

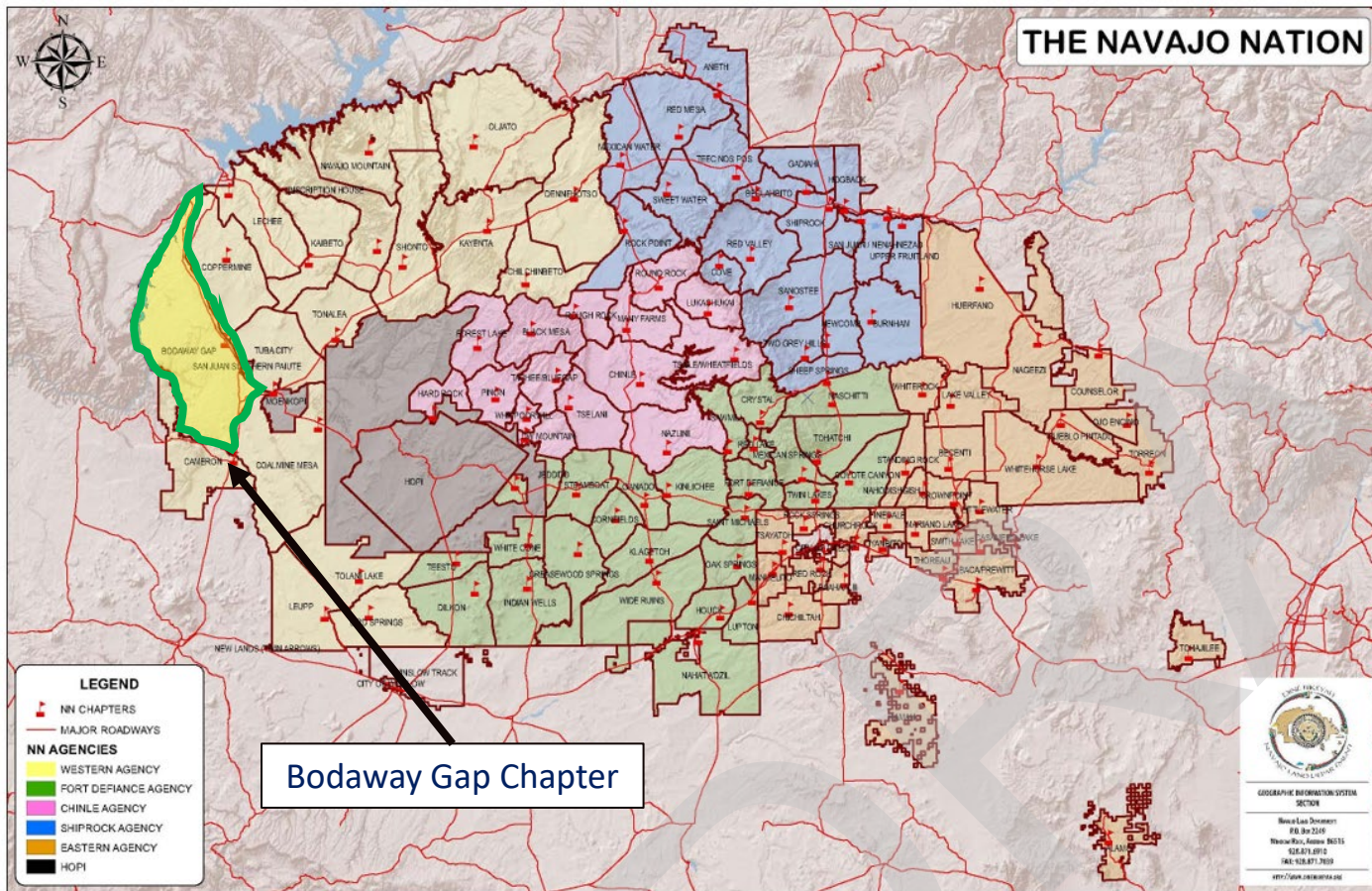


Applying Contextual Engineering to Engineering Needs for Bodaway Gap Chapter in the Areas of Water and Energy

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Water and Energy in the Navajo Nation



The Navajo Nation (comprising 5 agencies and 110 chapters) encircles the Hopi Nation (grey).

