Foundational Science Area Activities: Assessing Climate Change Impacts to Wildlife and Habitats in the North Central U.S.

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Public Summary

Rates of climate and land use change vary across the Great Plains and Rocky Mountains as do the responses of ecosystems to these changes. Knowledge of locations of rapid land use, climate change and changes in ecosystem services such as water runoff and ecological productivity are important for vulnerability assessment and designing locally relevant adaptation strategies to cope with these changes. This project assessed the loss of public, private, and tribal lands due to ongoing land use intensifications and fragmentation extents across the NC CSC domain. In addition, the project evaluated how the climate, ecosystem processes, and vegetation have shifted over the past half century and how they are projected to change in the coming century under various future scenarios. These analyses were carried out in Greater Wildland Ecosystems (GWEs) and Environmental Protection Agency level III ecoregions centered at public, tribal, and private lands. These areas of natural vegetation provide ecosystem services important to local people, and knowledge of patterns of climate and ecological change are important to resource managers. The results of the project can be used by the NC CSC Adaptation team to work with local stakeholders to develop strategies for coping with and adapting to the ongoing land use change and projected changes in climate.

Project Summary

Land use and land cover (LULC) intensification and climate change are major drivers of the Earth System influencing ecosystem processes, hydrology and biodiversity. We considered four objectives to evaluate the land use intensification and climate change impacts on North Central Climate Science Center (NC CSC) domain. Forest, shrubland, and grassland are the dominant vegetation cover types across the domain. The spatial units for analysis include the GWEs centered on federal, tribal and private lands and EPA level III ecoregions. The boundary of each GWE was defined based on hydrological units, contiguous habitat, and human influence affecting the ecological processes surrounding GWEs.

- Objective 1 analyzed the rates and patterns of fragmentation of natural cover types by human land use intensification after European settlements and recent past. For this purpose, we quantified fragmentation extents of each GWE after European settlements using LANDFIRE data and human land use layers including developed layers, housing density, and private lands. We also assessed the changes in land cover classes and housing density from 2001 to 2010 from the National Land Cover Database (NLCD).
- Objective 2 summarized climate change impacts on projected water balance in EPA level III ecoregions across the domain by using the Multivariate Adaptive Constructed Analogs (MACA) products. For this, we examined the changes in growing season potential evapotranspiration (PET) and moisture index (MI) by 2071-2099, relative to 1980-2005, using two different formulations of PET – Penman-Monteith and Thornthwaite – across eight ecoregions of the north central United States using a high resolution (~4km) downscaled data. Moreover, we analyzed the implications of water balance metric (PET) derived from two methods in vegetation response to climate change.
- Objective 3 was focused on developing and projecting habitat suitability models for 33 dominant tree and shrub species under IPCC climate scenarios. These species represent eight forest communities of NC CSC domain. Forest Inventory and Analysis (FIA) data was used to develop statistical models using the BIOMOD package in R and SAHM software to project tree/shrub species' suitable habitat under future climate change scenarios and vulnerable forest communities to changing climate.
- Objective 4 focused on assessing the climatic bias in the placement of public, private

and tribal lands of each GWE across the domain. In addition, Objective 4 evaluated the projected changes in climate and water balance metrics (PET and moisture index) in GWEs and land allocation types distributed along strong climate ecotones of the domain. For this purpose, historical and projected climate and water balance data from MACA under CCSM4 GCM was used.

- For each Objective from 1 – 4, we evaluated vulnerability of GWEs, land allocation types, tree species, and forest communities related to Objective 5.

Purpose and Objectives

The overall goal of the foundational science ecological impacts project is to assess vulnerability of forest and grassland vegetation to climate change and drought in the greater ecosystems centered on public and tribal lands across the NC CSC domain.

The specific objectives are as follows:

1. Quantify change in the spatial patterns of natural cover types as influenced by land use intensification for 2000 to present and projected to 2100.
2. Summarize the responses of ecological processes to past (1950-present) and projected (2010-2100) climate change.
3. Develop species habitat distribution models for dominant forest / shrub species and project species habitat suitability under IPCC climate scenarios.
4. Statistically relate grassland phenology to climate, soils, and landform and project potential changes in grassland phenology under IPCC climate scenarios.
5. Synthesize the results from Objectives 1-3 in the form of vulnerability assessments for major greater wildland ecosystems in the NC CSC domain.

In Year 1, in consultation with management, we modified Objective 1 by expanding LULC change analysis during 2000-2011 in addition to the originally proposed change in natural cover types. We dropped the analysis in future projections of LULC change as we learned that the projections that we had proposed to use had high levels of uncertainty in the rural landscapes that dominate the study area.

