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Conceptual Model of Climate Change Impacts at LANL

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Introduction

Goal 9 of the LANL FY15 Site Sustainability Plan (LANL 2014a) addresses Climate Change Adaptation. As part of Goal 9, the plan reviews many of the individual programs the Laboratory has initiated over the past 20 years to address climate change impacts to LANL (e.g. Wildland Fire Management Plan, Forest Management Plan, etc.). However, at that time, LANL did not yet have a comprehensive approach to climate change adaptation.

To fill this gap, the FY15 Work Plan for the LANL Long Term Strategy for Environmental Stewardship and Sustainability (LANL 2015) included a goal of (1) establishing a comprehensive conceptual model of climate change impacts at LANL and (2) establishing specific climate change indices to measure climate change and impacts at Los Alamos. Establishing a conceptual model of climate change impacts will demonstrate that the Laboratory is addressing climate change impacts in a comprehensive manner. This paper fulfills the requirement of goal 1. The establishment of specific indices of climate change at Los Alamos (goal 2), will improve our ability to determine climate change vulnerabilities and assess risk. Future work will include prioritizing risks, evaluating options/technologies/costs, and where appropriate, taking actions.

To develop a comprehensive conceptual model of climate change impacts, we selected the framework provided in the National Oceanic and Atmospheric Administration (NOAA) Climate Resilience Toolkit (http://toolkit.climate.gov/). The steps of the Toolkit are:

- Identify the Problem
- Determine Vulnerabilities
- Investigate Options
- Evaluate Risks and Costs
- Take action

The conceptual model of climate change impacts falls into the first step, Identify the Problem.

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The first step in the Climate Resilience Toolkit is to "Identify the Problem." Broadly speaking, this step is to identify the climate stressors (climate and weather events) that challenge the Laboratory's ability to deliver on mission requirements. We are very familiar with the climate change and weather events that have impacted the Laboratory over the past 20 years: drought, wildfires, floods, and rising temperatures. In identifying the problem, we must identify the specific aspects of the Laboratory's mission that have been, or could be, impacted by climate change and specific weather events. Then, specific climate stressors impacting the specific aspects of the LANL mission are identified, along with the likelihood of their occurrence and the severity of the impact on the LANL mission.

We use the LANL Strategic Goals (LANL 2014b) and the LANL Environmental Grand Challenges (LANL 2015) to identify aspects of the LANL mission that we will use to Identify the Problem. The aspects of the LANL mission to be considered are:

1. Operational Excellence (LANL 2014b). In this context, this is the ability of infrastructure, programs, finances, and people to deliver LANL mission success. As climate change stressors and weather events impact LANL infrastructure, programs, finances, and personnel, the conceptual model of climate change impacts should identify specific vulnerabilities, their likelihood, and the severity of the stressors impact.
2. Protect human and environmental health by managing and restoring lands (LANL 2015). Because climate stressors can impact the landscape, LANL human and environmental health can be impacted.
3. Stewardship of contaminants (LANL 2015). Climate stressors can impact the LANL commitment to environmental ALARA for on-site and off-site doses. For example, if drought conditions continue, the resuspension of contaminated soils will increase, potentially leading to an increase in the off-site dose. If heavy rainfall increases, the off-site transport of contaminated sediments will increase.
4. Integration (LANL 2015). LANL operates under various organizational structures, such as programs, Divisions, Facility Operations Directorates, and Technical Areas. All LANL operations are not completely integrated together; as such, organization actions can increased the impacts of climate stressors. For example, if LANL paves a parking lot without regard to rainfall runoff, flooding in canyons could increase during heavy rainfall events.

We have created a matrix to represent the conceptual model of climate change impacts to include the specific LANL aspects impacted by climate stressors. The likelihood and

severity of stressors are estimated and will be refined as we define and track climate change indices. At this time, we understand past damages, delays, losses, and costs; in the future, this may be changed by our climate adaptation actions.

Conceptual Model Definitions:

Likelihood

High – if this climate stressor has happened in the past 40 years, the likelihood is high

Low – we do not expect this climate stressor to impact LANL in the next 40 years

Moderate – it hasn't happened, but we expect it to happen within the next 40 years

Severity of Stressor on LANL aspects

High – could eliminate specific LANL operations/missions

Low – there may be some costs to deal with the specific stressor, but it is within the Laboratory's routine funding