- The largest sovereign Native American Reservation, comprising 5 agencies and 110 chapters.
- Sparsely populated:
 - 27,413 sq. miles,
 - resident population: 173,667
 - approx. 6.3 persons /sq. mile.
- Utility (water and electricity) networks are mostly aligned with major roads.
- Community members who are not near main roads do not have running water or electricity in the Nation.

Some statistics on access disparity in the Navajo Nation



“... Of the 50,000 homes in the Navajo Nation, about 15,000 – 30% – do not have electricity...” (APPA, 2019)

“... Approximately thirty percent of the Navajo Nation population does not have access to clean reliable drinking water...” (NNDWR, 2023)



The COVID-19 pandemic brought the crisis faced by Navajo to wider national and global attention.

“...the pandemic has ravaged the Navajo Nation, which has experienced more COVID-19 cases than any other tribe in the United States...”

“...While the rest of America logged onto their Wi-Fi to work remotely and ordered groceries online for no-contact delivery, many within the Navajo Nation were unable to take basic precautions against COVID-19, forced to haul water over a mile, and heat their homes with lumps of coal burned in wood stoves...”

(Brookings Institution Blog, 2021)



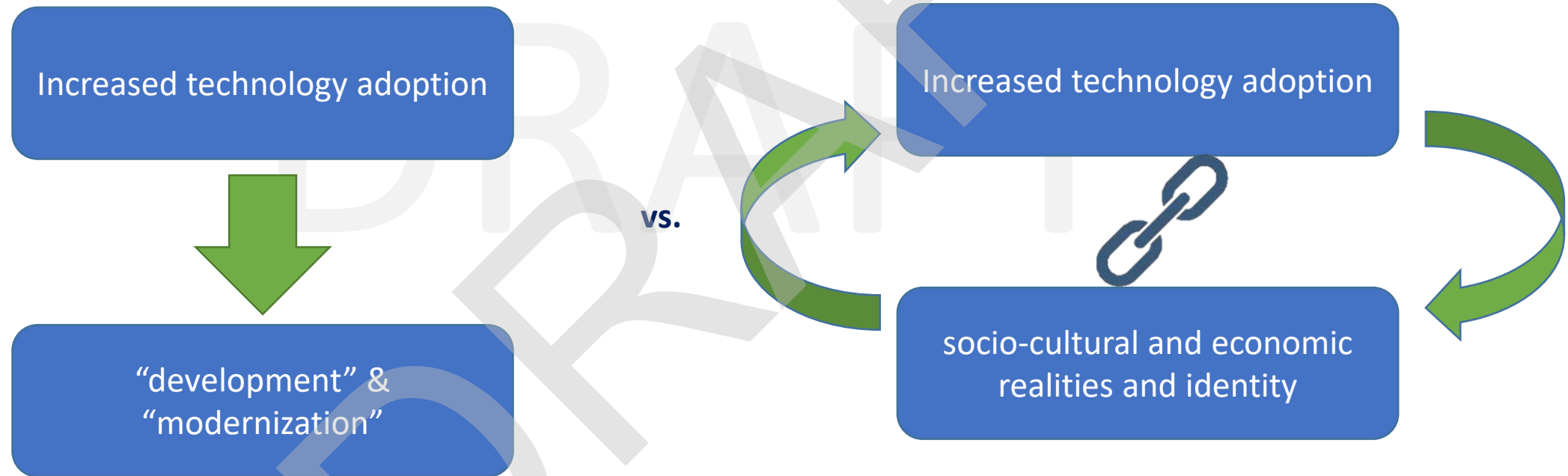
- With increased awareness came increased mobilization of resources by different organizations to address these access issues.
- Novel technological interventions deployed by outside organizations.



QUESTION: What determines the decision to deploy these particular solutions in this specific situation?



- Engineering education focuses on equipping students with technical knowledge to practice their discipline.



- Humility and inquisitiveness are critical counterweights to technological primacy when practicing in unfamiliar settings.



CONTEXTUAL ENGINEERING: dissociate personal predispositions to better understand user perspective and conditions when developing potential design solutions.

