

1. Title

Maka Sitomniya: Preserving Mother Earth by Asserting Lakota Sovereignty in Earth Data Science

2. Short Title **EDS for Maka Sitomniya**

3. Project Leaders and contact info

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4. Project Summary

The world is faced with growing threats from multiple, interacting environmental challenges ranging from chemical pollution to increasing demands and diminishing supplies of freshwater to loss of biodiversity to the climate crisis. Indigenous communities are particularly vulnerable to these threats as a result of a long history of injustice. At the same time, their holistic worldview, long tenure on the lands and waters, and time-tested stewardship practices provide the local knowledge necessary to understand and respond to environmental challenges. What is lacking are the resources and technical expertise to combine Indigenous Knowledges with the latest advances in data collection and analysis.

Climate change vulnerability assessment, mitigation and adaptation all depend on timely and reliable data. Recent advances in remote sensing technology and environmental data science (EDS) provide powerful tools for planners and decision-makers, but only if the data and analyses are accessible to them. Our Working Group is not focused on specific technological advances, but on enabling Tribes to access and use EDS for their own purposes. Our Indigenous-led group, consisting predominantly of Indigenous scientists and Tribal College faculty, proposes to facilitate the adoption of EDS by creating a DataCube and workflow that are customizable for the needs of specific Tribes and useful for training to build Tribal capacity. Advancing EDS is not just about pushing the edges of the science, it must also be about expanding accessibility and use of the science to benefit society, and extending its reach into communities that would otherwise be excluded.

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6. Introduction and Goals

The outstanding question we address is how to make environmental data science accessible and feasible for use by historically under-served and under-resourced communities to empower equitable problem-solving. The communities we focus on are the Tribal Nations of the Northern Great Plains and surrounding areas, although the same problems and solutions apply much more broadly. Environmental challenges are complex, multifaceted and interconnected. This has always been true, but the world is now undergoing rapid and unprecedented transformation that challenges our ability to adapt as a result of human impacts on climate, water, land, and on our more-than-human relatives (aka “wildlife” or “biodiversity”). Impacts are not experienced evenly, either geographically or demographically, because of extreme disparities in wealth and political power. Indigenous communities, in particular, have historically been and continue to be under-resourced and under-represented in decision making globally, including on the North American continent. Tribal Nations in what is now the United States are more likely to encounter and experience harmful environmental impacts, including on the Northern Great Plains and surrounding regions. Climate change is a ubiquitous problem that increases risks from many long-standing concerns, including drought and access to water, extreme heat and other weather events, and disease vectors, increasing vulnerability of fish, wildlife and plant populations, crop and livestock production, and public health. Other concerns include mining and other sources of disturbance and contaminants to land, water and air. All of these problems are manifestations of a breakdown in interconnected Earth systems and cannot be addressed in isolation. Indigenous Knowledges explicitly recognize *Maka Sitomniya*, the whole, and that we must seek holistic solutions. Tribal nations are sovereign, and therefore must make adaptive decisions with respect to these major challenges; however, they often have limited resources and human capacity to address them, particularly when many dimensions must be included in integrated solutions. Our goal is to help fill that need.

The foundation of problem-solving and adaptive stewardship (finding solutions and making adjustments in a dynamic world as we acquire new knowledge) is having access to and the ability to work with reliable and timely information. It is, therefore, critical that Tribal Nations have the ability to identify, analyze, monitor and work to address problems as they are encountered at the community-level, and not be reliant upon outside intervention. This is the basis for sovereign, locally driven decision-making and prioritization of actions (Johnson et al. 2023, Ramos 2018, 2022). Indigenous peoples have always followed a practice of gathering data and using it to make informed decisions to maintain sustainable lifeways (Johnson et al. 2023, Orlove et al. 2023). Recent technological advances such as satellite and novel, emerging means of remote sensing, computing and data storage, and continuously evolving computational methods offer greatly expanded opportunities for data gathering and analysis. For Tribes to leverage these approaches, they need broad access to data, the ability to collect their own data, the physical infrastructure to deploy computational and data management technologies, and the human expertise and capacity to manage their data science projects. These are the critical elements of a Tribal research program, conducted according to

