Different ways of knowing: exploring traditional ecological knowledge and climate modeling for the Turtle Mountains, North Dakota

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SOARS® Summer 2009

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Abstract

Different ways of understanding climate change are pertinent to the study thereof. Observations and perspectives from indigenous and local peoples, in combination with scientific climate data, are important to include in discussions and considerations of regional climate change to better understand the full scope of the impacts brought about by a changing climate. This study explores impacts of climate changes on plants, and therefore culture, in the Turtle Mountain Reservation (ND) community as seen through the eyes of an Anishinabe tribal elder who is the community’s medicine man. The analysis of CCSM3 coupled climate model projections for north central North Dakota revealed potential increases in regional monthly temperature’s between 0.5 -3.0°C by 2020. Precipitation is projected to increase in spring months, and decrease in summer and fall. Through a semi-structured interview the elder reported unpredictable regional weather conditions over the last ten to twelve years. Observations included changes in winter temperatures and precipitation, unstable weather patterns during the transition from winter to spring, and dry summer conditions. The elder stated he is indirectly impacted when the harvest of culturally significant plants is compromised by changing environmental conditions; the ecosystem’s plants, insect, and wildlife species are shifting. By way of exploring Traditional Ecological Knowledge and climate modeling we understand projected changes in temperature and precipitation are already underway in the Turtle Mountains. The breadth of knowledge and understanding of the region’s environment exposes the changing weather’s impacts on not only the ecosystem, but on a community’s cultural practice.
Introduction

“Yeah, [growing up] you could count on everything. Depend on it, I should say. Even the weather, the seasons, they were always the same. The same, same cold winter, once it snowed, it stayed. It wasn’t this, ah, warm up, melt. No, it got real cold and stayed cold for months.” – Anishinabe elder and medicine man

Amidst contemporary concern for changing climate, scientists are increasingly looking to traditional ecological knowledge (TEK) to better understand the scope of changing weather patterns from past, to present, to future. Climate change is a global issue that has indigenous and local peoples, climate scientists, the general public, and decision-makers world-wide paying close attention to weather and climate. Indigenous and local peoples are noting recent changes in weather patterns and effects on species’ life cycles, productivity, and symbiotic relationships (Turner & Clifton 2009). Simultaneously, the Intergovernmental Panel on Climate Change (IPCC) has released its fourth global climate assessment (IPCC 2007), and continues to implement state-of-the-art climate modeling technology to project potential changes in climate for the 21st century. Given the impending changes, all forms of knowledge, from local to global, are critical to help us inform decisions about adaptation and mitigation strategies.

Observations and perspectives from indigenous and local peoples, in combination with scientific climate data, are important to include in discussions and considerations of regional climate change to better understand the full scope of the impacts brought about by a changing climate. In order to facilitate adaptation, assessing the impacts that climate changes are having or may have on peoples’ lives requires a combination of disciplinary approaches and methods (Furgal & Seguin 2006). Climate change expands beyond modeling, forecasts, and debate; it is a potential threat to community quality of life and culture. Prior to assessing how to adapt to impacts, the culture of a people must be explored and better understood. These two ways of knowing, scientific and traditional, represent both the record of climate and the experience of climate.

Climate change is being investigated by scientists world-wide. Findings have been documented by the Intergovernmental Panel on Climate Change which was formed in 1988 by both the united UN Environmental Programme (UNEP) and World Meteorological Organization (WMO). The IPCC’s mission is to provide objective information about climate change to policy makers and to the public. According to the IPCC, “climate change refers to a change in the state of the climate that can be identified by changes that persist for an extended period, usually decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity”.

Climate change is recognized as an actual, ongoing, and accelerating phenomenon, and there is a need to understand its potential impacts on known weather patterns, ecosystems, and society (Turner & Clifton 2009). According to the fourth IPCC report, changes in climate patterns over the last 50 years have been documented; these categories of observed change in climate patterns are wide-ranging and represent unpredictable climate conditions impacting the complex
interrelationships within ecosystems. During the course of this century, the resilience of many ecosystems is likely to be challenged by an unprecedented combination of change in climate, associated extremes (such as flooding, drought, wildfire, insects, and ocean acidification) and global change drivers (such as pollution, land-use change, and over-exploitation of resources) if greenhouse gas emissions continue at or above current rates (IPCC 2007).