In Year 2, upon consultation with management, we modified Objective 2 by adding analysis of water balance functions derived from the new MACA products to those originally proposed using the TOPS data set.

In Year 3, upon consultation with management, we adjusted Objective 4 with a new approach of analyzing climate change impacts on water balance in GWEs and land allocation types across NC CSC domain. Due to the increased interest and more involvement of NC CSC in vulnerability assessments of tribal and private lands within GWEs, we dropped originally proposed work on statistically relate grassland phenology in favor of the land allocation analyses.

We also expanded Objective 3 by comparing habitat suitability of water limited tree species under two sets of predictors led by PET derived from two methods.

In addition, we proposed considering six to nine species for Objective 3. We expanded the work to include 34 dominant species of eight forest community types across the NC CSC domain. Hence, we are still analyzing the data and writing the manuscript.

Organization and Approach

Objective 1. Change in land cover, use, and natural cover types (Fig. 1). Change in land cover and use was quantified for the period 2000-2011 for the NC CSC domain and for the large landscapes centered on public lands that we delineated as GWEs. Changes in natural ecosystem types from pre-settlement times to present was estimated by overlaying locations of more intense human land use on biophysically-derived maps of natural cover type distribution. Methods are detailed in Adhikari and Hansen (Under Review in *Landscape and Urban Planning*).

Objective 2. Ecological processes (Fig. 2). We have analyzed trends in water balance using data from MACA products with the collaboration of NC CSC foundational science area physical climate group. The MACA data allows a more realistic formulation of evapotranspiration than used in the TOPS model, and we examined the consequences of this for estimated water balance across the domain. Details in methods and results are available in Hansen et al. (Under review in *Ecosystems*)

Objective 3. Tree and shrub species distribution modeling (Figs. 3 and 4). This objective has two specific questions: 1) to predict habitat suitability of 33 dominant tree/shrub species in eight forest communities under climate change scenario across the north central U.S. (Figs. 3 and 4), and 2) to evaluate the implications of a water balance metric (PET) derived from two methods on vegetation response to future climate change.

For the first purpose, we used 30-year monthly average of climate and water balance predictors under CCSM4 GCM derived from MACA data. We extracted presence and absence records of all species from FIA data. Random Forest was used to predict the historical and future (2040, 2070, 2099) suitable habitat of each species under two climate change scenarios (RCP4.5 and RCP8.5).

For the second purpose, we chose two sets of predictors from MACA outputs: a) 30-year monthly average of climate data led by Penman PET (estimated from Penman-Monteith equations), and b) 30-years monthly average of climate data led by Thornthwaite PET (estimated from Thornthwaite equations). We used FIA data to select presence absence of water limited tree species (*Pinus contorta*, *Pinus ponderosa*, *Juniperus scopulorum*, *Pinus resinosa*, *Pseudotsuga menziesii*, and *Pinus flexilis*) for our investigation to predict current and future habitat of each species under two sets of predictors. The species distribution model predicted suitable habitat of each species under two climate change scenarios (RCP4.5 and RCP8.5) under CCSM4 GCM. (Manuscript in preparation)

Objectives 4 and 5. Climate change impacts assessment on water balance across GWE and land allocation types and vulnerability analyses (Fig. 5). We assessed changes in historical temperature and MI in nine GWEs and three land allocation types (Public, Tribal, and Private) in each GWE across NC CSC domain. First, we assessed if there are any systematic biases associated with placement of land allocation types based on historical MI. A 30 year monthly average of temperature and moisture index from MACA outputs were analyzed to assess the changes in temperature and MI. Degree of vulnerability to changes in MI was assessed for each GWE. (Manuscript in preparation)

Project Results, Analysis and Findings

Objective 1. Change in land cover, use, and natural cover types.

Adhikari A and AJ Hansen. In Review. Land use change around the wildland ecosystems of the North Central United States. *Landscape and Urban Planning*.

Abstract

Wildlands and their ability to conserve biodiversity and provide ecosystem services are threatened by unprecedented land use intensification and habitat fragmentation. Effective conservation of these wildlands depends on identifying their ecological boundaries and assessing land use change trajectories and habitat fragmentation within those boundaries. We evaluated the extent of land use intensification and fragmentation in six natural land cover classes and six ecosystem types within nine GWEs of three ecoregions in the north-central United States: Central Plains, Western Plains, and Western Mountains. Land use intensification across the ecoregions was characterized by assessing changes in NLCD cover data and housing density within each GWE from 2001 to 2011. We used LANDFIRE BpS data to assess fragmentation effects on ecosystem types across the regions. The proportion of land cover changes was 1.2%, 1.1%, and 1% for the Central Plains, Western Mountains, and Western Plains ecoregions, respectively. The study region has retained 58% of the original ecosystem types during the post-European period. The mean patch size of ecosystem types was decreased by 50% across the ecoregion. The Central Plains ecoregion was highly fragmented, since it has retained only 19% of its original proportion. This analysis can help managers working in public, private and tribal lands in identifying sustainable conservation priorities to minimize surrounding land use patterns impacts on protected systems. We will provide Resource Briefs including major results of each GWE upon the completion of FY 2017 projects. We conclude that managers are likely to face multiple challenges to maintaining ecosystem conditions in their present or near present states while establishing connectivity with regional networks of protected lands.

