Analysis of Snow Pack in Big Chico Creek Watershed (1990-2008)

By Jamison Binowski and Alex Fearn

Introduction

Most of California's water comes from what scholars call hybrid stream flow which inputs come from snow melt as well as precipitation. Significant run-off loss and poor adaptations to possible water variability could be problematic for ecosystems, urban, rural, and health sectors along with economic activity. General assessment of temperature increases in Northern California confirms a warming mean temperature will result in snowline retreat, or increase in elevation, resulting in less snow cover (Powell et al., 2011).

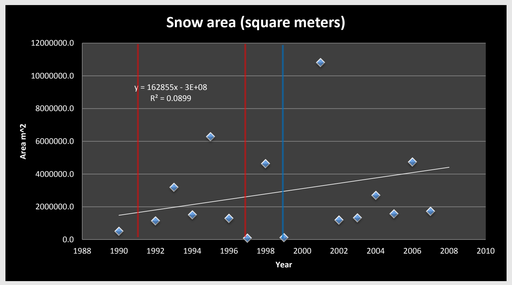
Data and Methods

Acquired Data

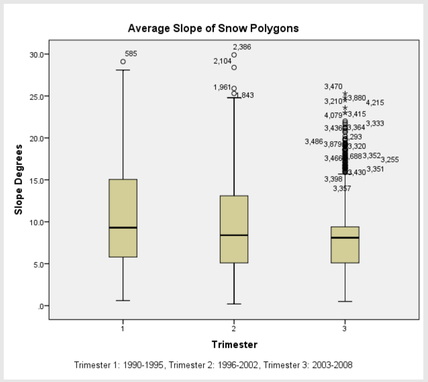
- Landsat Imagery from USGS LM 4-5 (1990-2008)
- Big Chico Creek Watershed (GIC)
- DEM from USGS National elevation Dataset

We classified each year of the imagery for snow using isoclusters. Once classified, we clipped the data to our watershed and converted classified snow to vector entities. We masked our elevation to search for areas above 600m to avoid error in terrain that's more heterogeneous. After that, we calculated the areas of the shapefiles. The shapefiles were then converted into trimesters for zonal statistical analysis.

Results and Analysis



- *Area:* Our results contradicted Powell et al. 2011 in his theory of a warming mean temperature will result in less snow cover. The ENSO years did not seem to play a profound roll in predicted hydrologic change in this area.
- *Elevation:* On the other hand, snowline retreat is relevant from our boxplots of the average elevations' impact on snow cover. The third trimester shows a mean elevation increase and a smaller range in between quartiles.
- *Slope:* The correlation between average slope and time also showed a downward trend. This may imply that snow accumulation in this region is occurring more in storage depression vs greater slope gradients.
- *Aspect:* While aspect shows a greater range in quartiles overtime, mean aspect shows less snow accumulation of south facing slopes which are more prove to solar radiation exposure.



Trimester 1: 1990-1995, Trimester 2: 1996-2002, Trimester 3: 2003-2008

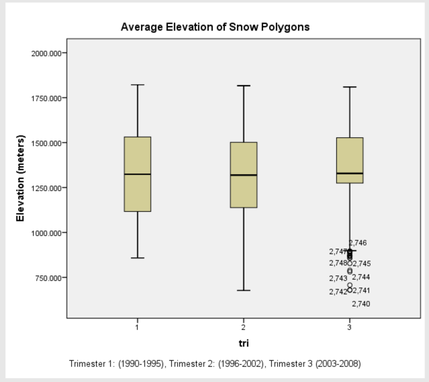
Multiple Comparisons

Dependent Variable: MEAN

Bonferroni

(I) tri	(J) tri	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	1.0947*	.1937	.000	.631	1.559
	3	2.5882*	.1869	.000	2.141	3.036
2	1	-1.0947*	.1937	.000	-1.559	-.631
	3	1.4935*	.1723	.000	1.081	1.906
3	1	-2.5882*	.1869	.000	-3.036	-2.141
	2	-1.4935*	.1723	.000	-1.906	-1.081

*. The mean difference is significant at the 0.05 level.



