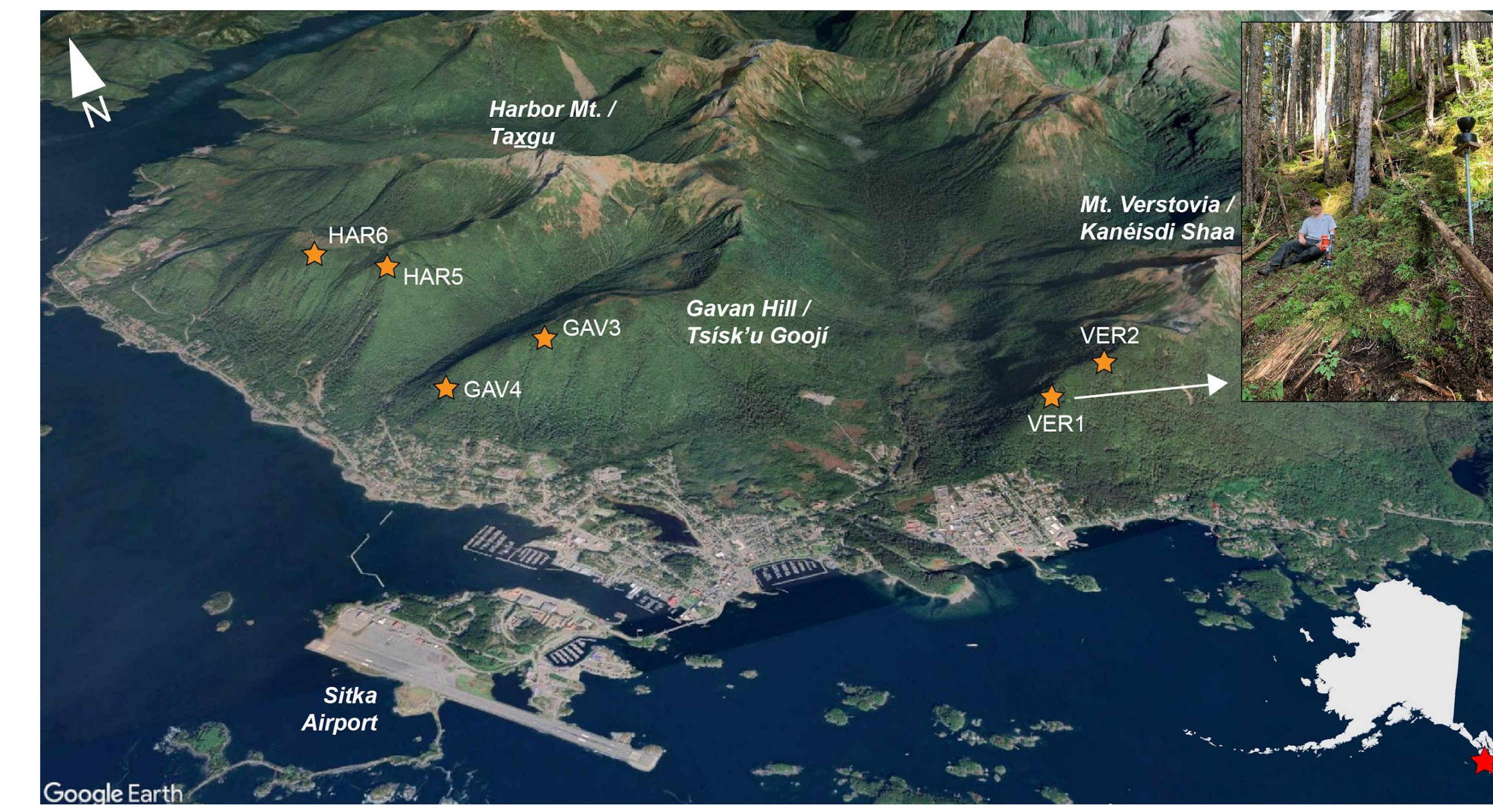


Figure showing the configuration of a node (left) and hub (right). The node is mounted to well pipe and an antennae for LoRa communication is mounted alongside the node casing. The hub is located within a building or other structure and is connected to an external, outdoor antenna for communication with the node.

The C/C++ code used to program the microprocessors is based on the open-source LOOM project, which provides a foundation to easily build and maintain sensor systems. LOOM allows the SitkaNet system to be adaptable and easily change between different sensing operations. This is what allows the SitkaNet system to monitor numerous variables at once and to hot-swap sensors into the system if needed.

Field Deployment

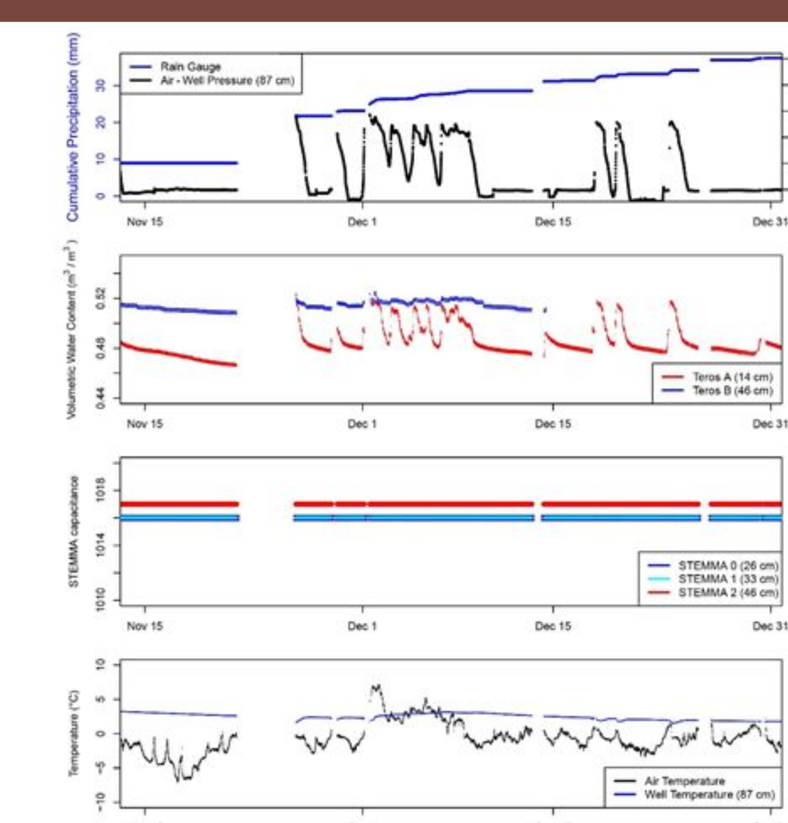


There are 6 sensor nodes and 2 hubs currently deployed in Sitka. The map above shows node locations.

Data

The series of graphs on the right display various types of data received from Harbor Mountain in November and December 2020.

Notable gaps in data occurred during heavy rainfall when LoRa transmits were unsuccessful.



Top: Precipitation

2nd: Teros Soil Moisture

3rd: STEMMA Soil Moisture

Bottom: Temperature

Future Objectives

Some future objectives and implementation goals for SitkaNet include:

- integration of 4G networking to increase flexibility of hub sites
- integration of batch data transmits to save power during low-risk seasons
- updating of hardware components to ease data collection and communication between hub and node

Currently, the SitkaNet team is troubleshooting connectivity and signal strength issues within the system.

Acknowledgements

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