Plant and animal species are especially reliant upon and sensitive to climate. Approximately 20 to 30% of plant and animal species assessed thus far by the IPCC are likely to be at increasingly high risk of extinction as global mean temperatures exceed warming by 2-3 degrees Celsius above pre-industrial levels. Projected impacts on biodiversity are significant and of key relevance, considering that global losses in biodiversity are likely irreversible (IPCC 2007).

Climate models give us an idea of the direction of change in respect to climate conditions. They enable us to project into the future with an estimate of what conditions we will potentially encounter. On the other hand, Traditional Ecological Knowledge (TEK) tells the story of where we have been, as well as providing an understanding of how ecosystems are changing as observed by those closely attuned to the land. TEK is a repository of knowledge acquired through observation and experience which is passed down through the generations by oral teaching. Traditional Ecological Knowledge accumulates incrementally, is tested by trial-and-error, and is transmitted to future generations orally or by shared practical experience (Berke et al. 2000). Indigenous communities have relied upon TEK for treating physical ailments from diarrhea and headaches to anxiety and insomnia for generations. Historical tradition, including the systems of knowledge possessed by people outside Western science, is a knowledge that often becomes encoded in rituals and in the cultural practices of everyday life (Feyerabend 1987).

When employed in scientific literature, TEK is defined as “a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission” (Berkes 2008). In the past, “tradition” has been a problematic term for some researchers because, as Warren (1995) explained, “‘traditional’ denoted 19th-century attitudes of “simple, savage and static.” Perhaps in order to avoid conflict from using potentially offensive language, some scholars favor the term “indigenous knowledge” (Warren 1995). The “Traditional Ecological Knowledge” framework has been established through the work of the International Conservation Union (IUCN) (Johannes 1989, Williams & Baines 1993, Berkes et al. 2000).

The gathering of traditional medicinal and ceremonial plant species represents a significant aspect of cultural identity and knowledge. TEK incorporates understandings of ecological processes as well as peoples’ relationships with the environment (Williams & Baines 1993).

Traditional Ecological Knowledge, as a way of knowing, is similar to Western science insofar that is based on an accumulation of observations, collected in a different manner than the fundamental ways of scientific research (Berkes et al. 2000). Observations and perspectives
from TEK combined with scientific technology, in respect to investigating climate change, empower humanity’s understanding of the environment in which we live. Climate change challenges an understanding of the environment that has developed through centuries of observation, interaction, and reliance upon the environment.

This study explores impacts of climate changes on plants, and therefore culture, in the Turtle Mountain Reservation community as seen through the eyes of a tribal elder who is the community’s medicine man.

Study Site

The Turtle Mountain Reservation is located in the north-central portion of North Dakota. The Reservation consists of 35,579 tribally owned acres and 104,005 allotted acres, within a six-by-twelve miles area (www.tmbci.net, accessed 6/8/09). The topography of the region consists of low, rolling hills covered with small trees, brush, and meadows, and interspersed with various lakes and sloughs. The tree-cover consists of birch, oak, willow, and aspen, and there are numerous kinds of wild fruits and berries.

Vegetation and temperature are used as the natural indicators of a region's climate (Ackerman & Knox 2007). The climate of the region as defined by the Koeppen Climate Classification is ‘Dfb’, which represents a humid continental climate with severe winters and cool-to-warm summers.

Anishinabe People

Originally from the Great Lakes, the Anishinabe, or “The Original People” have made their home in the Turtle Mountain region since 1882. Traditionally the Anishinabe lived off the land and relied on hunting, fishing, and gathering for subsistence. According to historic tribal ways of living, their daily lives were guided by the seasons (www.tmbci.net, accessed 6/8/09).

Today approximately 11,000 tribal members live on the Turtle Mountain Reservation. The town of Belcourt, ND is located on the reservation and provides employment through the Turtle Mountain Community College, Fire Department, Indian Health Services, dining, lodging, and farming. Although the community lives in a developed infrastructure, various members of the community continue to practice traditional ceremony and medicine.