Moderate – would require specific applications of new funds to adjust

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Climate Change Impacts at LANL	LANL specific aspects	Climate Stressor	Climate Stressor impact on specific aspect	Likelihood	Severity of Stressor
(1) LANL Operations	High explosives operations	Drought	Fire danger increases in response to drought, causing delays and/or postponement of operations	High	High
		Wildfire	Postponement or canceling of operations	High	Moderate
		Flood	Postponement or canceling of operations	High	Moderate
	Environmental Remediation (ER) remedies in canyons	Flood	Damage to ER remedies leading to maintenance and reconstruction costs	High	Moderate
		Wildfire	Damage to ER remedies leading to maintenance and reconstruction costs	High	Low
	ER remedies on mesas (soil erosion impacting covers)	wildfire	Damage to ER remedies leading to maintenance and reconstruction costs	High	Low
		Rain/Floods	Damage to ER remedies leading to maintenance and reconstruction costs	High	Moderate
		Drought	Increased soil erosion damaging remedies leading to maintenance and reconstruction costs	High	Low

Climate Change Impacts at LANL	LANL specific aspects	Climate Stressor	Climate Stressor impact on specific aspect	Likelihood	Severity of Stressor
LANL Operations (continued)	Groundwater and Surface water monitoring	Rain/Floods	Damage to groundwater wells and surface water monitoring equipment	High	Moderate
	LANL buildings electricity use (greenhouse gas emissions)	Temperature	Higher temperatures increase air conditioning requirements, leading to higher costs and greater greenhouse gas emissions.	High	Moderate
	Water supply for LANL facilities	Drought	Long term depletion of the aquifer supplying drinking/operational water	High	Low (Moderate in beyond 40 year time frame)
	LANL buildings, roads, grounds, utilities, landscaping	Rain/Flood	Damage to buildings, roads, grounds, utilities, landscape	High	Moderate
		Wildfire	Damage to buildings, roads, grounds, utilities, landscape	High	Moderate
		Drought	Erosion of soils around buildings, roads, grounds, utilities, landscape – increasing maintenance costs	High	Moderate
	Cultural Resources	Rain/Flood	Damage to archeologic sites or historic buildings	High	Moderate
	Waste Operations	Heavy rains/floods	Damage to outdoor waste storage areas; damage to TA-54 Area G	Moderate	Moderate

Climate Change Impacts at LANL	LANL specific aspects	Climate Stressor	Climate Stressor impact on specific aspect	Likelihood	Severity of Stressor
Climate impact on our landscape (2)	Plants/trees/vegetation	Temperature	Increased temperatures will lead to tree mortality, changes in vegetation	High	High
		Drought	Ongoing drought will lead to tree mortality, changes in vegetation, increasing erosion	High	High
	Soils	Rain/flooding	Increased erosion – feedback to loss of vegetation and increases in unwanted vegetation	High	Low
	Humans (safety, disease, immune system)	Increases in wildlife (e.g. bees, mice)	Increase in allergic reactions, hanta virus, etc.	Moderate	Low
	Humans (morale, attracting employees)	Temperature	Decrease in attractiveness of living in Los Alamos	Moderate	Low
		Wildfire	Wildfire producing smoke makes LANL less attractive, and reduces productivity of employees	High	Low

Climate Change Impacts at LANL	LANL specific aspects	Climate Stressor	Climate Stressor impact on specific aspect	Likelihood	Severity of Stressor
Stewardship of contaminants (3)	Air Pathway dose to humans	Drought	Increased resuspension of contaminated soils – producing higher doses to workers or public	High	Low
	Off-site Transport of contaminants in sediments	Drought	Increased resuspension of contaminated sediments – producing higher doses to workers or public	High	Low
		Heavy Rain/floods	Increased transport of contaminated sediments – producing bad public relations and higher doses to offsite biota	High	Low

Climate Change Impacts at LANL	LANL specific aspects	Climate Stressor	Climate Stressor impact on specific aspect	Likelihood	Severity of Stressor
LANL actions that could make climate change impacts greater (4)	Paving parking lots adjacent to canyons	Heavy Rain/flooding	Can increase runoff on adjacent areas – impacting canyons or other facilities	High	Moderate
	Changing drainage patterns via road construction	Heavy Rain/flooding	Can increase runoff on adjacent areas – impacting canyons or other facilities	High	Moderate
	Paving new roads	Heavy Rain/flooding	Can increase runoff on adjacent areas – impacting canyons or other facilities	High	Moderate

References:

LANL 2014a. "Fiscal Year 2015 Site Sustainability Plan," LA-UR-15-21896, December 2014.

LANL 2014b. "Los Alamos National Laboratory Strategic Plan 2014," LA-UR-14-22658, April 2014.

LANL 2015. "Long-Term Strategy for Environmental Stewardship and Sustainability 2015 Work Plan."