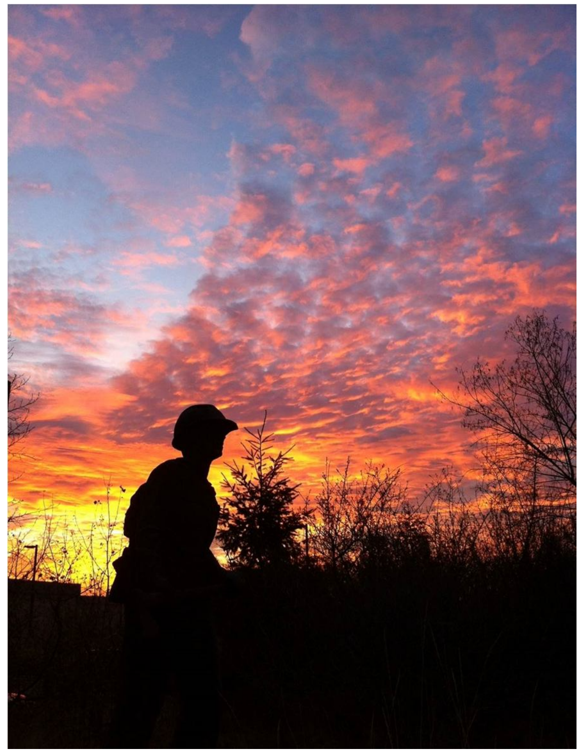
Climate Change and Indian Forestry



Changes in temperature and precipitation cycles are occurring in Indian Country. Photo by Robyn Broyles.

Changes in the earth's climate are affecting the growth, mortality, and composition of forestland resources and the ecosystem qualities and services upon which people depend. The range and scale of impacts are large. Changing weather patterns are imposing new threats to important species of plants (including trees), wildlife, and cultural resources. Adjusting forest plans and practices to accommodate climate changes will impose additional costs, logistical constraints, and other management challenges for forestry programs. While such impacts logically extend across political boundaries and property ownerships, IFMAT is most interested in the effects of climate change on Indian forestry. Federal responses to climate change are reshaping agency priorities and institutional arrangements affecting how federal trust obligations to tribes are being implemented. For instance, the availability of federal financial and technical assistance becomes a critical element in determining tribal potential for adaptive response to climate change. This is especially true where drought, insects, disease and wildfire are affecting Indian timberlands and woodlands. The rate of global warming and the range of observed impacts have increased since IFMAT I (Climate Central 2012, QFR 2009). Systems and resources supporting or depending on forests, such as water supplies, wildlife, energy, housing and infrastructure, food and agriculture, and human health are being affected.

Climate change exacts disproportionate social, economic, and cultural impacts on tribes limited by scarce resources, mobility, and access to information. These inequities are amplified as rates of change accelerate (Bull Bennett and Maynard 2013). Forestry programs that are underfunded, understaffed, or poorly connected to information sources will not be able to adapt. For these reasons, IFMAT III explored climate change as an emerging driver for Indian forests and forestry.

Climate changes and impacts on forests

Globally, the last decade was the warmest for at least 1,500 years (Marcott et al. 2013). Temperatures in the lower 48 states of the US have increased 1.3 degrees F over the last 100 years, with the top ten warmest years occurring since 1990 (NOAA 2012). Growing seasons have increased by 2 weeks since 1900, the largest change occurring over the last 30 years; more rapidly in the West that the East (Kunkel 2012). Because of higher winter temperatures, plant hardiness zones have shifted northward and many changes are being observed in wildlife wintering ranges, pollination, hibernation times, and other phenomena.

Precipitation has increased 6% overall in the last 100 years and has shifted to proportionately more rain (than snow) increasingly is distributed in heavy downpours. Snow pack has decreased by as much as 75% in some areas, the area covered by snow overall has been reduced by 7% since 1970 (NOAA 2012).