Research Methodology

The research was designed to acquire an understanding of the two ways of knowing: from the scientific perspective, we were interested in the difference between data from the end of the 20th century and future projections for temperature and precipitation for the study site; from the TEK perspective we were interested in observed changes in climate for the Turtle Mountain Reservation, and learning if climate change has affected medicinal plants in and around the
The climate data were gathered in the form of climate model averages over twenty year periods, 1980-1999 for the late 20th century, and 2010-2030 for climate model projections. The two data sets were compared to project changes in temperature and precipitation for 2020. The traditional ecological knowledge was recorded through an interview with an Anishinabe elder. We explored his perceptions of changes in regional climate as well as his observations of favorable or unfavorable climate conditions for growth of certain culturally significant plant species.

**Climate Model Projections**

We analyzed climate data from the Community Climate System Model 3 (CCSM3) obtained from the National Center for Atmospheric Research (NCAR). The CCSM3 is a fully-coupled, global climate model providing state-of-the-art computer simulations of the Earth's past, present, and future climate states. The model simulates individual processes of the atmosphere, land surface, sea ice, ocean, and their collective interactions. It belongs to a category of computer-based simulations known as general-circulation models. These models use mathematical formulae to represent the chemical and physical processes that drive Earth’s climate (www.ucar.edu/communications/CCSM/history.html, accessed 7/28/09).

Projections were produced using potential greenhouse gas emission scenario A2. Under this scenario, (IPCC 2007) infers, “The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines [scenarios].” Actual atmospheric greenhouse gas concentration levels depend on future global greenhouse gas emissions.

CCSM3 A2 scenario projections were generated for north-central North Dakota for potential change in temperature and precipitation for January through December in 2020. Soil moisture data was prepared and saved for future investigation.

The CCSM3 grid cell resolutions are approximately 4.5 kilometers. Shapefiles are a native file format for Environmental Systems Research Institute (ESRI) software. We used ESRI ArcGIS 9.3 to read the shapefiles, created temporal graphs, and mapped the projected anomaly by 2020 for variables temperature and precipitation, within our selected domain.

We repeated the following steps to represent the anomaly for each variable, using the temperature variable as an example. In order to create these graphs and maps we first calculated the change from end of the 20th century, 1980-1999 average, to the projected values of 2020, 2010-2030 average, by deduct the 1980-1999 average from the 2010-2030 average. ArcGIS 9.3 is designed to join two shapefiles together based on a common identifier such as the grid cell ID. By joining end of the 20th century temperature with projected 2020 temperature we calculated the projected difference. Using this difference calculation we represent the change in temperature in map form for the months of January through December. These maps used color to illustrate which months within January through December will experience the greatest change in temperature from end of the 20th century to 2020.

Line graphs were also developed to illustrate present temperature versus potential temperature in 2020 in Microsoft Excel 2007. Excel has inherent graphing capability which
provides an alternative perspective to viewing the anomaly data. These graphs also illustrate the temperature anomaly trend from present day to 2020.

Semi-Structured Interviews

Over the course of the field study, one in-person, audio recorded interview was conducted on the Turtle Mountain Reservation in compliance with UCAR’s Human Subject Research guidelines (HSC, #2009-0006).

The researcher’s primary task was to understand what was happening in the given situation, specifically, the observations of changing climate conditions as recollected by an Anishinabe elder, and the observed impact of climate changes on the local ecosystem. Grounded theory framework guided the interview structure to explore how regional climate was perceived by the participant. The theory is designed to understand the research situation rather than test a hypothesis; it is explicitly emergent (Dick 2005).

The interview process followed a semi-structured format guided by a list of open and closed ended questions. After information on the participant’s length of stay in the region was gathered, the subsequent questions followed a diagnostic interview process (Dick 2005) where open-ended questions were asked to explore the participant’s perceptions of climate change, observations of changing climate, and if or how changing climate effects the Anishinabe community; see appendix for instrument. The diagnostic interview structure is designed to ensure the participant’s answers are based on his/her experience, rather than being preempted by the interviewer’s questions.

