Solar Reflectivity of Mendenhall Valley

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EDGE Program, June 16, 2006

Introduction

How do different earth surfaces found in the Mendenhall Valley reflect solar radiation, and how might this be changing as the Valley develops?

Surfaces studied include representatives of all the surface types found in the Study area, including Auke Lake, cement, blacktop, cut grass, forest, and muskeg. Reflected heat and light intensity of each surface was measured at 3 heights above the ground at 0.5m, 1m and 2m. Solar heat and light was also measured at the ground. Data was treated in Microsoft Excel and spatially analyzed in ArcGIS.

Project Objectives

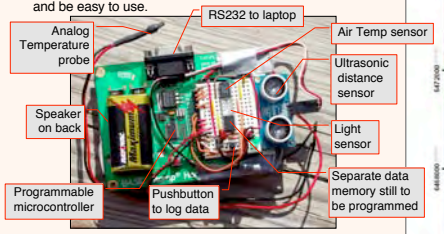
Determine the surface reflectivity for the Mendenhall Valley and identify any trends in reflectivity as the Mendenhall Valley has developed, ie., do some science.

Engineer a data logger with sensors that can be built and used by students within a math and science curriculum, collects volumes of data with a limited number of field trips, and supports a GIS workflow.

Learn the many skills needed with ArcGIS to support spatial analysis for scientific research and to teach GIS to students.

Steps & Methods

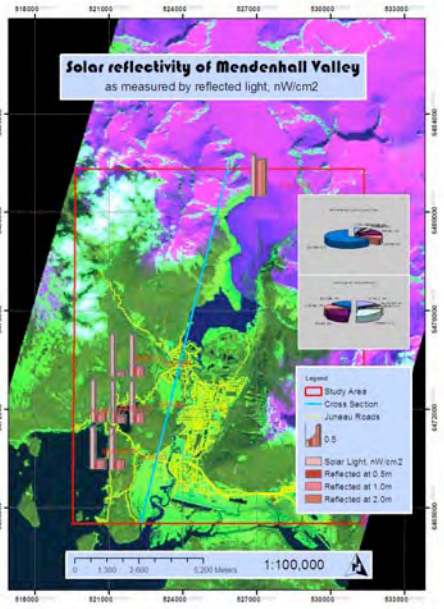
1) Select sensors and construct a data logger that will gather the data needed to answer the project question and be easy to use.

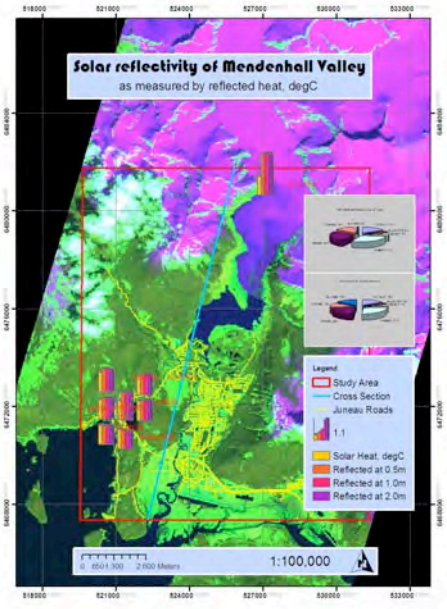


Future improvements: Build in a GPS module so the data collected is automatically time stamped and geo-referenced. Enclose the data logger in a water proof box, with buttons on the outside that are easy to reach. Add 64k of memory to support months of data logging at 15 minute intervals.