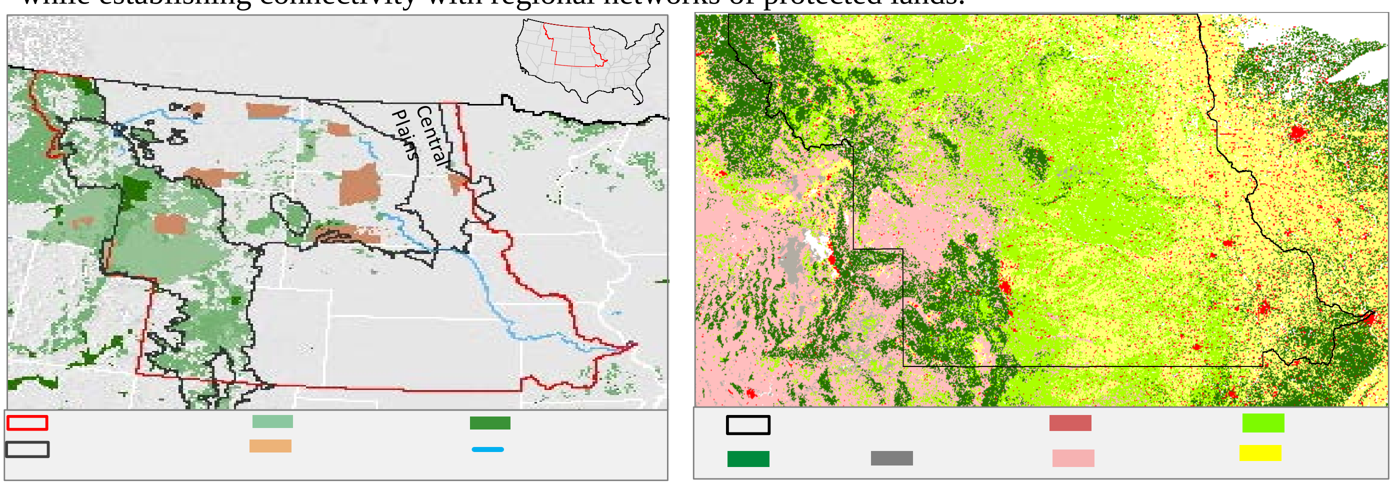

Fig. 1 Map of the study area showing land allocation types, state boundaries and ecoregion boundaries over shaded relief (left) and land cover map of study area from National Land Cover Data 2011 (right).

<u>*Objective 2.* Ecological processes</u>

Andrew J. Hansen, Arjun Adhikari, Imtiaz Rangwala. In Review. Ecological water stress under projected climate change across the hydroclimate gradients in north central United States: A comparison of two potential evapotranspiration methodologies. *Ecosystems.*

Abstract

Atmospheric evaporative demand for water from a land surface is driven by net radiation, vapor pressure deficit, wind speed, and surface temperature. However, a majority of studies that have examined ecosystem response to projected climate change have only

considered the temperature-based (e.g., Thornthwaite) methods to quantify future changes in this demand. In this paper, we examine the changes in growing season potential evapotranspiration (PET) and moisture index (MI) by 2071-2099, relative to 1980-2005, using two different formulations of PET – Penman-Monteith and Thornthwaite – across eight ecoregions of the north central United States using high resolution (~4km) downscaled data. We found that relative to the Penman- Monteith formulation, the Thornthwaite method overpredicted increases of PET by 2071-2099. Similarly, decrease in MI was overpredicted by the Thornthwaite method relative to Penman- Monteith. The Penman-Monteith PET formulation was influenced by change in vapor pressure deficit in addition to temperature and consequently large increases in PET were projected for the humid eastern portions of the study area. Under the more realistic Penman-Monteith method, the proportion of the study area classified as dryland (MI<0.65) was projected to increase by 32% from the historic period to the late century period. Our study indicates strong spatial variation in differences in the estimates of projected change in PET and MI based on the choice of PET formulation, and recommends the use of physically robust Penman-Monteith method to reduce the uncertainty arising from choice of PET formulation for future assessments of ecosystem response to the changing climate.