After exploring the participant’s knowledge and observations of the regional climate, the CCSM3 projection graphs were presented to the participant to provide visual representation of the climate data. The anomaly, illustrated in map form, using a color-scale legend to represent change in temperature and precipitation, was used to explore how the participant thought the projected climate anomaly could impact local plant species.

Compiling Interview Data

The participant responses contribute to a foundation for investigating potential impacts of environmental change on culturally significant plants.

Grounded theory recommends refraining from audio recording an interview; however, the interview in this study was recorded and transcribed to ensure accurate representation of the participant’s statements. Directly following the interview, the audio recordings were transcribed. Throughout the transcription process, a priori themes and emerging themes were coded to organize the data. Examples of coded themes include, and are not limited to, “Regional Climate Change”, “Observations of local Plants”, or “Collective Observation”. These codes resulted in a comprehensive and thematic data set and served to simplify analysis.
Results:

The CCSM3 anomalies between the end of the 20th Century and 2020, for Bottineau and Rolette counties, show increases in temperature ranging 0.5 – 3.0 °C dependent upon the month; every month’s temperature is projected to increase, see Figure 1. February and August anomalies show the most significant increases; February’s mean increasing from -3 to -6°C, and August increasing from 25–27.25°C. Projected precipitation anomalies show increases in January, April-June, and October-December, ranging from 1–8 mm/month. Decreases are projected for February-March and July-September, see Figure 2. The projected August anomaly shows the most significant change in increasing temperatures and decreasing precipitation. See Table 1. for temperature and precipitation projections per month.

Figure 1.

![Temperature anomaly, Present Day to 2020](image1)

Figure 2.

![Precipitation anomaly, Present Day to 2020](image2)
Table 1: CCSM3 Temperature and Precipitation Anomalies, End of 20th Century - 2020

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature Anomaly (°C)</th>
<th>Precipitation Anomaly (mm/mo.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.0–1.5</td>
<td>3–4</td>
</tr>
<tr>
<td>February</td>
<td>2.0–3.0</td>
<td>-1–0</td>
</tr>
<tr>
<td>March</td>
<td>0.75–1.75</td>
<td>-2–0</td>
</tr>
<tr>
<td>April</td>
<td>0.5–1.0</td>
<td>2–6</td>
</tr>
<tr>
<td>May</td>
<td>0.75–1.0</td>
<td>3–8</td>
</tr>
<tr>
<td>June</td>
<td>1.0–1.0</td>
<td>0–3</td>
</tr>
<tr>
<td>July</td>
<td>1.5–1.75</td>
<td>-2–1</td>
</tr>
<tr>
<td>August</td>
<td>2.0–2.5</td>
<td>-2– -1</td>
</tr>
<tr>
<td>September</td>
<td>1.5–2.0</td>
<td>-1–1</td>
</tr>
<tr>
<td>October</td>
<td>0.5–1.5</td>
<td>2–5</td>
</tr>
<tr>
<td>November</td>
<td>1.75–2.0</td>
<td>2–4</td>
</tr>
<tr>
<td>December</td>
<td>0.5–0.75</td>
<td>4–8</td>
</tr>
</tbody>
</table>

Semi-Structured Interviews

Emergent themes which resulted from qualitative analysis of our interview transcript are represented in Table 2. The tribal elder’s perception of climate change was based on observations of changes in weather patterns and local plant species in comparison to former climate patterns for the region. His observations included changes in winter temperatures and precipitation, unstable weather patterns during the transition from winter to spring, and dry summer conditions. Observations of the ecosystem include change in budding and flowering of local plant species, migratory patterns of birds, change in wildlife presence and behavior, and change in wildlife consumption of local herbivore.
### Qualitative Analysis: Observed Change in Climate and Ecosystem