- I. **Awareness** – Recognition of the existence of a need that can admit a technological intervention,
- II. **Attestation** – Witnessing first-hand the conditions on the ground, and the needs and issues of a community,
- III. **Assimilation** – synthesis of knowledge of needs and conditions to understand potential technical interventions while dissociating from personal attitudes, values, and motivations.





Practicing Contextual Engineering in Bodaway Gap Chapter

How holistic insights can help practitioners better understand a community's needs



- An indigenous Navajo individual who grew up in the neighboring chapter

Stakeholder 1



- An indigenous non-profit serving water needs in Bodaway Gap and adjoining chapters

Stakeholder 2



- A non-indigenous non-profit mostly of ex-public utility executives who served in metropolitan water utility boards

Stakeholder 3

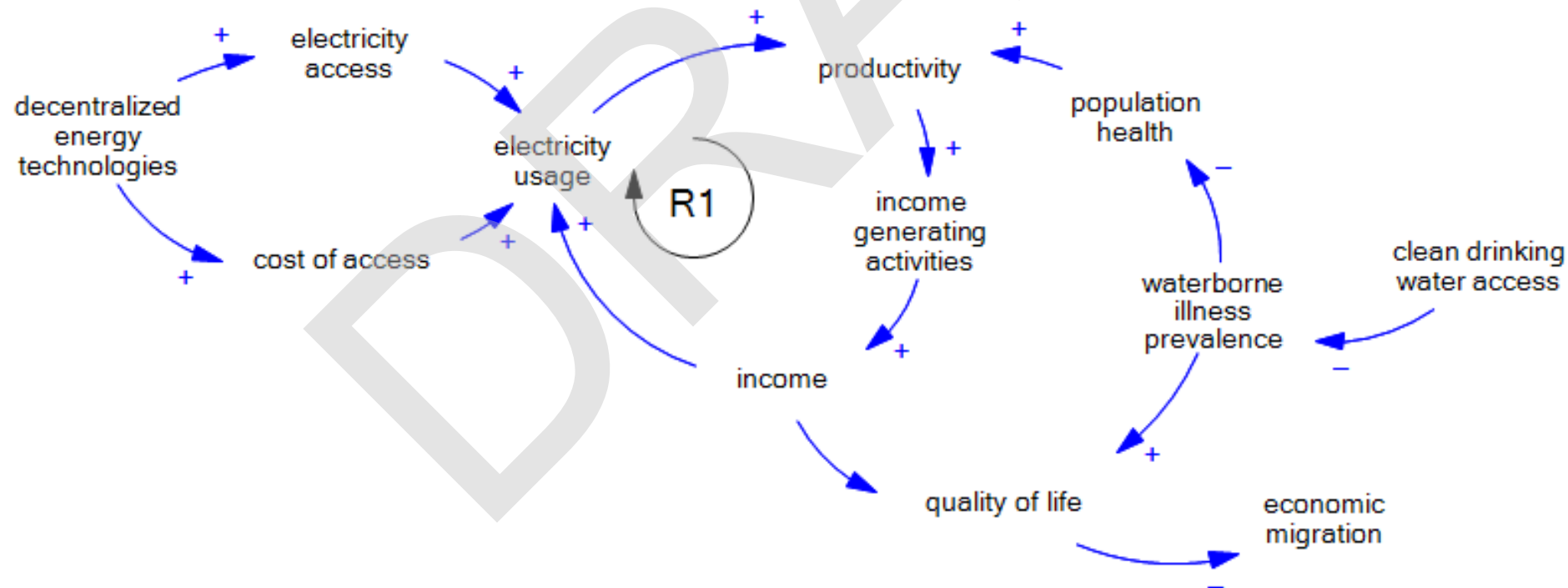


Three different stakeholders, three different (but equally compelling) stories.