Extreme events such as heat waves, downpours, droughts, and windstorms are more frequent. In the US, eight of the top 10 precipitation days have occurred since 1990, mainly in the eastern US. Yet in the West, the current drought is one of the worst on record and has been accompanied by record temperatures. More than 64 percent of the United States experienced moderate to severe drought in 2012 and, for some parts of the country, 2012 was the driest year on record. Six of the 10 most active hurricane seasons have occurred since 1990, and April 2011 was the most active tornado month on record since 1950 (NOAA 2012). Across the West, wildfires are starting earlier and ending later, extending the average wildfire season by about 75 days since 1970 (Climate Central 2012).

Climate change forecasts include more frequent and extreme weather events such as windstorms.
Storm damage – Leech Lake. Photo by Vincent Corrao. Blowdown – Makah. Photo by Larry Mason.

A recent synthesis (Vose et al. 2012) provided the principal input for the new US Global Change Research Program (USGCRP) National Climate Assessment (NCA) on the effects of climate variability and change in North American forested ecosystems. This synthesis lists the following observed and expected future impacts:

- Increases in temperature will reduce the growth of some species (in dry forests) and perhaps increase the growth of others (high-elevation forests).
- Decreased snow cover depth, duration, and extent will lead to drier conditions

especially in the West, decreasing tree vigor and increasing susceptibility to insects and pathogens.
- Mortality will increase in older forests, especially those already experiencing soil moisture stress.
- Species habitats will shift, in general moving up in elevation and northward in latitude.
- Interacting disturbances will impact forest ecosystems.
    - Wildfire will increase throughout the US, doubling the area burned by the mid-21st century.
    - Insect infestations will expand affecting greater areas than wildfire.
    - Invasive species will become more widespread, especially in dry forests after disturbance.
    - Increased flooding, erosion and sediment movement can be expected from fire disturbance and downpour combinations especially in steep areas.
- Tree growth and regeneration will decrease for some species, especially near limits of the range.
- Increased drought will exacerbate the interactions of stressor complexes leading to higher tree mortality, slower regeneration, and shifting combinations of plant species that may result in changed and possibly novel forest ecosystems.
- Eastern forests will continue to serve as carbon sinks while Western forest ecosystems may transition to carbon sources because of combustion and decay associated with wildfire and insects disturbances.

The Vose et al. synthesis described Regional perspectives and key issues for the forest sector in the NCA regions. Table CC.1 crosswalks those regions to the regional breakdown used in the IFMAT III report. Table CC.2 characterizes some of the more important implications of the Vose et al. (2102) and other climate effects literature for tribes in those regions.

Table CC.1. Crosswalk between IFMAT, BIA, National Climate Assessment Geographical breakdowns.

IFMAT Region	BIA Regions	States	National Climate Assessment Regions (approx.)
Northwest	Northwest	WA; OR; MT	Northwest
	Rocky Mountain	MT; WY; ID	
	Pacific	CA	
Southwest	Southwest	NM; CO; TX	Southwest
	West	AZ; NV; UT; CA; OR; ID	
	Navajo	NM	
Lake States	Midwest	IA; MN; MI; WS	Midwest
	Great Plains	ND; SD; NE	Great Plains
	South Plains	OK; KS	
	Eastern Oklahoma	OK	
East	Eastern	ME; NH; CT; RI; PA; WV; MD; VA; KY; TN; NC; SC; AR; MS; AL; GA; LA; FL; TX	Northeast
			Southeast

Table CC.2. Regional impacts from Vose et al. (2012) for IFMAT III regions.