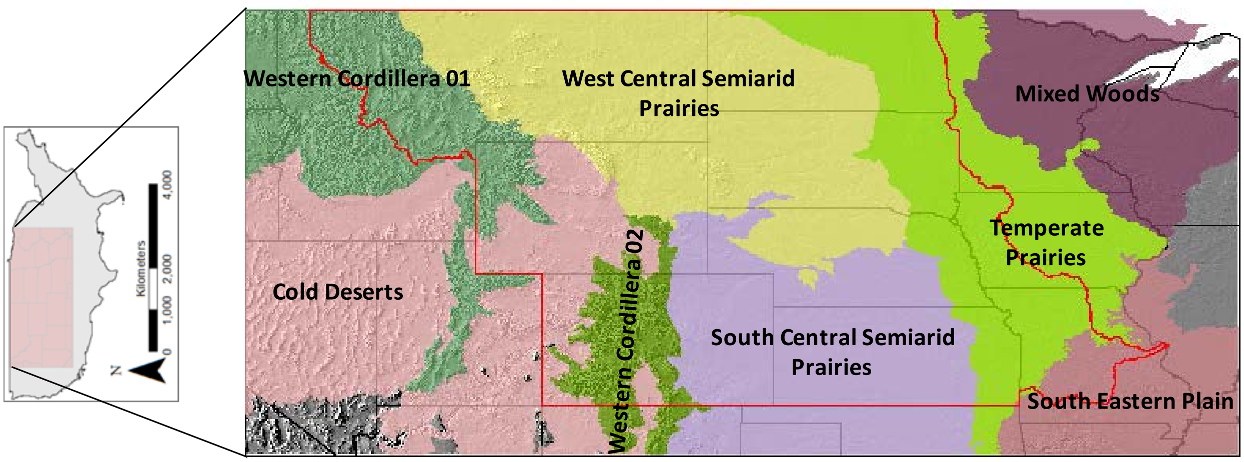

Figure 2. Shaded relief map of the study region in the north central U.S. EPA level III ecoregions are indicated by colored polygons and state boundaries are indicated by black lines.

Objective 3. Tree and shrub species distribution modeling (Manuscript under preparation for *PNAS* and *Ecological Modeling)*

The species distribution model predicted suitable habitat of 33 tree species under two climate change scenarios (RCP4.5 and RCP8.5) under CCSM4 for the year of 2040, 2070, and 2099. Currently, we are analyzing the model outputs and details will be reported to NC CSC upon completion. Here we report what we have so far.

We have identified eight forest ecosystems across the region (Fig. 3). Based on total basal area, 33 ecologically and economically important dominant tree species have been selected from FIA data set, at least four tree species for each forest types (Fig. 4). The climate predictors were derived from MACA products with spatial resolution of 1 km^2. We used SAHM to remove auto- correlated climatic predictors. The prediction was carried using BIMOD2 to predict the historical and future habitat of selected tree species. We will determine vegetation response and vulnerabilities of tree species to future climate change by comparing change in habitat range of each species in future.

The model predicted a considerable reduction in future suitable habitat for most of the species from all forest communities across north central US. However, the rate of reduction in suitable habitat was species specific. Precipitation, minimum temperature and solar radiation have been found as the he major predictors in influencing the distribution of these species across the study region.