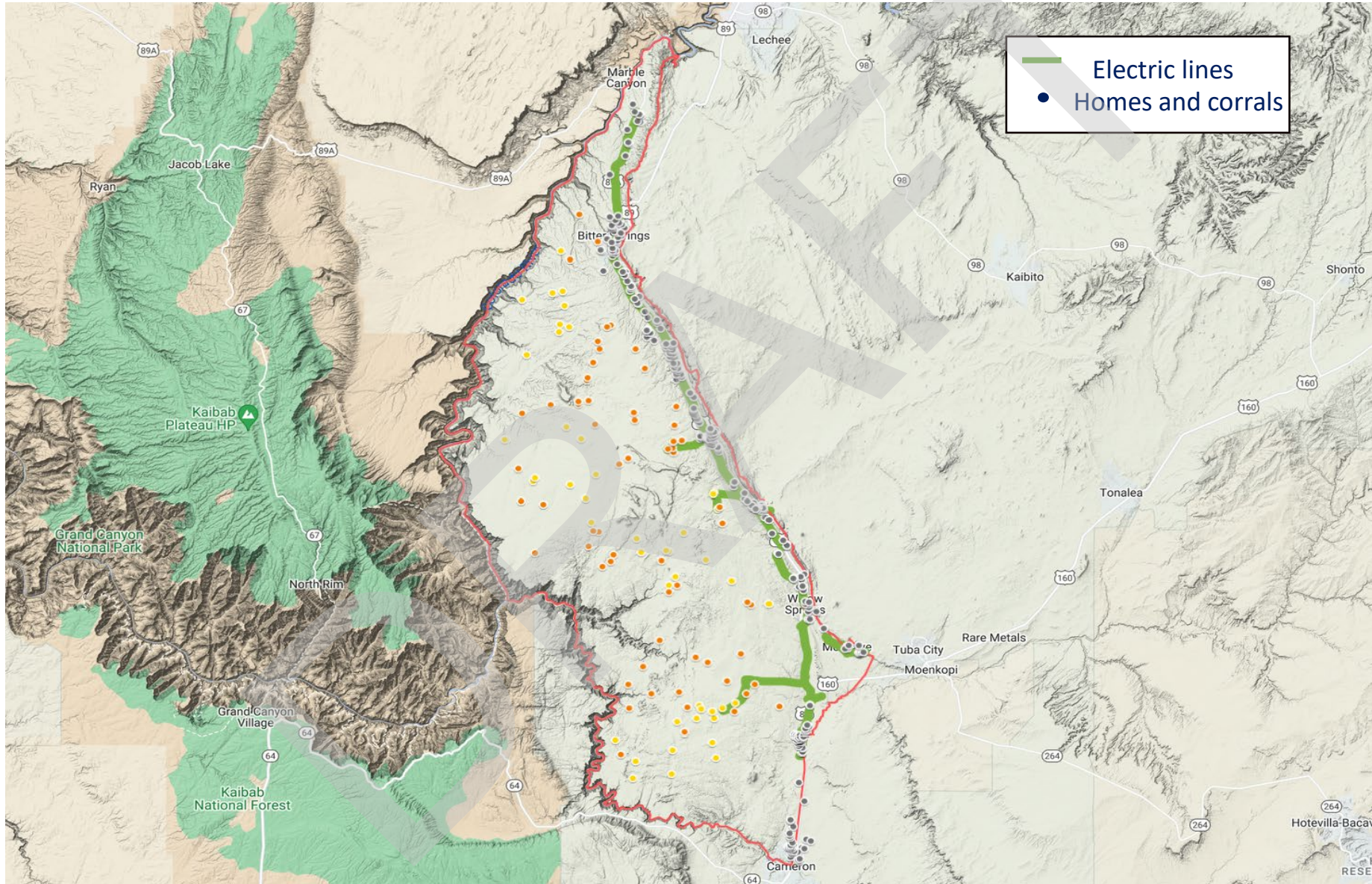


Awareness - Initial impressions

- Historical lack of access to water and electricity is an injustice, and must be corrected.
- Water is crucial for general health and sanitation.
- More solar deployment will improve electricity access, leading to more business opportunities.
 - will create jobs, increase productivity, and contribute to income, so will help prevent migration.



Attestation of conditions and needs in Bodaway Gap





A homestead with full-time residents in the range lands of the Bodaway Gap Chapter, approx. 10 miles from the closest paved road (Dated May, 2022)



- Grid electricity service provided by Navajo Tribal Utility Authority (NTUA), feasible only for community members living along main highway.
- \$30,000 - \$60,000 per mile for distribution line extensions.
- Community members living on range lands do not have grid access to electricity.
- NTUA provides remote customers with the option for skid-mounted solar home systems (SHS).
- SHSs subscriptions are expensive (\$90/month for a 1-kW system).
- Propane or firewood for heating.



