Enabling battery-less environmental sensing with DASH7

Priyesh Pappinisseri Puluckul

FutureArctic

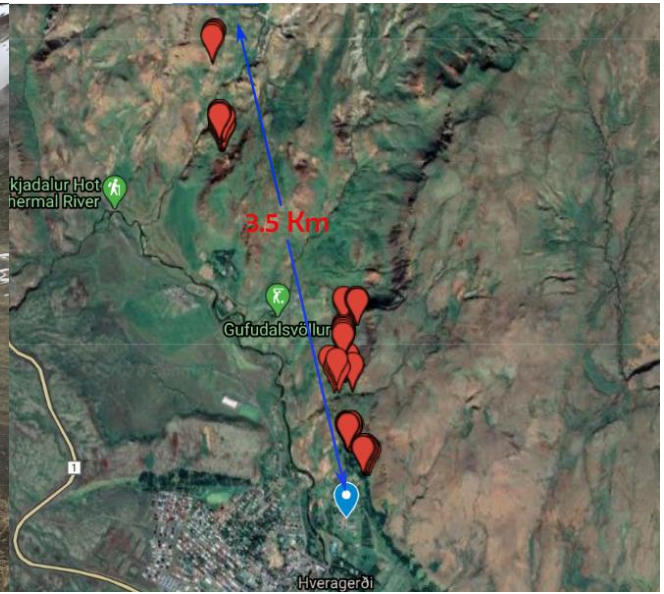
A glimpse into the Arctic future: equipping a unique natural experiment for next-generation ecosystem research

How much carbon will escape from the (sub)Arctic in future climate?

How do the multitude of ecosystem processes, driven by plant growth, microbial activities and soil characteristics, interact to determine (sub)Arctic soil carbon storage capacity?

Sensor Network for the (Sub) Arctic Ecosystem Monitoring

- 3 Sites in a stretch of 3.5 Km
- Sense- soil and ambient temperature, humidity, soil content, etc.
- Low power wake-sleep schedules for reduced energy consumption
- Data dissemination with DASH7 ALLIANCE



Challenges!

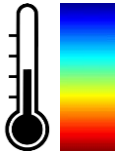
- 3 sites spanning in 3.5Km- hilly and not easy to access
- No access to mains power
- Harsh climate
- Limited sunlight (during winter)

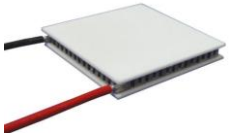
How do we make sensor nodes self-sustainable?

Energy harvesting…!

- Devices can work in situations where traditional resources are not available
- Sensor node with prolonged lifetime!
- No battery replacement- less maintenance & hazardous wastages
- True deploy-and-forget architecture
- The reliability of power source decides the reliability of the electronics

Sources for Energy Harvesting





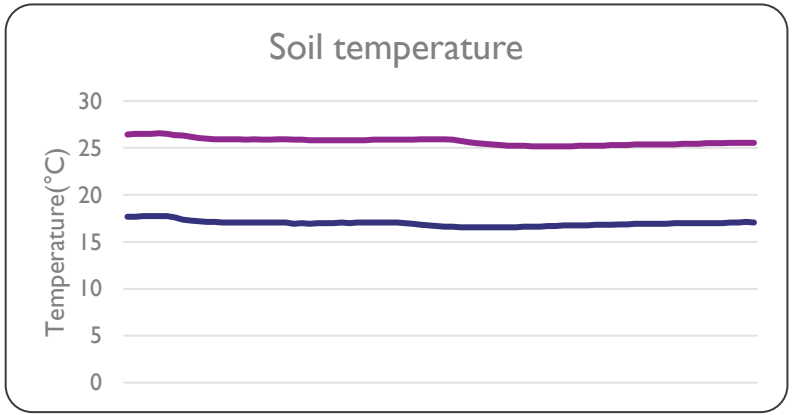
What can help us?

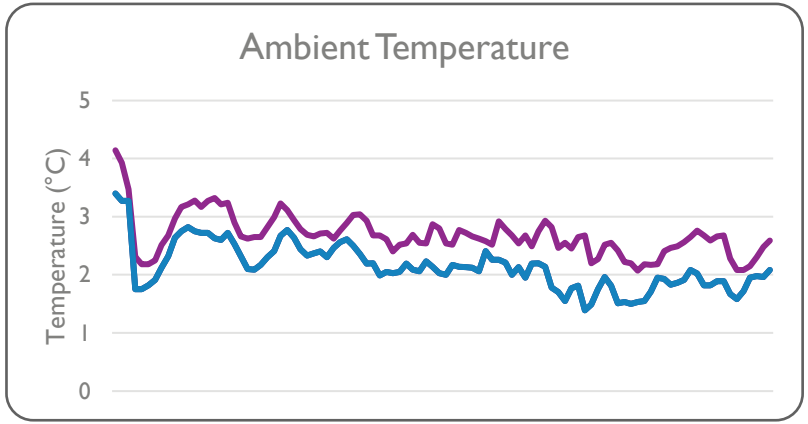
- Solar?
  - Limited availability in winter
  - Sites covered with snow in almost all the winter
  - Sensors deployed close to ground level- vegetation and dust
- Wind?
  - Needs to be at a height
  - Moving parts in harvester- snow can create problem