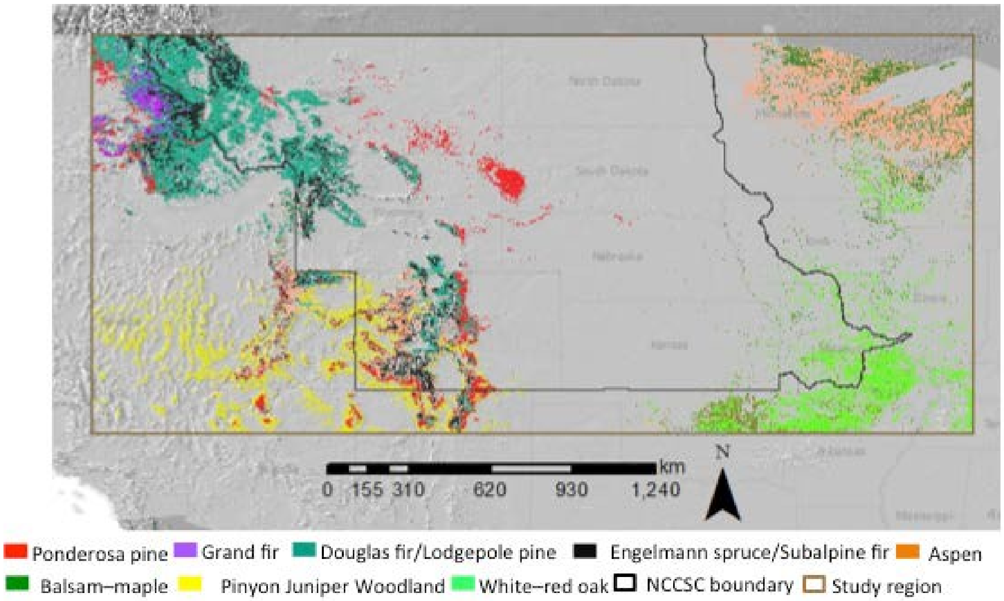

Figure 3. Eight forest communities across North Central U.S. considered for habitat prediction of 33 dominant tree and shrub species.

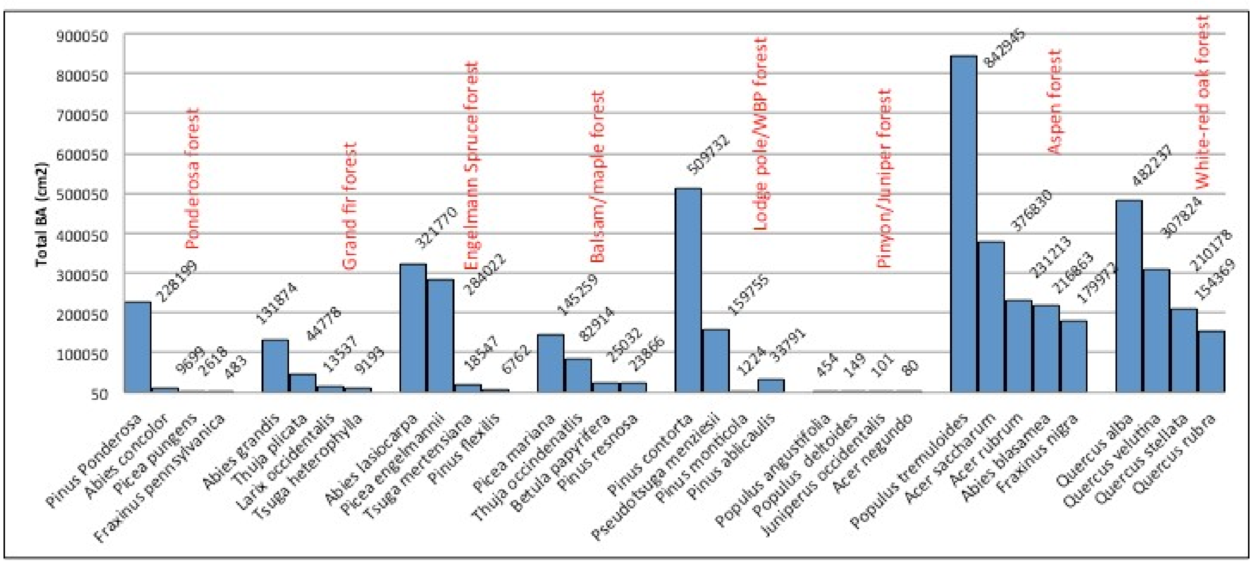

Figure 4. Major tree species considered for habitat predictions under future climate change across eight forest communities in North Central U.S.

We also assess the implication of PET derived from two methods on predicting suitable habitat of water limited species. The model overpredicted the historical habitat suitability under environmental predictors lead by Thornthwaite PET compared to that of Penman PET (Fig. 3). This is also especially true for the future prediction of habitat suitability of most of the species. In addition, Thornthwaite PET showed higher influence in predicting the suitable habitat than that of Penman PET. However, the modeling output showed that there is no difference in the performance and accuracy between the models led by two sets of PET.

Currently, we are analyzing the output and writing the manuscripts. The complete results will be reported to NC CSC upon completion.

Objectives 4 and 5

A. Adhikari and A.J. Hansen. Projected climate change and water balance on Greater Wildland Ecosystems across north central USA (Manuscript under preparation for *Journal of Climate*).