IFMAT Region	Major Climatic Changes	Climate-driven stressors	Major non-climate stressors	Effects on forest systems	Forest management implications
NW	More precipitation as rain. Smaller snowpack/ earlier melt. Temp increases, esp. winter. Drought duration & intensity.	Wildfire. Bark beetle & other insect/disease. Downpours.	Fire suppression. Fragmentation.	Growth reductions in Southern range. Species distribution change – Doug-fir decrease. Grass, shrub lands, woodlands interface. Disturbance area increase.	Wildfire management. Forest density and spp. Composition management. Reforestation strategies. Woodlands mgt.
SW	Multiyear droughts. Heat waves. Episodic flooding.	Wildfire intensity. Insect outbreaks. Sedimentation. Lower carbon storage.	Water competition. Exurban profusion. Grazing.	Large scale diebacks. Growth decreases. Species shifts: conifer to mixed. Species distribution changes. Disturbance area increase. Increased mortality in “fringe pine” and woodlands	Aggressive fuels management. Density mgt. Woodlands management.
Lake States	Heat waves. Precip. Increases. Downpours. Multiyear droughts. Lower winter temps.	Floods and erosion. Insect, disease and invasives increases.	Fragmentation. Air pollution.	New species assemblages. Moisture stress. Nitrate leaching losses. Soil carbon losses.	Changes to reforestation species and strategies.
East	Heat waves. Intermittent droughts. Snow accumulations. Precipitation increases. Downpours. Windstorms.	Heat and moisture stress. Insect and disease increase, expansion. Flooding, sedimentation and erosion. Wind damage Wildfire season lengthening (Southeast).	Urban expansion. Fragmentation. Air pollution. Invasives.	Growth increases in some species. Species reductions and shifts (conifers and some hardwoods). New species assemblages. Moisture stress. Cold-water fish habitat degradation. Nitrate leaching losses. Soil carbon losses. Shifts in commercial forest and carbon sequestration productivity (Southeast).	Reforestation strategies. Forest health management. Open space conservation strategies.

Climate change vulnerability – a framework for understanding and managing climate impacts

Vulnerability is used here to describe the degree to which a system(s) is susceptible to adverse effects of climate change, including variability and extremes (Adger and Brown 2009, IPCC 2007). Communities in the weakest economic or resource position are often the most vulnerable to change, especially when multiple stresses converge and interact (Lynn et al. 2011).

Climate adaptation is the proactive management of the range of vulnerabilities presented by changing climate and its interaction with existing and other emerging stressors (Rose 2010). Vulnerability management is organized around three key concepts: *exposure, sensitivity* and *adaptive capacity*. Improvements in any or some combinations of these elements of vulnerability contribute to overall resilience of the system. Resilience is the ability of a social or ecological system to absorb change while retaining structures and ways of functioning, the capacity for self-reorganization, and the ability to adapt to stress (IPCC 2007). Losses in resilience mean losses of adaptive capacity.

The following is a basic framework for evaluating and comparing multiple impacts of the changing climate on tribes and for designing interventions to reduce negative impacts and/or take advantage of possible opportunities. The terms and structure used here are generally accepted management principles of climate change adaptation (IPCC 2012). The framework breaks vulnerability into key components (*exposure, sensitivity, and adaptive capacity*) to make it easier to evaluate the contributions of different policy, management, and other options. This approach can be used to analyze a specific value or range of vulnerabilities yet is general enough to address broad ecological, social, economic, and cultural impacts (Adger 2006, Smit and Wandel 2006).

Exposure is determined by regional and local differences in stressors such as fire, insect, disease and other disturbance, the proximity of tribal lands to hazards posed by other ownership conditions, and the circumstances conducive to transmission such as fuels, forest density, or other attributes of the forest. *Sensitivity* refers to susceptibility to harm (or benefit) that may be influenced by the level of dependence (e.g. economic dependence of communities on forest resources or cultural reliance on individual species) and the forest properties (species mix, diversity, density or other properties) that resist harm to system functions. Many tribes are exposed and sensitive to climate change impacts due to their resource-based livelihoods, the nearly 3000 miles of shared boundaries with federal lands, and the locations of their homelands in remote and marginal environments.

