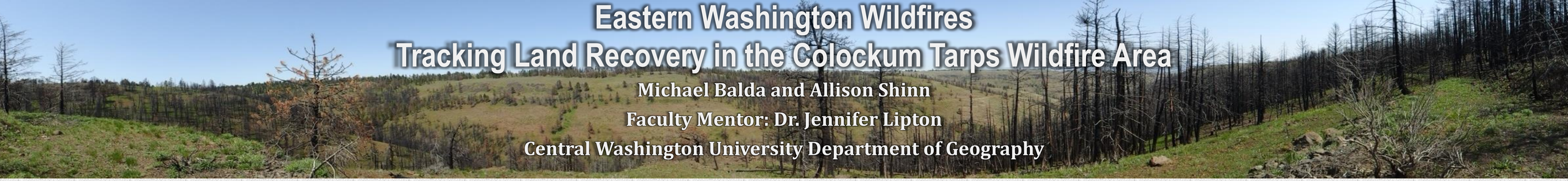

Eastern Washington Wildfires
Tracking Land Recovery in the Colockum Tarps Wildfire Area

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Introduction

The Colockum Tarps Fire started from a pumping house malfunction on July 27, 2013 in the town of Malaga, WA and was officially out on August 14, 2013. In total, the fire burned an area of 80,408 square acres or 125 square miles. To put this into perspective, Seattle is 142.5 square miles. One of the primary concerns in relation to vegetation regrowth is how elk will respond to the fire because the area burned is prime winter range for the elk.

Study Area

The Colockum Tarps Fire occurred in southeast Chelan County and eastern Kittitas County. There two main types of vegetation within our study area: forest vegetation and grasses. The Colockum Tarps Wildlife area is also used for recreational activities such as hiking, horseback riding and hunting. Current land ownership of this area are Bureau of Land Management, Washington Department of Fish and Wildlife Department of Natural Resources, and private land owners.

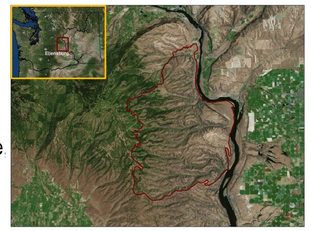

Figure 1 Vicinity Map

Methods

Our methodology includes:

- Analyzing how human and environmental factors played a role in the spread of the fire
- Fieldwork
- Remote sensing analyses such as Normalized Burn Ratio (NBR), Change Detection, and Normalized Difference Vegetation Index (NDVI)

To analyze the impacts of human and physical factors we utilized ArcGIS and air photo interpretation to spatially analyze and interpret the effects. Air photos, shapefiles and graphs were used to determine the results and came from several sources:

- Kittitas County Climate Data
- Washington Department of Ecology
- Washington Department of Natural Resources
- U.S. Geologic Survey
- U.S. Department of Agriculture

The human factors included:

- Land Use Land Cover (LULC)
- Infrastructure
- Agricultural practices
- Recreational activities

The physical factors included:

- Topography
- Climate
- Soils

Figure 2 Study Site – October 2014

The fieldwork for this project included GPS points as well as photos taken in October 2014. Another goal was to use fieldwork to determine after effects of the fire, fire severity, and to confirm that our remote sensing analyses correctly interpreted what was on the ground.

Methods Cont.

Remote sensing analysis included 2013 & 2014 Landsat 8 imagery from Earth Explorer. The images were unzipped and opened in PCI Geomatica. A Normalized Burn Ratio was calculated to determine fire severity and regrowth of the fire area. The Raster Calculator was then used, with the following equation:

$$\frac{(0.0001 * (Band5 + 100) - 0.0001 * (Band7 + 100))}{(0.0001 * (Band5 + 100) + 0.0001 * (Band7 + 100))}$$

This equation looks at Near Infrared (Band 5) and Short-Wave Infrared (Band 7) which can easily detect fire areas then visible bands. The images were translated to a TIFF and opened in ArcGIS and clipped to the study area. Using the raster calculator again, a dNBR (differenced NBR) was found using: (pre-fire image (2013) – post-fire image (2014))

Using symbology, the different classes were created to represent fire severity and vegetation change by area (see table 1)

A Normalized Difference Vegetation Index (NDVI) was computed to look at the health of the vegetation before and after the fire. The Raster Calculator was then used with the following equation:

$$\frac{(0.0001 * (Band5+ 100) - 0.0001 * (Band4+ 100))}{(0.0001 * (Band5+ 100) + 0.0001 * (Band4+ 100))}$$

The NDVI calculated the Near Infrared (Band 5) and the Red Band (Band 4). This calculation determines healthy versus unhealthy vegetation based upon light reflected from the vegetation in an image. To determine the change in vegetation before and after the fire the Change Detection (CD) tool in Geomatica was used and produced a new image..