For the modified Objective 4, we assessed climatic bias in placement of land allocation types and analyzed the impacts of projected changes in water balance among GWEs and land allocation types across NC CSC domain. Our result showed no systematic climatic bias in placement of public, tribal, and private lands. The climate model projected substantial warming in all GWEs by the end of the century. The mean growing season temperature increase projected for all GWEs was 5.3 °C. The highest increase in mean temperature was projected for Theodore Roosevelt GWE (5.5 °C) and the least was in Great Sand Dunes GWE (4.6 °C). The historic MI was 0.35 across the region. As the projected PPT decreased and PET increased, the projected MI was decreased as expected by 24% across the region. The spatial patterns showed the strong east-west gradients of historic MI, greatest in relatively humid Lake Traverse GWE (0.55) and the least in relatively dry Bighorn and Yellowstone GWEs (0.27). The spatial pattern showed the projected decrease in MI was higher in humid Lake Traverse GWE (28%) and the least in Bighorn GWE (17%). Western Plains GWEs experienced slightly lower changes in projected MI compared to GWEs of two other ecoregions.

We will report vulnerability analysis of forest communities upon completion of analysis of modeling work.

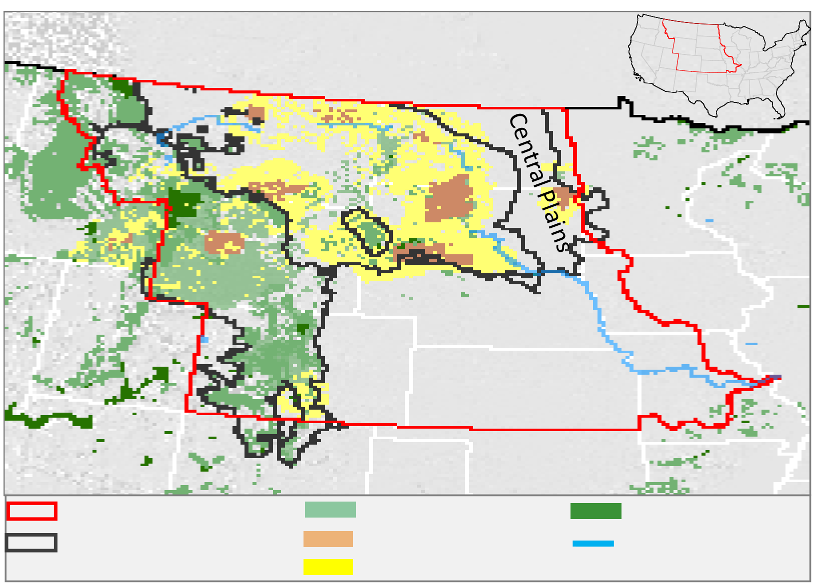

Figure 5: Land allocation types within GWEs of North Central Climate Science Center (NC CSC) domain across north central U.S.

Conclusions and Recommendations

We believe this research will contribute to understanding the vulnerability and sustainability of land and forest systems across the north-central U.S. This area is considered highly affected by land use and climate change. However, we faced some constraints and limitation of resources during this project. For example, we were unable to model land use intensification for future due to lack of publicly available quality data. Similarly we had to adjust Objective 4 on predicting grassland phenology for the similar reason. While working on species distribution modeling, we were concerned about the unavailability of spatial soil data as soil properties are also considered a limiting factor of plant growth and distribution.

Our LULC change analysis (Objective 1) contributes to existing knowledge that provides a context for conservation for wildlands within the study area. This analysis is, to our knowledge, the only study in LULC change in the study area for 2000-2011 and is unique in focusing wildlands, tribal, public lands and their surrounding ecosystems. Our study suggests that despite similar trends in net land use changes among the GWEs, land use/land cover types across the study area showed strong differences in land use dynamics and expanding, contracting, and stable land cover types. Differences in land use change among GWEs call for actions to develop an integrated regional-scale adaption plans that include quantitative assessments of exposure to multiple global change factors. This study helps managers to identify candidate areas for protection and/or restoration where ecosystem degradation is rapid.

Our study on projected water balance (Objective 2) is the first in evaluating how the two methods differ in spatial patterning of change in PET and MI at an ecologically-relevant resolution across a landscape with complex gradients in climate. This analysis is important because accurate projections of changes in water balance are needed to quantify ecological and agricultural response to climate change and to inform climate adaptation strategies.

The modeling of habitat suitability of dominant tree species (Objective 3) across the region includes an important water balance predictor (PET) which determines the distribution patterns of many water limited plant species. This study contributes in assessing vulnerability of forest communities across strong climate gradients. Assessments of forest communities' vulnerability to climate change based on projected habitat of some dominant species in this region are rare. Therefore, the findings of this study have important implications in resource allocation in conservation of most vulnerable tree species and forest communities across the region. Our approach helps to identify the important variables correlated to the distribution of dominant tree species across the domain. In addition, implications of PET derived from two different methods help to fill an important knowledge gap regarding the selection of appropriate predictors estimated from reliable methods that helps to reduce the uncertainty associated with species distribution models (SDM). Future work in modeling should be focused on improving the ability of models to generate accurate information required for management of biological resources across the targeted biomes.