Adaptive capacity is the ability of a system to withstand disturbance and retain, recover, or transform important functions. Adaptive capacity to changing environmental conditions is strongly rooted in the ability of people to modify both their behavior and the resiliency of forested environments (Ford et al. 2006). Diversification provides a buffer against change and is an important attribute of adaptive capacity.

Adaptive capacity is influenced by:

- Resources – nature and level of investments and financial capital
- Capacity of management and technical staff
- Nature and strength of relationships (intratribal, landscape neighbors, and service providers)
- Access to technology and information
- Institutional and governance effectiveness (e.g. intratribal social and political systems; effectiveness of federal trust system)
- Access to markets and competitive position in those markers (e.g. individual vs. collective marketing approaches)
- Management strategies (embodied in forest management plans and IRMP's)
- Knowledge systems (diversity and integration of traditional, experiential, and scientific knowledge; education, public information, and professional development systems)
- Policy fabric within which the tribe operates (e.g. self-government and federally sponsored programs (Prno et al., 2011).
- Others

Managing vulnerability and adaptation – roles of traditional knowledge

Adaptive capacity for tribes is rooted in traditional ecological knowledge (TEK), diversified resources and livelihoods, social institutions and networks, and cultural values and attributes that encourage innovation in the face of uncertainty. The paradigm of active management in pursuit of multiple goals is a hallmark of Indian forestry and a source of inherent adaptive capacity (Berkes et al. 2000). Guided by TEK and closeness to the land, active management allows for the experimentation, learning and adjustment that will be needed to keep pace with the trends and surprises of a changing climate. Adaptive management, present in Indian forestry, should be viewed as a valuable asset in collaborative attempts to deal with climate and other stressors at landscape scales.

During IFMAT visits, we observed tribal uses of scarce financial and technical resources that were effective, leveraged, and creative. Tribal adaptations to harsh physical and social environments can provide lessons for others who heretofore have been insulated from climate change by plentiful resources, infrastructure, and protective institutions (Nakashima 2012). Tribes are disproportionately affected by climate change due to the marginal nature of their lands and their direct dependence upon natural resources to sustain tribal lifeways (Lynn et al. 2011, Salick and Ross 2009). The federal government's responsibility to protect Tribes' rights to water and hunting, fishing, cultural practices, and other resources extends to support for climate impact adaptation. Williams and Hardison (2006) raised questions about culturally important species and sites and the cultural sustainability of tribes. Hanna (2007) maintained that climate change threatens the rights of tribes to inhabit lands and continue social and cultural practices on those lands. There may also be an issue of social inequity given the relatively small contributions by tribes to the causes of climate change – greenhouse gas emissions – as compared with resultant impacts for Native cultures, practices, and rights (Curry et al. 2011). Emerging policies for adapting to climate change or reducing greenhouse gas emissions may have unintended, perhaps negative consequences for tribes and could either change some aspects of the relationship between tribes and the federal government or intensify existing problems in that relationship (NTAA 2009). Policies and practices that underlay tribal forestry and federal trust relationships need be evaluated to determine potential for improvement/detriment to the adaptive capacity of tribes facing climate change (Curry et al. 2011).

Multiple forms of knowledge and innovative thinking will be needed to cope with and adapt to changing climate patterns. TEK with its emphasis on holistic thinking, long-term perspectives, experiential learning and communication appears to offer a great complement to scientific knowledge (Parrotta and Trosper 2012, Kimmerer 2000, Pierotti and Wildcat 2000). Effective and appropriate deployment of TEK could help tribes and other landowners and communities diversify and enrich their ability to address climate-driven changes (Nakashima et al. 2012).

Berkes (2012) defines TEK as “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living things (including humans) with one another and their environment.” Houde (2007) describes TEK as consisting of six interactive “faces” including factual observations; systems (“complex webs of practices’) for place-based management and adaptation; past and current uses of the land embodied in life stories; ethics and values expressed as cultural norms and expectations; vectors for maintaining cultural identity in the face of landscape, societal, and other change; and overall assumptions and beliefs about how the ecological or other systems work (“cosmology”).