2) Program the data logger in PBASIC using a Windows editor to collect the data from each sensor, convert and scale the values, store the data in memory, erase the memory, and dump the data into an Excel spreadsheet. The program is modular so a change in sensors can be easily accommodated. Double precision calculations with decimal constants proved difficult with integer math. During most of the data collection a memory leak would overwrite the program and much data did get lost. Best would be to put the data and program memory into separate ICs so data could be retrieved even if the logger failed. A code snipet from the 315 line program:

```
'TS230 light sensor, double precision
OUTS = 4096                     'Set light sensitivity to 10x
COUNT 10,1000,lightx10          'Count pulses on P10 for 1 second
x2 = lightx10 ** 23592 + lightx10   'convert to nWx10/cm2
GOSUB Write_Data_Word           'Write the data to EEPROM
```





type	desc	lat	long	y_proj	x_proj	altitude	position_m	location	notes	avg_air_degC	avg_probe_degC	temp_reflect_percent	avg_light_nWcm2	light_reflect_percent
WAYPOINT	GRASS	58.39462448	-134.63737800	6471417.139	521308.8683	96.0	0	cut grass	overcast	27.0	25.0	1.000	17199.3	1.000
WAYPOINT	GRASS	58.39462448	-134.63737800	6471417.139	521308.8683	96.0	0.5	cut grass	overcast	26.0	24.7	1.040	4342.7	0.265
WAYPOINT	GRASS	58.39462448	-134.63737800	6471417.139	521308.8683	96.0	1.0	cut grass	overcast	26.0	24.3	1.040	4118.3	0.232
WAYPOINT	GRASS	58.39462448	-134.63737800	6471417.139	521308.8683	96.0	2.0	cut grass	overcast	26.0	24.0	1.040	3760.3	0.212
WAYPOINT	BLACKTOP	58.39477418	-134.63747129	6471433.777	521303.3202	93.0	0	blacktop	overcast	26.0	26.7	1.000	21000.7	1.000
WAYPOINT	BLACKTOP	58.39477418	-134.63747129	6471433.777	521303.3202	93.0	0.5	blacktop	overcast	26.0	27.7	0.907	4202.7	0.199
WAYPOINT	BLACKTOP	58.39477418	-134.63747129	6471433.777	521303.3202	93.0	1.0	blacktop	overcast	26.0	25.7	0.907	4217.0	0.200
WAYPOINT	BLACKTOP	58.39477418	-134.63747129	6471433.777	521303.3202	93.0	2.0	blacktop	overcast	26.0	25.0	0.907	4266.3	0.202
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	0	Auke Lake	overcast	25.0	25.7	1.000	21266.7	1.000
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	0.5	Auke Lake	overcast	24.7	16.0	1.194	1625.0	0.076
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	1.0	Auke Lake	overcast	24.0	19.0	1.161	1800.3	0.085
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	2.0	Auke Lake	overcast	23.0	18.0	1.113	2202.7	0.104
WAYPOINT	CEMENT	58.39507316	-134.64049154	6471466.120	521128.5403	136.0	0	cement (white)	overcast	24.3	23.3	1.000	20299.0	1.000
WAYPOINT	CEMENT	58.39507316	-134.64049154	6471466.120	521128.5403	136.0	0.5	cement (white)	overcast	24.0	24.0	0.947	4796.0	0.236
WAYPOINT	CEMENT	58.39507316	-134.64049154								27.0	0.947	4796.7	0.235
WAYPOINT	CEMENT	58.39507316	-134.64049154								27.0	0.947	4812.0	0.237
WAYPOINT	MUSKEG	58.39516897	-134.64131230								24.0	1.000	19299.3	1.000
WAYPOINT	MUSKEG	58.39516897	-134.64131230								22.7	1.042	4536.7	0.268
WAYPOINT	MUSKEG	58.39516897	-134.64131230	6471476.532	521078.4917	131.0	1.0	muskeg	overcast	25.0	23.0	1.042	4438.3	0.263
WAYPOINT	MUSKEG	58.39516897	-134.64131230	6471476.532	521078.4917	131.0	2.0	muskeg	overcast	25.0	24.7	1.042	4450.7	0.265
WAYPOINT	FOREST	58.39423723	-134.63733798	6471374.123	521327.8111	152.0	0	forest floor, open canopy	overcast	25.0	22.0	1.000	1492.7	1.000
WAYPOINT	FOREST	58.39423723	-134.63733798	6471374.123	521327.8111	152.0	0.5	forest floor, open canopy	overcast	24.0	22.0	1.091	270.0	0.181
WAYPOINT	FOREST	58.39423723	-134.63733798	6471374.123	521327.8111	152.0	1.0	forest floor, open canopy	overcast	24.0	22.0	1.091	296.0	0.198
WAYPOINT	FOREST	58.39423723	-134.63733798	6471374.123	521327.8111	152.0	2.0	forest floor, open canopy	overcast	24.0	22.7	1.091	420.3	0.282
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	0	dock	sunny	35.7	23.0	1.000	21016.1	1.000
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	0.5	dock	sunny	33.0	26.0	1.435	4224.9	0.201
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	1.0	dock	sunny	32.0	26.0	1.391	3126.6	0.149
WAYPOINT	AUKE_LK	58.39463796	-134.63693876	6471441.155	521304.8664	67.0	2.0	dock	sunny	32.0	27.0	1.391	3123.4	0.149
WAYPOINT	GLACIER	58.46709075	-134.53784593	6480634.366	527065.4303	1469.0	0	glacier	sunny	15.0	7.0	1.000	33653.0	1.000
WAYPOINT	GLACIER	58.46709075	-134.53784593	6480634.366	527065.4303	1469.0	0.5	glacier	sunny	15.0	8.0	2.143	29453.0	0.875
WAYPOINT	GLACIER	58.46709075	-134.53784593	6480634.366	527065.4303	1469.0	1.0	glacier	sunny	15.0	10.0	2.143	29333.0	0.872
WAYPOINT	GLACIER	58.46709075	-134.53784593	6480634.366	527065.4303	1469.0	2.0	glacier	sunny	15.0	10.0	2.143	29533.0	0.881