Our study contributes to climate change assessments of wildland ecosystems centered at public, private and tribal lands (Objective 4). This study is the first in evaluating and comparing climate change impacts among different land allocation types across north central U.S. The projected change in water balance metrics (PET and MI) has important implications for vulnerability assessment of GWEs and land allocation types. This study gives more insight into degrees of exposure of GWEs and land allocation types to projected climate change, which helps to add knowledge and understanding of the vulnerabilities of these lands. Though land allocation types do not vary considerably on the rate of projected climate change, the ecological function of tribal lands are more vulnerable to changing climate due to their low adaptive capacity and placement in extreme biophysical settings.

Outreach

Books

Hansen, A.J., D. Theobald, T. Olliff, W. Monahan, editors. 2016. Climate Change in Wildlands: Pioneering Approaches to Science and Management. Island Press.

Peer-Review Publications

Piekielek, N., A.J. Hansen, T. Chang. 2015. Using custom scientific workflow software and GIS to inform protected area climate adaptation planning in the Greater Yellowstone Ecosystem. Ecological Informatics 30:40-48.

Garroutte, E., A.J. Hansen, R. Lawrence. 2016. Using NDVI and EVI to map spatiotemporal variation in the biomass and quality of forage for migratory elk in the Greater Yellowstone Ecosystem. Remote Sensing 8-404

McClure, M.L., A.J. Hansen, R.M. Inman. 2016. Connecting models to movements: testing connectivity model predictions against empirical migration and dispersal data. Landscape Ecology 31:7 pp. 1419-1432.pdf

Manuscript under Revision

Hansen AJ, Adhikari A and Rangwala I. Ecological water stress under projected climate change across the hydroclimate gradients in north central United States: A comparison of two potential evapotranspiration methodologies (Manuscript in review: Ecosystems).

Adhikari A and AJ Hansen. Land use change around the wildland ecosystems of the North Central United States.(in review: Landscape and Urban Planning).

Hansen, A.J., L. Phillips, G. Tabor, S.T. Olliff, J. Watson, C. Groves, J. Gross, S. Goetz, D. Theobald. Submission Dec 2016. A Call for Better Sustaining Yellowstone and America's Other Wildlands. BioScience. Previously submitted and now under revision.

Non Peer-Review Publications and Reports

(Note: we are working with Data Steward Manager to provide these publications whenever necessary)

Adhikari, A., A.J. Hansen. 2016. Land Use Land Cover Changes across the Wind River Indian Reservation. Landscape Biodiversity Lab Technical Report, Montana State University, Bozeman, MT.

Chan, T. and Ireland, K. 2015. Workshop report: Development and application of mechanistic ecosystem models at regional scales (November 5-6, 205). Montana State University.

Adhikari, A., A.J. Hansen. 2015. Land Use Change across the Greater Wildland Ecosystems of the North Central Climate Science Center Domain: Effects on Natural Vegetation Cover. Landscape Biodiversity Lab Technical Report, Montana State University, Bozeman, MT.

Hansen, A., S. Goetz, J. Gross. 2016. Final Report: Sustaining Wildland Ecosystems through Monitoring and Communication to Stakeholders. For NASA Headquarters, Science Mission Directorate, Cross Division.

Hansen, A., M. Clark, D. Glick, R. Gressewll, J Hilty, K. Krasnow, A. Middleton, C. Preston, G. Tabor, K. Trotter, T. Wilkinson. 2016. A new conservation for Yellowstone and western landscapes. Submitted to Jim Lyons, Asst. Sec for Land and Minerals, US DOI for transmittal to a White House transition team.

Proposals Funded

Inmann, R., A. Hansen, J. Gude. Wolverine meta-population monitoring and connectivity in the

U.S. Rocky Mountains and North Cascades. National Fish and Wildlife Foundation. $112,000 for 2016-2017.

Hansen, A.J., J. Gross, S. Goetz. Sustaining wildland ecosystems through monitoring and communication to stakeholders. NASA Applied Sciences Program. Aug 2015 – July 2016. $73,000.

Hansen, A. J., K. B. Ireland, B. Poulter, K. Emmett. Mechanistic modeling of vegetation dynamics under climate change: development and application within regional ecosystems. EPSCoR RII Track-1 Year 5. Sept 2015-Sept 2016. $50,000.

Proposals not Funded

Hansen, A.J., A. Adhikari, N.R. Chapagain, D. Theobald, C. Woodcock. Biodiversity of Protected Areas in Nepal: Monitoring, Assessment, Communication. Step-1 proposal. NASA Applied Sciences.