Houser et al. (2001) affirmed that the oral histories and TEK of native peoples across North America offer insight and are useful for understanding climate changes and impacts on human communities. Oral histories record not only the consequences of climate fluctuations, but also the responses that helped communities adjust and survive. For example, traditional ways of caring for the forest, such as density management and underburning, are gaining acceptance as helpful alternatives to failed policies of fire suppression (Mason et al. 2012). TEK also carries the principles that underlie subsistence economies - personal relationships, generosity, and diversifying resource reliance among others – that could help to inform the adaptive responses by the broader society (WCED 1987).

TEK embraces features that will be essential in dealing with turbulence and uncertainty of a changing climate: knowledge creation, knowledge transfer and sharing, preservation and protection of knowledge from exploitation, learning through stories about actions and consequences, and the acceptance of interconnected systems and constant change (Whyte 2013).

Several authors suggest powerful potential for integration between traditional and scientific knowledge to deal with environmental change, including inclusion of local expertise, history, and baseline information; fruitful hypotheses for research; insights about the impacts of adaptation measures and strategies; and shared basis for long-term monitoring by communities (Motanic 2012, Nakashima et al. 2012, Berkes 2012, Trosper 2007, Michel and Gaton 2002). Vinyeta (2012) described how the differences between TEK and Western scientific knowledge complement each other in dealing with the complex problems of adaptation. TEK accumulates localized, field-tested wisdom that have been communicated orally through generations, while scientific knowledge tests hypotheses in controlled settings and reports results through publications. Both forms of knowledge are based in observation and are subject to modification as new observations, experiences, or assumptions emerge Vinyeta (2012).

Informal interviews with tribal forest managers

To help us to better understand how tribal foresters regard climate changes, we conducted a series of informal interviews with the forest managers of the tribes visited by IFMAT. Each interviewee was asked to summarize representative perspectives for his or her forestry program. The questions were provided in advance to allow managers and staff to reflect on the nature of climate influences and to offer specific examples. Questions were open-ended and consisted of the following:

What changes in climate and weather patterns have been most evident in the last 10 years?

1. Are any of these changes affecting the tribe's forests? How?
2. Has your tribe adjusted its forest management practices or planning in response to these climate and other weather pattern changes? How?
3. What is the most important barrier(s) your tribe faces in responding to changing climate and weather patterns?
4. Has your tribe received any federal or other outside funding to assist it in responding to the changing climate?
   If yes, what programs and/or agencies provided this funding?
5. Please describe your experience in considering and/or applying for funding, whether or not you were successful.
6. Please provide any additional thoughts about your tribe's response to changing climate or general comments about climate change in Indian Country.

Forest managers are observing changes in species distributions that impact water availability. For example, juniper encroachment (as shown left) degrades watersheds (Bedell et al. 1993). Photo right shows results of a juniper removal project with retention of scattered mature trees - San Carlos Apache. Photos by Larry Mason.

Findings – Tribes, forests, and climate change

CC1. Tribes and the BIA have not been successful in accessing new and redirected federal funding for climate change response during the period 2009-2012. Tribes are not experiencing equitable access to funds or technical services related to climate change planning, adaptation and response. In 2012, DOI received $175 million in climate change related funds that make up their LCC efforts. In contrast, the BIA received $0.2 million despite the fact that they have a unique federal trust obligation for tribal lands that also encompass 10 percent of DOI's land base and host the largest human population living on the land overseen by DOI agencies.

CC2. Managers of tribal forests are observing impacts of a changing climate. Some of these impacts include increased severity of wildfires and insect and disease activity, increased frequency and intensity of precipitation events, more severe droughts, changes in the timing of plant and animal activity, and the spread of invasive species. These observed impacts vary by region and tribe and are informed in many cases by comparison with observations and stories provided through TEK and memories of tribal elders.