<table>
<thead>
<tr>
<th>Themes</th>
<th>Representative Quote: Anishinabe elder and medicine man</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Climate Change</td>
<td>“Nobody knows what’s going to happen. It [weather] changes all the time.”</td>
</tr>
<tr>
<td>Observations of Local Plants</td>
<td>“…There are a lot more plant diseases now…”</td>
</tr>
<tr>
<td>Change in Wildlife</td>
<td>“There are lots of birds now that have never been here before… and ah, there are new insects every year.”</td>
</tr>
<tr>
<td>Comprehensive Observations</td>
<td>“Yeah, it seems like a lot of it starts with the weather. And the, ah, other things take off from there, you know, like, everything gets affected down the line…”</td>
</tr>
</tbody>
</table>

**Source: Anishinabe Tribal Elder and Medicine Man**

**Regional Climate Change**

“The weather, as far as rain and snow, is hit and miss. Nobody knows what’s going to happen. It changes all the time, constantly.” Anishinabe elder and medicine man

The elder we spoke with said he had noticed unpredictable weather conditions over the course of the last ten to twelve years. Observed changes to climate conditions in the region include: 1. early and late seasons, 2. storms and snow are “hit and miss” and occur at the wrong time of year, 3. “big” hail no longer occurs, 4. winter temperatures are no longer consistently -40 degree Fahrenheit, 5. the emergence of winter chinooks, and 6. an onset of tornadoes.

The change in regional climate is noticeable and consistently changes. The weather has been unstable and the elder reported being unable to recognize former patterns. The seasons – winter, spring, summer, and fall – are emerging early and/or late. Previous winter temperatures consistently remained below zero degrees Fahrenheit, and in recent years winter temperatures are frequently repeating a warming then cooling cycle. Warm air fronts sweep over and melt snow cover; the occurrence is known as a Chinook, or “snow eater” (Ackerman & Knox 2007). Warming temperatures early in the spring season turn to cold fronts that kill the premature budding of plants and trees. Heavy rains are continuing into late April and May. The growing season is shorter, Augusts have been dry. In 2006 it was so hot and dry that local sloughs dried up. On July 7, 2008 a category EF-3 tornado, with winds between 136 and 165mph passed through the Reservation.

**Observations of Local Plants Species**

“…There are a lot more plant diseases now. Just about everything seems to have a disease. Like the Juneberries, Chokecherries, the Birch trees. All kinds of plants like that got a disease. Actually, that seemed to start about five years ago. Maybe a little longer.” Anishinabe elder and medicine man
According to the Anishinabe medicine man, north-central North Dakota is, “plant heaven up here.” He reported watching the plants to gauge the health of the ecosystem and finding that the changing weather seems to negatively affect the plants. He has noticed more plants are diseased, some unexpectedly turning black without apparent cause. Amongst other noted changes are late cold fronts in spring freezing certain berry crops. Late spring rains are delaying the planting of agricultural crops such as wheat, oats, and barley. The growing season is shorter and the wheat kernels have been smaller. The fields cannot dry out and farmers are unable to plow in muddy conditions. In some years farmers have been unable to plant crops altogether. Sugar beet crops have suffered from a lack of “hard cold” conditions. The medicine man said some of the berry plants, high bush cranberry, and rosehips were not being eaten by the birds and deer which usually consume them to supplement their diet. Plants of medicinal importance are emerging more slowly in spring and are not consistently growing in their usual places. Non-native plant species are also reported.

Change in Wildlife

“There are lots of birds now that have never been here before…and ah, there are new insects every year.”
Anishinabe elder and medicine man

Changes in local wildlife have also been observed. The ducks and pelicans do not stay in the area anymore, and more species of song-birds are new to the region. Bald eagles are also more abundant. The beavers went from large and plentiful in 2007 to scarce in 2008. Wolves, coyotes, mountain lions, and black bear are more common on the Reservation and in the surrounding Turtle Mountains. Non-native insects are moving into the area.

Comprehensive Observation

“Yeah, it seems like a lot of it starts with the weather. And the, ah, other things take off from there, you know, like, everything gets affected down the line…” Anishinabe elder and medicine man

Collectively, unstable weather conditions experienced over the last 10-12 years have affected local plants, animals, and people. More children have been getting sick and the “old timers” say a really good cold spell is needed to kill off the germs emerging with warmer temperatures. The medicine man suspects native plant species will vanish over the years and simultaneously prevent regional gathering of certain medicine.