A solar-wind hybrid system like the systems NTUA provides their off-grid customers.

Attestation highlights – water needs and access



- NTUA provides drinking water as well.
 - Minimum pressure requirements to prevent contamination means that piped water is only feasible for community members living along highway.
 - Community members living on range lands do not have access to piped water.
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- NTUA provides communal water access points.
 - Pay-and-fill water stations for potable water.
 - Community members haul potable water from filling stations or buy bottled water.



Water transported from NTUA stations (top) are stored in cisterns next to homes (bottom) for households without piped water access.

An unexpected highlight from attestation



- Animal rearing is the most prominent and traditional means of income for many residents.
- Mixed herds of cattle and sheep.
- Cattle rearing is more profitable, but sheep form a part of their cultural identity.
- People have been moving closer to the highway to get access to water, electricity, and other services.



Livestock herds of sheep (top) and cattle (bottom) penned in the range lands.

An unanticipated dimension of water access



The productive grazing lands are far from the highway.

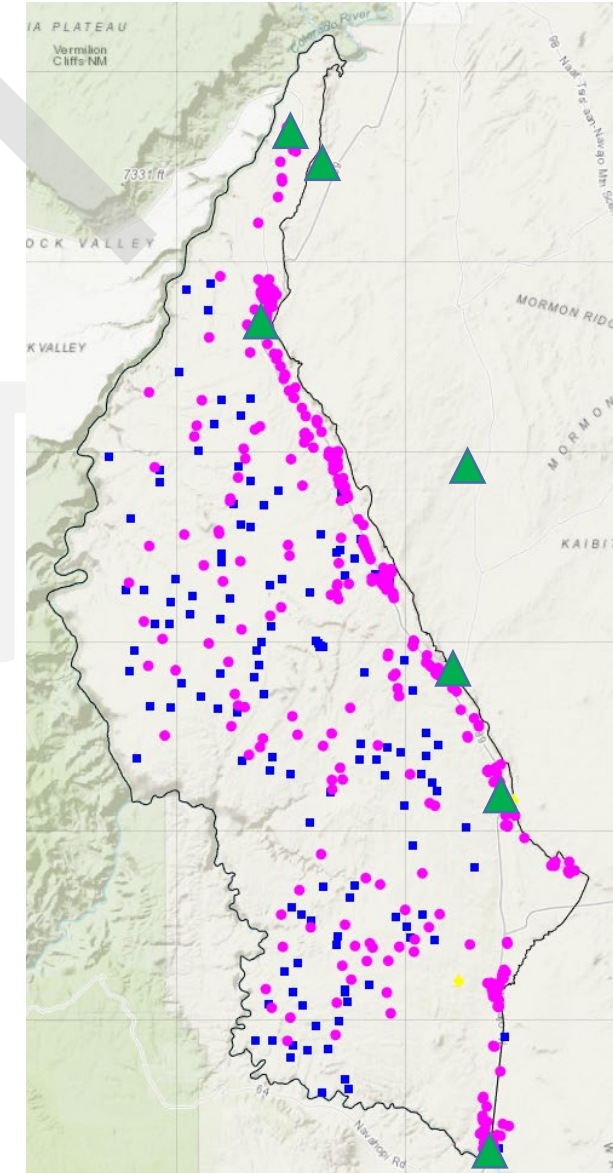
For their animals, residents maintain secondary, intermittently inhabited residences in the range lands.



These secondary residences are places where their livestock herds are penned and grazed.