CC3. Tribal forestry managers and tribal leadership recognize the inevitability and some of the implications of a rapidly changing climate for their prosperity and culture.

CC4. Some tribes are already building adaptation to climate into their forestry programs and practices, but few tribes have incorporated climate change into their forest management plans

CC5. Intertribal organizations perform an important function and some have direct benefits, including tools and resources for tribal forest managers. There are numerous coalitions, networks, and other organizations that have emerged through intertribal collaborations, university, tribal college, and agency sponsorships devoted to assisting tribes and their natural resource managers in responding to climate change.

CC6. Tribes need better access to relevant science-based information about the impacts of the changing climate on local forests and management options. The effects of the changing climate on woodlands are particularly of interest given the paucity of scientific information about these ecosystems and the potential for dramatic climate-induced ecological transitions.

CC7. There is little specific information about the carbon sequestration value of tribal forests and woodlands and the potential for tribes to benefit from participation in programs and policies designed to reward long-term carbon sequestration.

CC8. Tribes can be key players in landscape scale partnerships to manage climate vulnerabilities. Climate-influenced impacts occur at scales large enough to demand better mechanisms for convening, governing, and resourcing landscape-scale partnerships. Tribes have much to offer landscape-scale conservation in the form of TEK, long-term observations, holistic (systems-level) approaches, and the proclivity for active, adaptive approaches to broad-scale stressors.

CC9. Institutional arrangements to promote landscape-level collaboration and science delivery have not yet been successful in engaging and meeting the needs of tribes. Tribes have had little to no representation or access to the regional LCC's that have been launched to facilitate integrated multi-agency and ownership strategies for responding to the changing climate. In the last year, tribal involvement in the NW LCC steering committee has created a much-needed precedent of involvement in these DOI funded consortia. However, opportunities for consultation and collaboration that come without sufficient resources to support participation can bring greater burden than benefit.

"Tribal leaders stated their desire to partner with state and federal government to address issues, but indicated the need for greater resources to allow tribal capacity building, particularly in addressing climate change" [13]

[13] Achieving A Brighter Future For Tribal Nations: Synopsis of the 2012 White House Tribal Nations Conference, March 2013.

Findings – Adaptive capacity

Exposure and sensitivity lead to vulnerability. Higher adaptive capacity allows tribes to reduce or better cope with vulnerability. In Table CC.3, we assess the above findings as *upward, neutral, downward or not applicable* (within the definitions) and *weak, strong, or uncertain* for each of the elements of vulnerability defined above. For example, the worst assessment combination of vulnerability would be *up* and *strong* for exposure and sensitivity whereas *down* and *strong* is the worst assessment for adaptive capacity. These are subjective judgments offered by IFMAT III to help inform overview of the relationship between IFMAT findings and the expected prospects for incorporating climate change into future discussions.

Table CC.3. IFMAT III general findings and their judged contribution to overall vulnerability to a range of climate change impacts.

Finding	Exposure	Sensitivity	Adaptive Capacity
Innovative silviculture	Down/strong	Down/strong	Not applicable, but supported by strong adaptive capacity
Density-related threats	Up/strong	Up/strong	Not applicable, but management supported by adaptive capacity
Emphasis on fire and fuels	Down/strong	Down/strong	
Declining funding levels and grant money dependence	Up/indirect	Up/indirect	Down/strong – erosion of adaptive capacity
Inadequate staffing and pay	Up/indirect	Up/indirect	Down/strong – erosion of adaptive capacity
Declining availability of technical support	Up/indirect	Up/indirect	Down/strong – erosion of adaptive capacity
Plans – adequate but variable forest plans; IRMP progress slow	Uncertain/indirect	Uncertain/indirect	Down/uncertain – inadequate attention to changing and future conditions and integration
Resource management varied and distinct; lacking comparators	Down/uncertain	Down/uncertain	Down/uncertain – need for standards and benchmarks for progress
State-of-the-art forestry variable and incompletely defined	Uncertain	Uncertain	Down/uncertain – need for better definition, engagement by Tribal Councils, and consideration of future drivers (e.g. climate)