Data averaged, scaled, and geo-referenced before importing into ArcGIS

Steps & Methods (continued)

3) Measure solar reflectivity between 10 am and 2 pm when the sun is mostly overhead. Since reflectivity is calculated as a percent of solar reflected, variations in sunlight on different days and cloud conditions are accounted for. A Stadia rod was used to measure height.

4) Use StampDAQ ActiveX control to download data from the data logger directly into Microsoft Excel and do basic data treatment, calculations, and geo-referencing. Export as a text file.

5) Import the Excel text file into ArcView, export to a shape file, and project the points. ArcGIS only allows letters and numbers in field names, so there were many round trips to step 2 above getting the formats correct.

6) Build the ArcView maps shown here. Draw a representative cross-section and determine percents for each surface type along the section.

Next time: Get surface type GIS base maps from the US Forest Service so that the area of each surface type can be calculated in ArcGIS using polygons.

Conclusions

Even though glaciers only cover 15% of the cross section, they contribute an overwhelming 67% of reflected light. This suggests that the changes in Mendenhall Valley in the last 30 years from vegetation to roads, cement, and cut grass are insignificant compared to the ice and snow contribution, even accounting for cover percent.

No patterns emerged from measuring reflected heat. Temperature of the substrate and direct heating of the air seemed more significant than reflected heat. Therefore, nothing can be concluded from this study concerning reflected heat. Different sensors need to be used.

References

Allen, Tracy. 2004. Applied Sensors. *A high school curriculum for teaching about data logging and earth measurements.*

Hebel, Martin. 2001. StampDAQ. *ActiveX control for downloading data into Microsoft Excel.*

Parallax http://www.parallax.com. *Source of sensors, microcontroller, PBASIC editor, and high school curriculum.*

Datasheets and application notes for all sensors.

Acknowledgments

Wow have I learned a lot. Dr. Cathy Connor and Dr. Anupma Prakash provided leadership and inspiration. Edwin Knuth provided first aid for ArcGIS. Finally, all the staff of the EDGE program that made this project possible.

For further information

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