Medicine

Climate change is thought to be responsible for an increase in disease amongst plants traditionally used by the tribe for medicine. Symptoms such as upset stomach, diarrhea, headache, and anxiety can all be treated with Anishinabe traditional ecological knowledge of medicinal plant remedies. Local plants can also be used to numb the mouth, to relieve sore throats, as a laxative, to stop cuts from bleeding, to take away the pain and/or sting from a cut, to reduce the swelling in horses legs, and to remove tumors and cancers on the outside of the body.
According to the medicine man, the efficacy of plants can depend on the location in which they grow. While certain plants are preferred for medicine, many have substitutes which can be used if other species are unavailable.

However, certain species are preferred. The elder we spoke with reported transporting such preferred species from the bush into his garden. Inconsistent weather has compromised the health of and access to such culturally significant species.

“But there is a lot of good medicines. They, they work…yeah, a lot of that [plant] medicine really works good...”
Anishinabe elder and medicine man

Discussion

Understanding climate change is a complex challenge calling for a multifaceted approach to study. Temperature and precipitation together determine the environmental conditions under which certain plants and animals flourish while others vanish (Ackerman & Knox 2007). Therefore, climate change poses a substantial threat to the environment. Scientific knowledge is extraordinarily invaluable to the understanding of the environment; technological advancements of climate modeling provide insight into potential future conditions, as well as an opportunity for communities to consider prospective mitigation strategies. Simultaneously, indigenous perspectives attuned to the interconnectedness of life systems, the importance of long-term views, and the linking of human health and well-being to the health of the environment as a whole, reveal the degree of environmental impact. Collaborative processes not only incorporating, but respecting both scientific and indigenous ways of knowing are critical to attaining a comprehensive understanding of our environment (Turner & Clifton 2009).

By way of exploring Traditional Ecological Knowledge and climate modeling we understand that projected changes in temperature and precipitation are already underway in the Turtle Mountains. The elder medicine man reported that unstable weather patterns, warming winters, heavy spring rains, and uncharacteristic transitions between seasons are already in progress. Detailed observations further unveil how these changes are affecting the regional ecosystem. The IPCC’s projection (2007) that 20-30% of plants and animals are at increasingly high risk of extinction under regional warming of 2-3°C agrees with the elder’s prediction that certain plants species will vanish as environmental conditions change.

The breadth of knowledge and understanding of the region’s environment exposes the changing weather’s impacts on not only culturally significant plants, but on the interacting wildlife and people. The elder medicine man stated he is indirectly affected by change in the ecosystem. Warmer and drier conditions in August compromise his harvest of medicine plants and therefore cultural practice. Adaptive measures are already implemented through the transportation of medicine plants from the bush to a domestic garden to increase the likelihood of access to traditional medicine, no longer secure in the bush.
We recommend continued study to investigate reported changes in the ecosystem. Observations of change in the wildlife populations, the emergence of non-native birds, plants, and insects, as well as the disappearance of former species all need close examination. Future directions could incorporate working with an ethno-botanist to better understand specified species and conditions conducive to their growth. Examining if and how increasing April/May rains and a shorter growing season are impacting regional agricultural practices could open discussion on potential alternative approaches to such practices.

More interviews of community elders, adults, and youth are called for to better understand community perceptions of climate change, observed impacts, and potential adaptive strategies; maintaining voluntary participation and community-determination. The elder reported more children are getting sick in the winter time, and investigating trends between winter weather and reported illness could potentially substantiate the impact of climate change on health.

Conclusion

Climate change is more than a discipline’s study or political debate; it is an impending threat to the welfare of people and their cultural practice. Examining two different ways of knowing over the course of this study increased the depth of our understanding on how changing climate conditions are impacting the Turtle Mountain ecosystem and community. When approaching the assessment of environment and human interaction, it is critical cultural sensitivity is upheld to the directives of the community in which assessment takes place. Community perspectives are key elements to understanding experienced conditions and therefore potential adaptive strategies. Within the integration of Western science and indigenous knowledge, the direction of study should be guided by the community.
References