Trimester 1: (1990-1995), Trimester 2: (1996-2002), Trimester 3 (2003-2008)

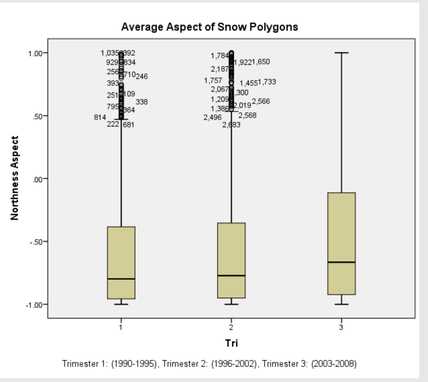
Multiple Comparisons

Dependent Variable: MEAN

Bonferroni

(I) tri	(J) tri	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	4.724102	8.993833	1.000	-16.81483	26.26304
	3	-42.936676*	8.671943	.000	-63.70473	-22.16862
2	1	-4.724102	8.993833	1.000	-26.26304	16.81483
	3	-47.660778*	8.000615	.000	-66.82110	-28.50046
3	1	42.936676*	8.671943	.000	22.16862	63.70473
	2	47.660778*	8.000615	.000	28.50046	66.82110

*. The mean difference is significant at the 0.05 level.



Trimester 1: (1990-1995), Trimester 2: (1996-2002), Trimester 3: (2003-2008)

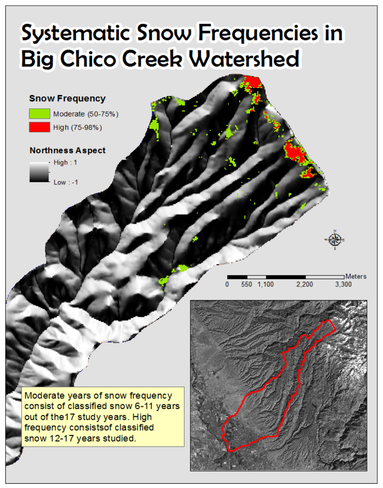
Multiple Comparisons

Dependent Variable: MEAN

Bonferroni

(I) Tri	(J) Tri	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.01474	.02000	1.000	-.0626	.0332
	3	-.13517*	.01930	.000	-.1814	-.0890
2	1	.01474	.02000	1.000	-.0332	.0626
	3	-.12043*	.01779	.000	-.1630	-.0778
3	1	.13517*	.01930	.000	.0890	.1814
	2	.12043*	.01779	.000	.0778	.1630

*. The mean difference is significant at the 0.05 level.



Conclusions

- Aggregate predictions about hydrologic behavior can sometimes be inaccurate for local analyses.
- ENSO events may also have little or no effect on study regions of this size. Snow accumulation on mellower slopes occurred statistically significant with trimesters although linear trends in snow cover resulted in more snow accumulation over time for the study region.
- Also statistically significant is the mean increase in elevation for classified snow. This is a widespread concern for snow under warming conditions.
- The difference in means for trimester 1 and 3 is also significant meaning that accumulation is occurring less on slopes more exposed to direct radiation.
- Snow frequencies also correlate well with elevation and the most frequency takes place at the top of the canyon

References

- Cynthia Powell, Leonhard Blesius, Jerry Davis, Falk Schuetzenmeister, Using MODIS snow cover and precipitation data to model water runoff for the Mokelumne River Basin in the Sierra Nevada, California (2000–2009), Global and Planetary Change, Volume 77, Issues 1–2, May 2011, Pages 77-84
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- Jeff Dozier. Spectral Signature of Alpine Snow Cover from the Landsat Thematic Mapper Department of Geography and Center for Remote Sensing and Environmental Optics, University of California, Santa Barbara and Jet Propulsion Laboratory, California Institute of Technology. Remote Sensing Environment. 28:9-22 (1989)

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Data Sources: Geographic Information Center, www.eros.usg.gov