their own standards, controlling their own data, both to be self-reliant, but also for maintaining data sovereignty in accordance with their local application of emerging international standards such as the CARE Principles (Carroll et al. 2019, Jennings et al. 2023, Orlove et al. 2023). One essential means of achieving this goal is to facilitate education in environmental data science through Tribal Colleges and Universities (TCUs).

Vision: Build the geospatial infrastructure for Tribal holistic environmental planning and problem-solving, centered on relevant areas-of-interest and Tribal priorities, including the capacity to add, maintain and sustain data, investigative tools and expertise.

Goals:

- Create example data products (Data Cube) relevant to Tribal Nations of the central and northern Great Plains.
- Develop and document a model workflow for Data Cube generation and analysis that can be used in training and skills transfer to other Tribal and resource-challenged communities.
- Develop educational and outreach products that
 - Demonstrate EDS applications to Tribal authorities and decision-makers
 - Facilitate training of Tribal professionals and educators who are likely to use or need to understand the benefits and limitations of EDS in their work
 - Serve as instructional material for TCU faculty for student education and professional development

7. Proposed Activities

- Pre-meeting preparation for in-person workshop 1: Building a Data Library
 - Catalog and obtain data that might be useful based on a range of potential applications
 - Adopt Data Management Plan to include TEK/IK, Indigenous Data Sovereignty / Tribal and TCU Data Governance
- In-person Workshop 1
 - Refine scope of work, including potential applications
 - Construct “core” Data Cube - the frame on which everything else will be layered
 - Document in detail the process of data acquisition and management.
 - Analysis of a specific problem as a case study for the methodology.
 - Document the process of analysis.
- Prep for in-person Workshop 2
 - Refine / revise goals and approaches
 - Data gaps and potential sources
- In-person Workshop 2
 - Refine / extend Data Cube
 - Build or revise specific applications identified by team members
 - Plan for products to be disseminated
 - Detailed documentation of Data Cube construction and applications to serve as template
 - Outreach communication/ translation products for demonstrating utility to community
 - Educational / training products for professional development
 - Educational products for Tribal College faculty and students
- Post-meeting debrief and plan for next steps

Teams

- Technical / Science: Coding, Integration, Statistical Analysis, Visualization, Geospatial

- Policy / Application: Decision tools & guidance, Indigenous Data Sovereignty/Governance
- Education / Training / Outreach

We know that we need to think multi-scale. Every environmental problem has local manifestations that are in part driven by processes operating over much wider areas, e.g., air quality in any location may be impacted by wildfires occurring somewhere else, sometimes at great distances. Similarly, water quality or availability locally is impacted by wide-area climatological processes and non-local water use practices in a watershed or shared aquifer. In contrast, some factors are much more localized, such as mining or natural gas flaring that produces toxic pollution in the air, water and land. Regardless of the spatial extent, impacts that affect human health and well-being, ecosystem health, or economic stresses must be monitored locally where people live.

Our strategy is to identify a broad region that is relevant to the majority of Working Group members, recognizing that this will serve as a template that can be replicated in other domains of interest. As a practical consideration, we will limit our project to areas where we expect to be able to obtain a wide range of data of interest. Given these boundaries (see map in supplemental Data Table), we will focus primarily on the Missouri River basin and lands included in the Laramie Treaty of 1851, which are contained within the ancestral homelands of the Oceti Sakowin and include Tribal lands of several members of the Working Group. Tribal lands within the Missouri Basin, the Black Hills, and other localized areas-of-interest will receive particular attention.