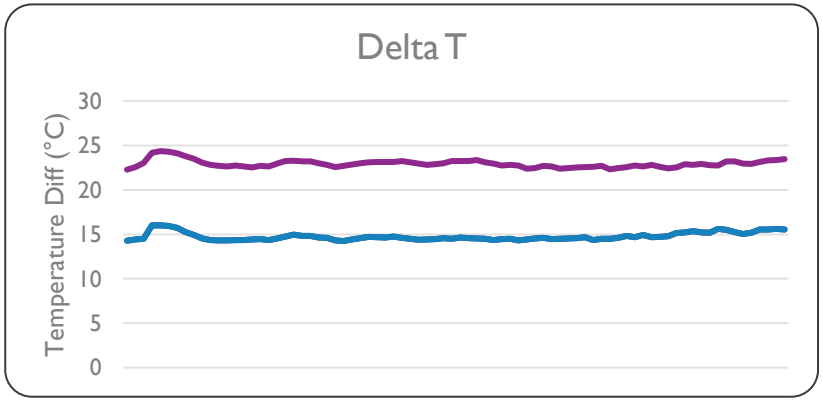
What else then?

- Temperature gradient!
  - Geothermally active area
  - Temperature gradient at soil-ambient interface and at different depths
  - We can use this temperature gradient to power a wireless sensor node (?)