Resourceful leadership despite constraints	Down/indirect through active management	Down/indirect through active management	Up/strong. Strength that needs to be built on with adequate resources.
Proactive stewardship of Indian lands	Down/strong	Down/strong	Up/strong. Strength that needs to be built on with adequate resources.
Allotment: fractionalization fragmentation	Up/strong	Up/strong	Down/strong. Negative influence on the costs and effectiveness of managing vulnerabilities.
Lack of payment for ecosystem services	Uncertain	Uncertain	Down/uncertain. Diversion of scarce resources from action to process with little funding.
BIA streamlining	Uncertain	Uncertain	Uncertain
Trespass for illegal plant cultivation, theft, and poaching	Up/strong. Vectors for invasives, fire, other stressors.	Up/strong	Down/uncertain. Diversion of resources to law enforcement and security.
Inadequate attention to woodlands resource	Up/strong	Up/strong	Down/strong. A major resource with thin science base and management guidance
Wood processing infrastructure declines	Up/strong. Inability to economically manage forest density on tribal and adjoining lands.	Up/strong. Little economic buffer or ability to use damaged resource.	Down/strong. Key element of adaptive capacity.

Findings – NIFRMA tasks and climate change

Table CC.4. below displays key findings taken from the NIFRMA Task reports and applied across the exposure/sensitivity/adaptive capacity framework. Each finding is rated (+) or (-) for the direction of its contribution to climate vulnerability and adaptive capacity. A positive (+) in exposure for sensitivity denotes an upward influence on vulnerability. A positive (+) designation under adaptive capacity denotes an influence on the ability to counteract or reduce vulnerability as discussed above. No attempt was made to rate findings for the strength of their contribution to vulnerability.

Table CC.4. IFMAT III task-specific findings and their judged relationship to overall vulnerability to a range of climate change impacts.

IFMAT Task	Exposure (+) is bad/(-) = good	Sensitivity (+) is bad/(-) = good	Adaptive Capacity (+) is good/(-) = bad
Overall Findings	Locations at edges of changing ecological systems (-)	Dependency on natural resources high (-)	Depressed economies (-) Loss of markets (-) Low access to services (-) Low mobility (-)
A. Practices and funding	A6. & A7. –Fire prep and HFR funding low (+) A8. - Law enforcement funding vs. trespass (+) A10. - BIA roads funding low (+)	A5. - Land base size (+) A10. - BIA roads funding low (+)	A1.- BIA alloc. and inflation (-) A2. – Reliance on outside grants (-) A4. – funding/acre low (-) A7.- land base size (-) A6. & A7. – fire prep and HFR funds (-)
B. Condition of forest lands	B1. – Few unusual forest health issues (-) B5. – Volume and densities lower than federal lands (-) B7. & B10. – Insect and fire less impactful than on federal lands. (-)		B2. - Diversity in seral conditions and proactive density mgt. (+) B3. – ownerships remain intact (+) B4. – Timber volumes have increased (+) B5. & B6. – Productivity and growth as good or better that other owners (+)
C. Staffing patterns	C2. - Reductions in fire staff (+) C10 – Lack access to technical skills in inventory, planning, and wildlife (+)		C1. - Overall staffing decline (-); Low salaries hamper recruitment and retention (-) Aging workforce not being replaced (-) C5. – Professional staff increased but improvements needed (+) C6. - Increases in Native American professionals (+) C7. – Diversion of staff time for funds development (-); CE1. –graduation levels of Native foresters insufficient for future demand (-) CE2. – Tribal colleges have increased and play important roles (+) CE3. – Only 1 of 7 NIFRMA educational programs being implemented (-) CE5. – Access to continuing education a problem (-) CE6. - Lack of coordination with research institutions (-)
D. Timber sale procedures and enterprise	D1. & D2.– Federal regulations & unfunded mandates (+) D9. – TFPA not well-used (+)		D2. – Sales processes need to be efficient and flexible (-) D.3. & D.4. – Lack shelf-ready sales to reduce costs and meet