We will include in our prototype Data Cube a wide range of data layers (Supplemental Table), spanning environmental, geomorphological, hydrological, biological, public health, demographic, economic and cultural data, according to the needs of the group. Different tribes and communities have a variety of place-specific problems and data needs, which are likely to change over time. A comprehensive Data Library will be a valuable resource for a diversity of potential uses and users, and will allow expansion or revision of Data Cubes for specific purposes. We will also classify data types based on cultural sensitivity. Many of the data layers listed here are publicly available and often open access. However, Tribal Nations are the only authority on what data specific to place should be considered private and remain protected, or available more broadly under restricted terms (Jennings et al. 2023). All of the data in our prototype Data Cube will be publicly available/ open access and wide-ranging, because we do not want to pre-judge what specific Tribes might find most useful. Additional data that may be private / protected will only be added when Tribes identify a need and we can ensure it remains restricted access.

8. Advancing DEI: how this group advances ESIL's diversity, equity, and inclusion mission.

Indigenous peoples in North America (and globally) inhabited all regions of the continent for millennia prior to the arrival of European colonists and settlers. Centuries of hostile colonial campaigns and enforcement of governmental policies took away most of their lands and nearly eradicated Indigenous peoples, their lifeways, cultures, and languages. The history is well-documented and readily accessible for those who care to learn it. Today, these inequalities and harms continue because of a wide range of persistent systemic issues. In addition to loss of lands and often restricted access to water, many ongoing problems directly involve environmental degradation, pollution, and resource extraction by non-Indigenous actors, both on and off Tribal lands. Tribal Nations will be better positioned to take action to protect their

sovereignty, their lands, and secure a healthier future for their people if they have the expertise and capacity to conduct their own research, and have reliable sources of information to better inform policy and decision-making. We intend that the work we propose will provide a step towards this future. Ultimately, the enhanced capacity for Tribal access to EDS that results from our group's work will represent a step towards environmental and climate justice.

9. Rationale: Why can this activity be most effectively conducted through ESIIL?

Most of our Working Group members have some experience working with spatial data, with environmental data, and with computational methods and tools. Fewer have experience with “big data” and methods of the sort that ESIIL envisions. From the geographic extent of our interests, to the multi-dimensional data needs and variety of sources, complexities of data management, analyses and applications, we will rely on the expertise of ESIIL to get started and to provide guidance in the development of our project. ESIIL also provides access to and training on the computing platforms and tools that will be essential for the work we envision. ESIIL is also going to be the hub of multiple initiatives working on different aspects of groundbreaking environmental data science solutions, which we will be able to leverage as they develop.

10. Collaborations with other ESIIL activities

We have a fairly large group with diverse backgrounds. If there are other working groups focused on technical areas we are missing, or focused on specific overlapping concerns, we will explore opportunities to collaborate. All of our group attended the Summit and at least two signed up for the upcoming Hackathon, which should help expand our capabilities. Our group will also explore how to integrate this effort into the expansion of the NSF funded Sovereign Network Project with SIPI, NTU and UCAR. This will demonstrate the ability to maintain sovereignty over data collected and the ability to share and integrate the data from multiple TCUs in a federated, distributed system.

11. Anticipated IT Needs

The greatest anticipated need is additional training or technical expertise. As we develop a prototype Data Cube, we will need to explore options for making products available to Tribes or Tribal Colleges in a form that is accessible and durable. Most of the data we are currently considering are open access and available online. As we move more into specific applications that may involve culturally sensitive data, that will not be shared and access will be limited to and under the control of Tribes whose data are involved.

12. Proposed Timetable (see Item #7 above) for Two in-person, several virtual meetings

In person: April/May 2024 and Oct 2024 preferred; 5 days for in-person

13. Outcomes:

Our main outcomes include DataCube(s), applications of EDS to serve Tribal needs, and enhanced expertise to build capacity for Tribal partners and TCUs. Our work will also serve as a model for the use of culturally sensitive and tribally relevant environmental data science. The most unique and compelling contribution of our work is to put EDS directly in the hands of Tribal Nations.

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