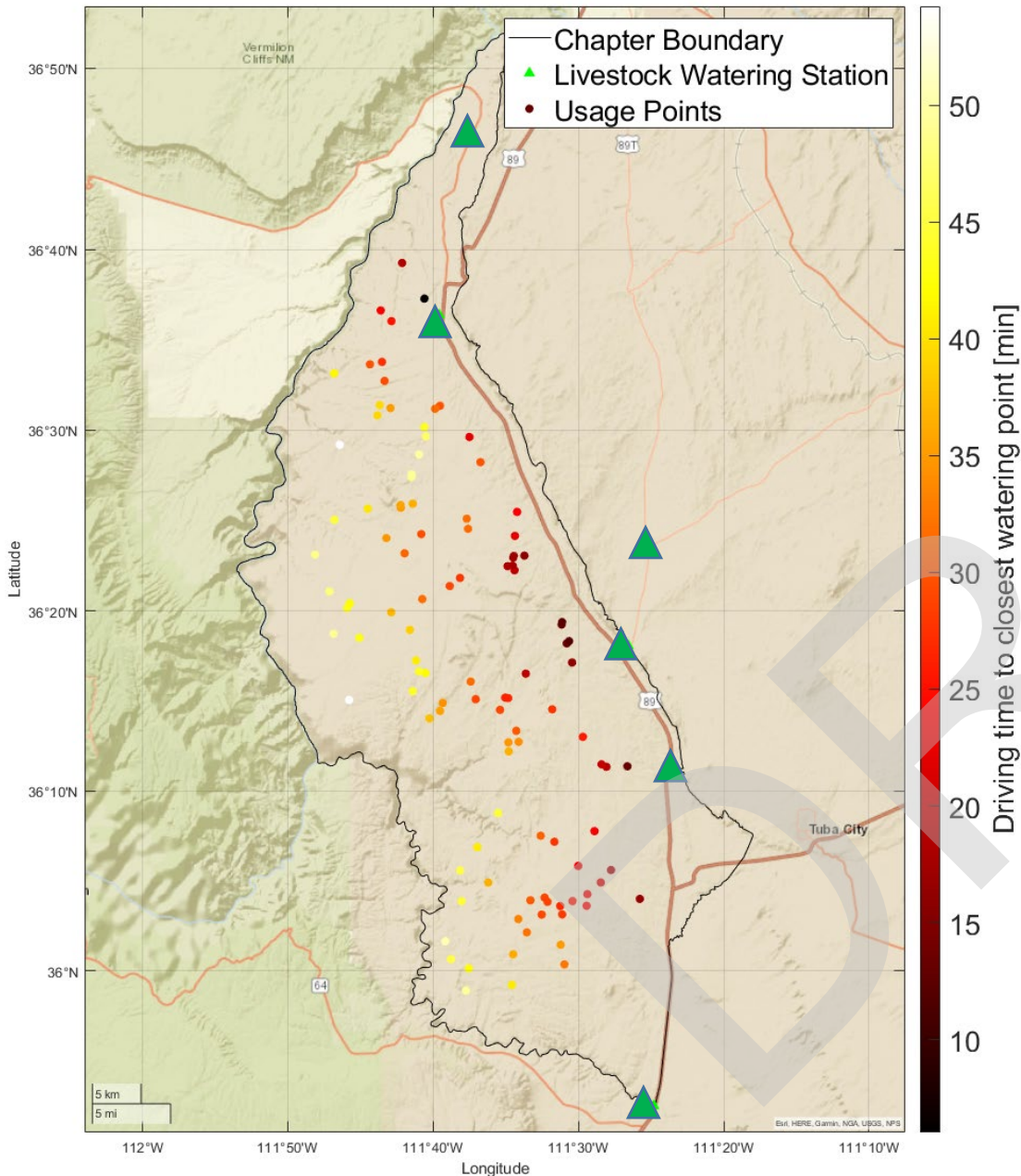
Two examples of traditional Navajo homes (hogans) that serve as intermittently inhabited residences in the grazing lands.

The livestock water access issue



Reservoirs in the range lands (top). When these dry out in the summer, residents have to go to livestock stations (bottom left) to collect and haul water for their animals in the range lands (bottom middle)

Water for livestock is the greatest unfulfilled need!



Water availability during the dry season is a crucial problem:

- determines the survivability of their livestock,
- Residents must haul large volumes often to sustain their animals,
- More frequently hauling driving up fuel and vehicle costs
- Reduction in herd sizes reduces the economic viability of their primary occupation.