Hansen, A.J., B. Klein, S.T. Olliff, E. Shanahan, G. Tabor. Conservation in the 21st Century: Launching the Greater Yellowstone Ecosystem Collaborative. Camp Monaco Prize.

Proposals in Review

Hansen, A.J., S. Goetz, J. Ervin, M. Hansen, J. Watson, O. Venter, P. Jantz, L. Phillips. 2016. Informing UN-assisted National Biodiversity Strategy Action Plans with Earth Observations: Application to Forest Integrity and Connectivity. Submitted to NNH16ZDA001N-ECO4CAST.

Presentations

Hansen, A., and A. Adhikari. Vegetation Impact Assessment: Species distribution modeling at multiple scales. Watershed Vegetation Impacts under Climate Change (WVICC): A CCAWWG Training Workshop for Researchers and Resource Managers in Water, Agriculture, Natural Resources and the Environment. 17-19 May, 2016. Fort Collins.

A. Adhikari and A.J. Hansen. 2016. Estimating potential habitat range of selected tree species across the North Central United States. 13th Biannual Scientific Conference on Greater Yellowstone Ecosystem.

A. Adhikari and N.R. Chapagain. 2016. Wildlands in the Himalaya: current state, challenges, and opportunities (Oral presentation for a case study at NASA sponsored Sustainable Wildland Ecosystems Workshop).

Hansen, A.J., and A. Adhikari. Ecological Impacts and Vulnerability Assessment in the Context of the NC CSC. NC CSC Open Science Conference. Fort Collins, CO. June 2015.

Hansen, A.J. Climate Adaptation Planning in the US Northern Rockies. NSF Reverse Site Visit. Washington, D.C. Sept 2015.

Hansen, A.J., Landscape Climate Change Vulnerability Project (LCC-VP). NASA All Scientists Meeting. Washington, D.C., April, 2016.

Early Career/Postdoctoral Scientist Training Opportunity
[For Arjun Adhikari]

- Sustaining Wildland Ecosystems through Monitoring and Communication to Stakeholders Project sponsored by NASA (Feb 17-22, 2016)
- Wind River Drought Preparedness Workshop (July 26-27), Fort Washakie-Frank Wise Center, WY

Workshops and Training Sessions Convened

- Sustaining Wildland Ecosystems through Monitoring and Communication to Stakeholders Project sponsored by NASA (Feb 17-22, 2016)
- Vegetation Vulnerability across the Greater Yellowstone Ecosystem: Managing under Climate Change. Bozeman, MT. April 2015. 30 participants.
- Ecological Impacts and Vulnerability Assessment in the Context of the NC CSC session in the Student/Early Career Scientist Training Exposure to the concepts and tools being used in the NC CSC. May 2015, Colorado State University, CO.
- Climate Change in Wildlands: Pioneering applications of Science to Management in the Rocky and Appalachian Mountains. Ecological Society of America Oral Session. Baltimore, MD. Aug 2015. 25 participants.
- How can Vegetation Dynamics under Climate Change Best be Modeled at Greater Ecosystem Scales? NC CSC and MT EPSCoR sponsorship. Montana State University, Bozeman, MT. Nov 2015. 25 participants.
- Webinar to NC CSC 2/9/2016
- Presentation to the GYCC's WBP Subcommittee 4/13/2016

Other products

We have prepared land use change report for Wind River Drought Project. We will also prepare report on habitat of some tree species important for Tribal people inhabiting Wind River Indian Reservation.

Integrations / Synergies with other NCCSC projects

1. We are collaborating with Physical Climate Team for downscaled climate data to predict the habitat of major tree species across the North Central U.S. region.
2. We are closely working with Adaptation Team. We have already prepared land use change report for Wind River Drought Project. We will also prepare report on habitat of some tree species important for Tribal people inhabiting Wind River Indian Reservation.
3. Wind River Drought Project. We have coordinated activities with Shannon McNeeley and Jennifer Wellman of the Wind River Reservation Drought Project. Specifically, we have provided data sets on projected climate suitability for vegetation for the Yellowstone Area, provided our book manuscript on climate vulnerability, and provided an analysis of land use change and habitat fragmentation in the Wind River area.
4. We are closely working with Data Steward Heather 'Meagan' Battles Manley to update data management plan on USGS Science Base system for the management of the Impact project. The DMP of Impact project has been approved in 2015.
5. NC CSC All Scientists meeting on October 12-15. We presented two scientific talks at the meeting.
6. Monthly Check-ins. We have participated in these monthly calls.
7. We are coordinating an effort in the Greater Yellowstone Ecosystem aimed at improved public and private collaborative adaptive management. We will include the progress in FY 2017 report.