operations		changing markets (-) D5. – Tribal enterprises provide jobs and enable forest management (+) D7. – Coordination between tribes, enterprises, and nat. re-source programs can be improved (-) D8. – Lack of expertise and information about market opportunities (-) D10. – Allotment management not responsive to owners' needs (-) D11. – Trust asset and accounting system not fully effective (-)
E. Federal trust responsibility – rules and policies	E3. – Roads of lower quality (+) E4. – Trespass (+)	E1. – NEPA increases planning costs (-) E2. – Unfunded mandates hinder self-determination (-) E6.– Few IRMPs developed and implemented (-) E7. – Inadequate supply for tribal processing facilities from surrounding lands (-)
F. Plans and planning processes	F4. - Most FMPs predominately timber plans (+) F5. - Plan technology lacking (+) F8. – FMPs do not address climate or forest restoration. (+) F13. – Little recognition of enterprises in FMPs. (+) F14. – Allotments underplanned (+) F15. – Limited planning and direction for woodlands (+)	F1. - The Indian Forest Management Handbook is an excellent document (+) F8. – FMPs do not address climate or forest restoration. (-) F9. – Most forests covered by FMP (+); Few IRMPS (-) F14. – Allotments underplanned (-) F15. – Limited planning and direction for woodlands (-)
G. Adequacy of trust implementation	G1 – Few standards to measure impacts of federal land management on tribal forests (+) G3. - Tribal forestry programs, guided by self-determination policies, are increasingly focused on provision of environmental and cultural values (-) G5. – Consultation with federal agencies remains challenged (+)	G3. - Tribal forestry programs, guided by self-determination policies, are increasingly focused on provision of environmental and cultural values (+) G8. – Indian forests are places of experimentation (+)

Recommendations – Tribes, forests, and climate change

CC1. Require allocation of federal agency funds for climate change response and develop process and criteria to assure a more equitable distribution of funding to tribes.

CC2. Require all regional and national assessments of the forest resource to include an assessment of the condition and trends of Indian forest lands under a range of future scenarios.

CC3. Encourage the exchange of traditional ecological knowledge and Western scientific knowledge in planning and adjusting to climate change impacts, recognizing the unique strengths that each form of knowledge brings to the challenges of adaptation. Develop more effective policies for the appropriate sharing and protection of TEK through the adoption of guidelines similar to the Natural Resources Conservation Service guide (NRCS 2010).

CC4. Require federal agencies to develop mechanisms for coordinated interagency delivery of science findings, technical and financial services to tribes.

CC5. Provide technical support for tribal assessments of climate-driven vulnerabilities towards incorporation of this information into forest planning and management processes.

CC6. Incorporate adaptation planning into the IRMP and forest management planning processes of tribes using a template similar to the one developed by ITEP that integrates traditional and scientific knowledge.

Many of the IFMAT main findings and recommendations would enhance the resiliency of tribes through reductions in exposure to stressors, moderating the sensitivity of tribal forests and other resource to these influences, or enhancing the adaptive capacity of forest management programs, tribal organization, or the institutional relationship between the tribes and the federal government.

By addressing the barriers to state-of-the-art adaptive capacity for Indian forestry programs such as funding inequities, diversion of technical expertise to funding development, and risk transfers from lack of management on neighboring ownerships, and others, the IFMAT recommendations envision an enterprise that can better handle existing vulnerabilities and grow stronger as these stressors increasingly interact and become more intense. Although tribes have dealt with variability in the climate for many centuries, the speed and volatility of change are intensifying the need for the improvements recommended by this report.

Climate changes threaten endemic ecotypes such as California woodlands – Tule River. Photo by Larry Mason