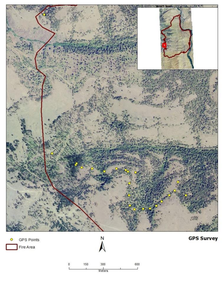

Figure 3 GPS Survey – October 2014

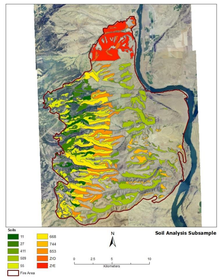

Figure 4 Soil Analysis

Results

- Figures 5, 6 and 7 show how the fire burned through the area and level of severity. These maps show a NBR from three separate dates, all comparing the pre-fire (06/13) landscape to the post-fire landscape (08/13, 10/13 and 09/14). The dark green shows areas of high post-fire regrowth, whereas red shows areas of moderate-high severity burns.
- Figures 8, 9, 10 and 11 are a NDVI analysis. The more white the image it shows a greater concentration of actively photosynthesizing or green vegetation that is in that specific area on the ground. The darker areas show where there is little vegetation or barren land. The two images on the left are from August 2013 while the two on the right are from September 2014.
- Figure 12 shows Change Detection. This shows how the land has changed from August 2013 to October 2013. Blue shows the least amount of change while pink shows the most change.

Results Cont.

Normalized Burn Ratio

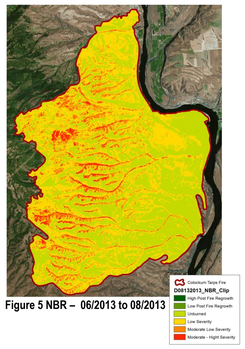

Figure 5 NBR – 06/2013 to 08/2013

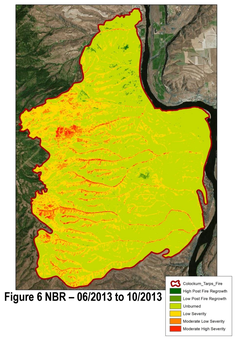

Figure 6 NBR – 06/2013 to 10/2013

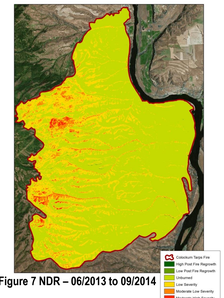

Figure 7 NDR – 06/2013 to 09/2014

Pixel Values	Classification
< -0.25	Post Fire – High Regrowth
-0.25 to -0.1	Post Fire – Low Regrowth
-0.1 to 0.1	Unburned
0.1 to 0.27	Low Severity Burn
0.27 – 0.44	Moderate – Low Severity Burn
0.44 – 0.66	Moderate – High Severity Burn
> 0.66	High Severity Burn