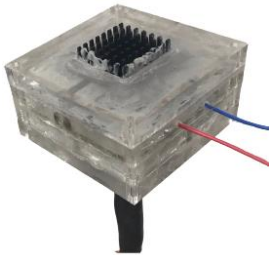
Validating hypothesis







PoC Deployment



Harvester

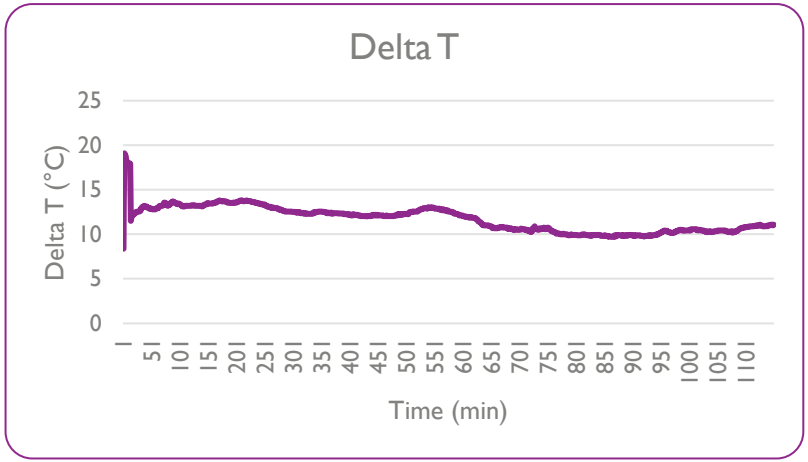
Power management board

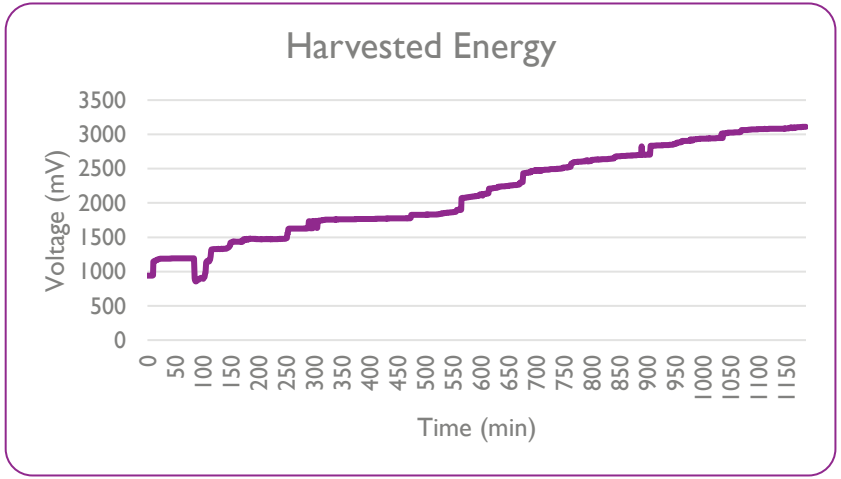
Deployment in Iceland

DASH7 Module

Sensing board- air temperature, humidity and soil temperature

Results





Temperature gradient and Capacitor voltage measured over 20 Hrs

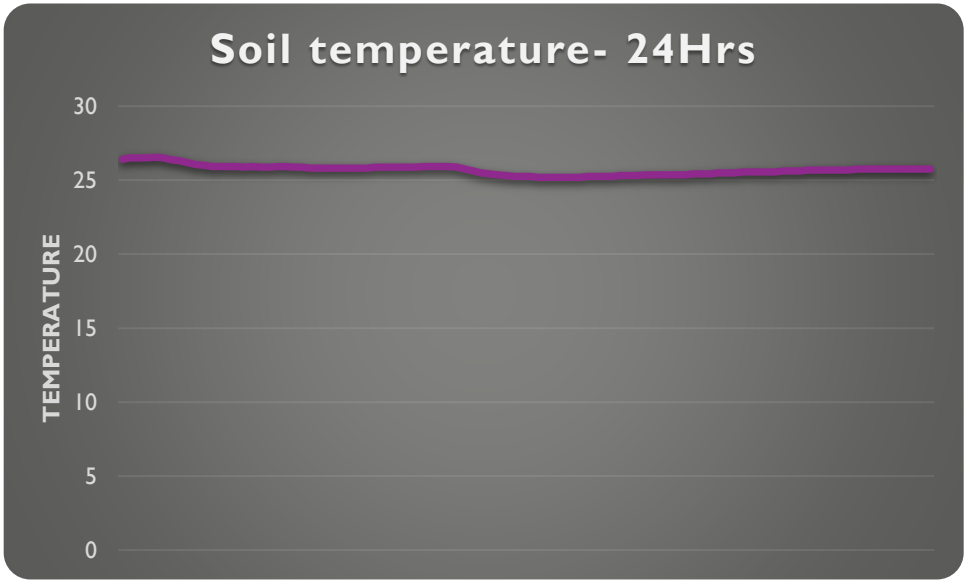
We could harvest ~720mJ over 20 Hrs

DASH7 Node consumption ~8mJ for 1xSensing and transmission

But.. We need to transmit frequently?

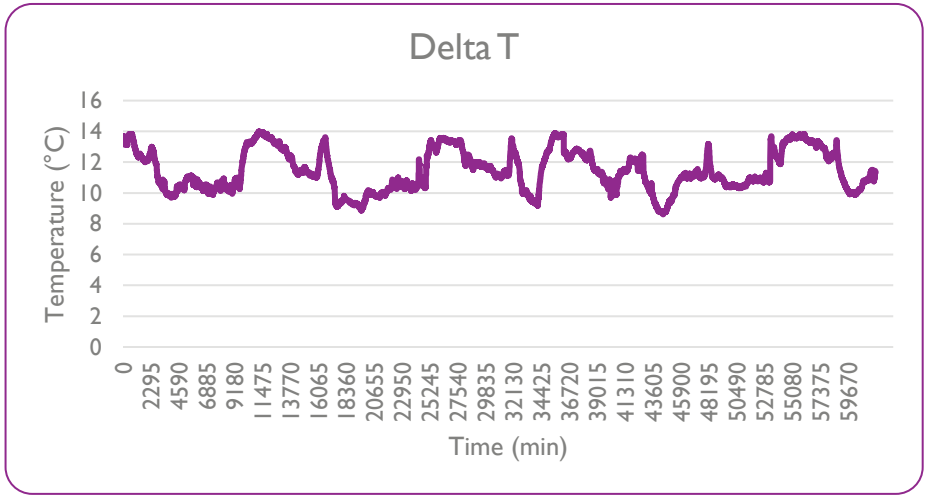
- No!

There is very little variation in soil temperature over time



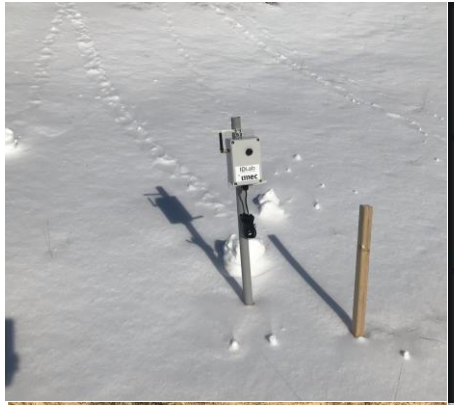
What if the area is not geothermally active?

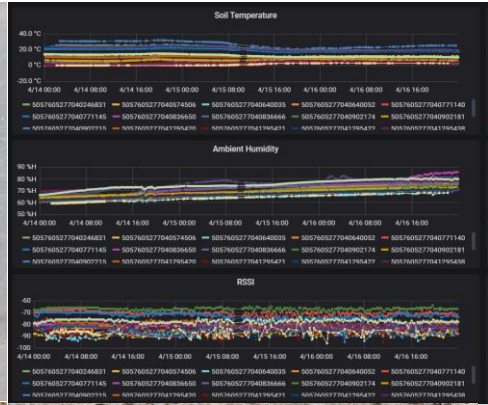
1. Yes, the harvester will still work
2. Soil takes time to warm and cool compared to the surface/air
3. Our system can harvest energy from temperature difference as low as 6°C (or 25mV)



Delta between ambient and soil temperature (@15cm) measured from the University of Antwerp Campus, BE in Spring 2021

Deployments and Real Time Data





imec

embracing a better life