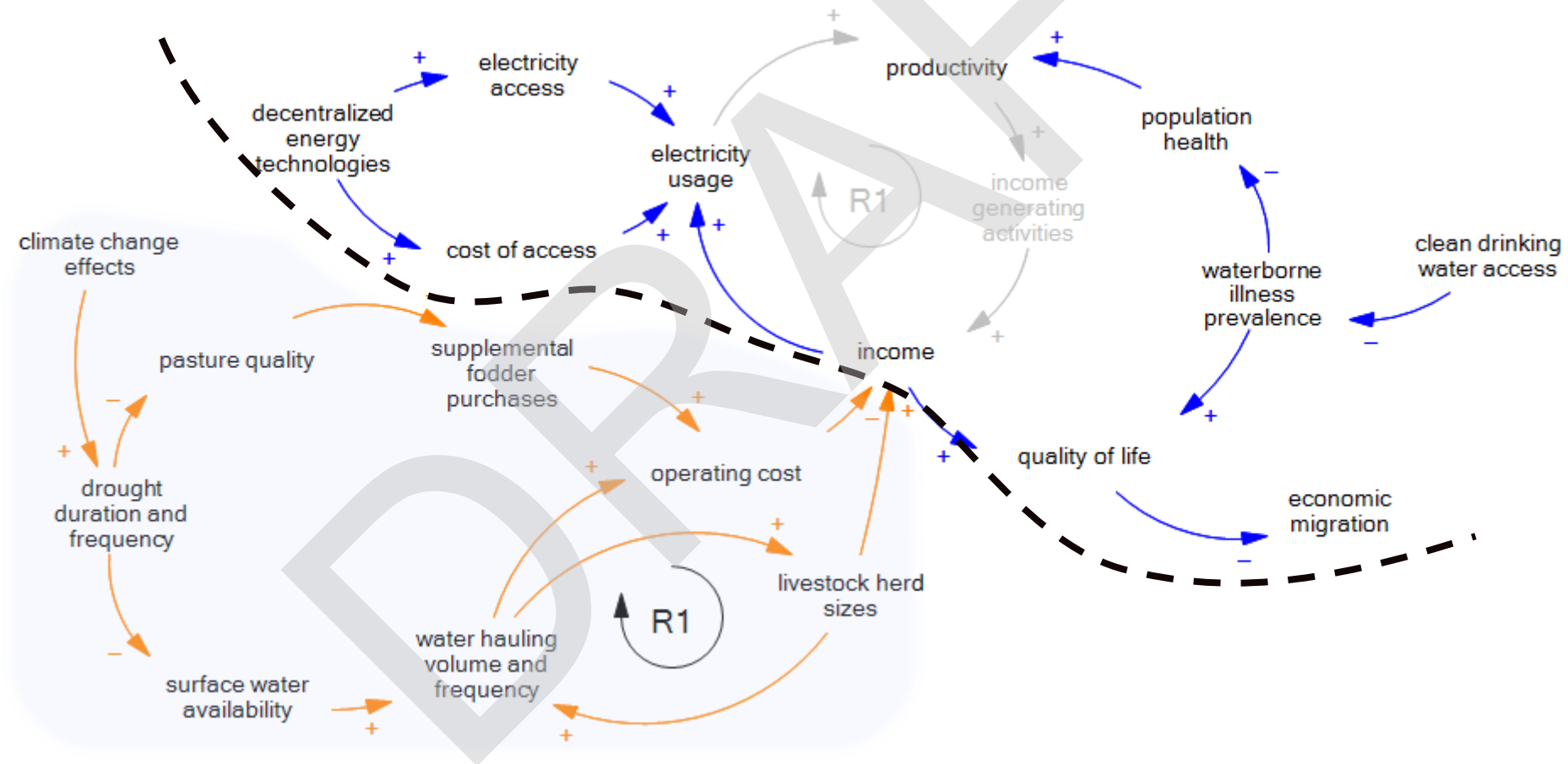


Ranchers waiting in line to haul water for their livestock herds.

Assimilation - Changing perceptions



- Inability to maintain livestock herds is an existential crisis, as it affects their economic independence.





- An attitude of learning is much more helpful to develop a better understanding of how local conditions, cultural needs, economic identities, and practices are connected.
- Designer's predispositions in pre-selecting "the most appropriate solution" leaves limited scope to incorporate community feedback in the design process.
- Some fundamental ("axiomatic") connections between factors may not always translate when practicing in unfamiliar settings.



Thank you!

Questions?



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