Table 1 NBR Classifications

Normalized Difference Vegetation Index

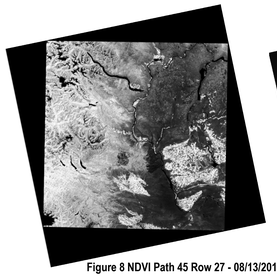

Figure 8 NDVI Path 45 Row 27 - 08/13/2013

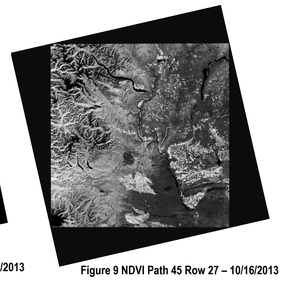

Figure 9 NDVI Path 45 Row 27 – 10/16/2013

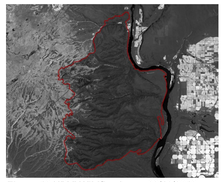

Figure 10 NDVI Wildfire Area - 08/13/2013

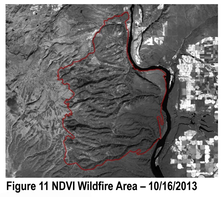

Figure 11 NDVI Wildfire Area – 10/16/2013

Change Detection

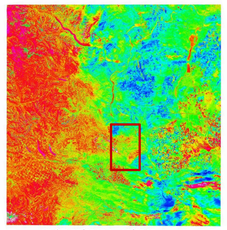

Figure 12 CD 08/2013 to 10/2013

Conclusion

The fieldwork displayed the fire pattern that was represented in the air photo and remote sensing analysis. The fire moved from the North Eastern regions of the wildlife area and moved in a South West direction. The fire moved across grasslands and burned down and up multiple ridge lines through forested vegetation. The NBR displayed the severity of the fire along ridge lines and across the open area of the wildlife area which reflected in our fieldwork. The NBR also displays vegetation regrowth after two months in October 2013 and after a year in September 2014. This showed that areas where grasslands have recovered well post fire but the areas that were forested have not recovered a year after the fire occurred. The results of the NDVI and the Change Detection Analysis showed significant change in the vegetation before and after the fire. However, the Change Detection image showed some inaccuracies. Some areas were displayed as high areas of change, however, these were incorrectly display due to shadows within the October 2014 image. Overall, we found that our fieldwork accurately supported the results of the dNBR, NDVI and CD analysis. The GPS points that were taken for fieldwork correctly matched our analysis of the spread of the fire.

Figure 13 Study Site - August 2013

Future Research

For future research, we can do these same steps and analysis processes for imagery for 2015 in order to continue to monitor the vegetation regrowth and land recovery in the Colockum Tarps Wildfire area.

Acknowledgements

We would like to thank Dr. Jennifer Lipton of the CWU Geography Department for her help and ideas with this project. We would also like to thank Bob Marshall and the Southeast Division of DNR for providing us with imagery of the fire area.

References

Earth Explorer
- Landsat 8 TM
  - LC80450272013161LGN00 (6/10/13)
  - LC80450272013225LGN00 (8/13/13)
  - LC80450272013285LGN00 (10/16/13)
  - LC80450272014244LGN00 (9/1/14)

Kittitas County Website
- Climate Graphs

Washington Department of Ecology
- Land Cover Land Use Shapefile

Washington Department of Natural Resources
- Air Photos: 2013

U.S. Department of Agriculture
- 2013 NAIP Image

USGS
- Inciweb report
- Colockum Tarps Fire Shapefile
- Soil Map

Articles
- De Santis, A., and Chuvieco, E. "GeoCBI: A modified version of the Composite Burn Index for the initial assessment of the short-term burn severity from remotely sensed data" *Remote Sensing of Environment* 113 (2009) pg 554 – 562.
- Epting, J., Verbyla, D and Sorbel, B. "Evaluation of remotely sensed indicies for assessing burn severity in interior Alaska using Landsat TM and ETM+" *Remote Sensing of Environment* 96 (2005) pg 328 – 329.
- Lentile, A. D., Holden, Z. A., Smith, A. M. S., Falkowski, M. J., Hudak, A. T., Morgan, P., Lewis, S. A., Gessler, P. E., and Benson, N. C. "Remote Sensing Techniques to assess active fire characteristics and post fire effects" *International Journal of Wildland Fire* 15 (2005) pg 319 – 345.
- Roy, D. P., Boschetti, L/. And Trigg. S. N. "Remote Sensing of Fire Severity: Assessing the Performance of the Normalized Burn Ratio" *IEEE Geoscience and Remote Sensing Letters* 3(1) 2006 pg 112 – 116.
- Hussain, Masroor., Chen, Dongmei., Cheng, Angela., Wei, Hui., Stanley, David. "Change detection from remotely sensed images: From pixel-based to object-based approaches." ISPRS Journal of Photogrammetry and Remote Sensing 80 (2013) 91-103. Web. 26 Feb. 2015
- Sadegh Jamali., Per Jönsson., Lars Eklundh., Jonas Ardö., Jonathan Seaquist. "Detecting changes in vegetation trends using time series segmentation." Remote Sensing of Environment 156(2015): 182-195. Web. 26 Feb. 2015
- Andrew P. Tewkesbury., Alexis J. Comber., Nicholas J. Tate., Alistair Lamb., Peter F. Fisher. "A critical synthesis of remotely sensed optical image change detection techniques." Remote Sensing of Environment 160 (2015): 1-14. Web. 26 Feb. 2015

Non-Journal Article Sources
- Fire Mapping with ASTER
- Landscape Toolbox: Normalized Burn Ratio
- The Normlized Burn Ration (NBR) – Brief Outline of Processing Steps

Photos
- Figure 2 – Photo Credit: Allison Shinn
- Figure 13 – Photo Credit: Erik Larsen