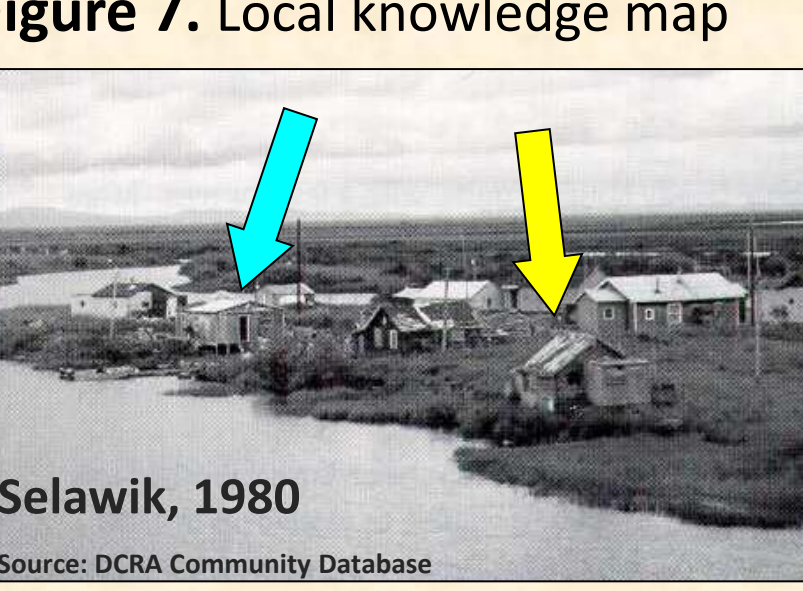
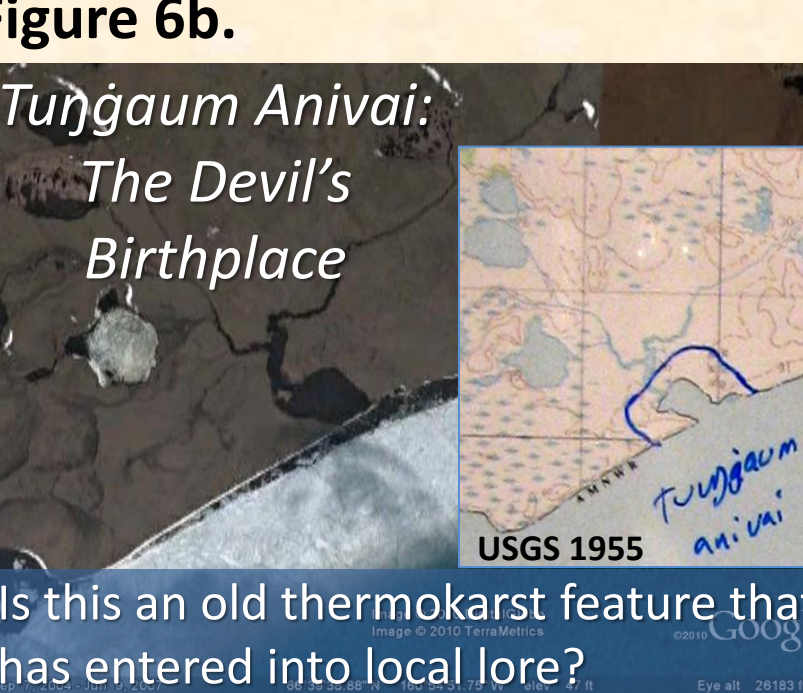
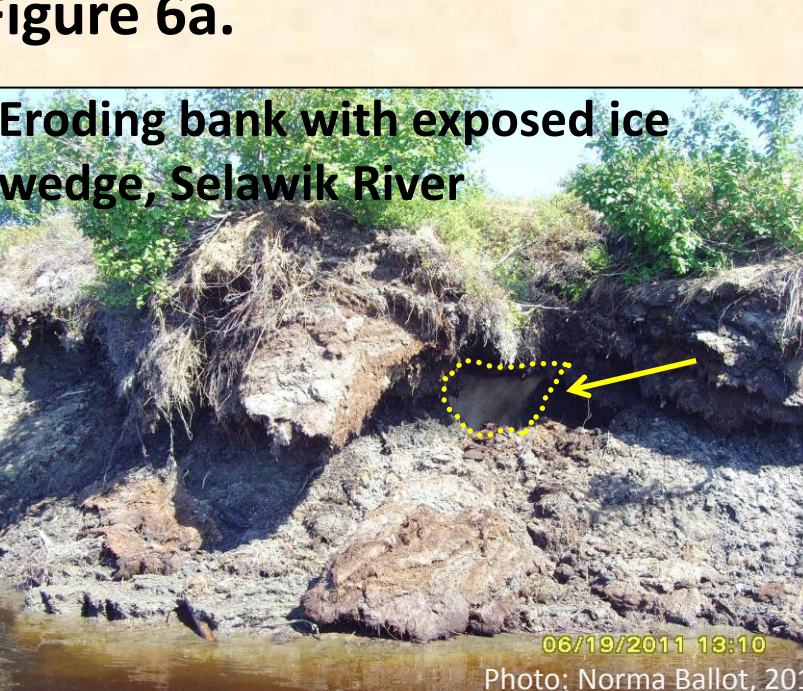
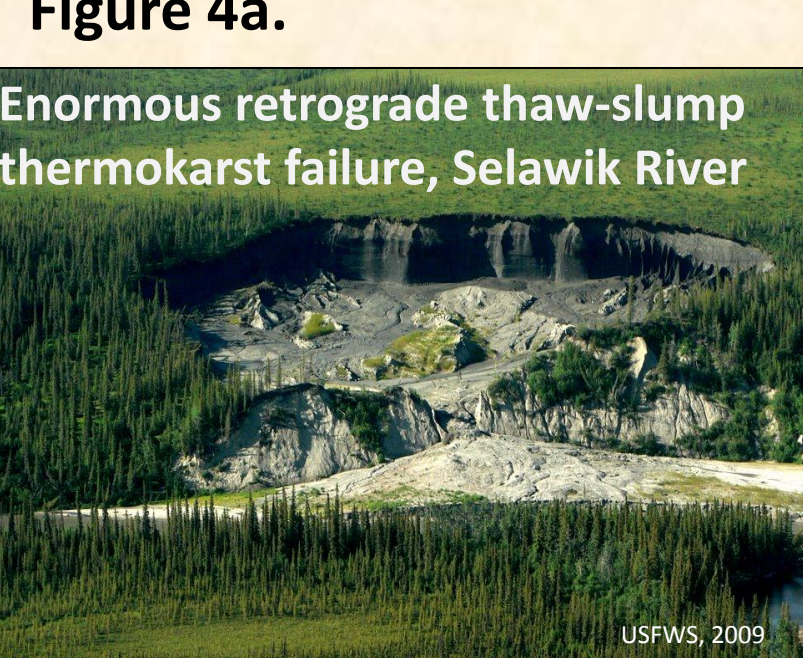
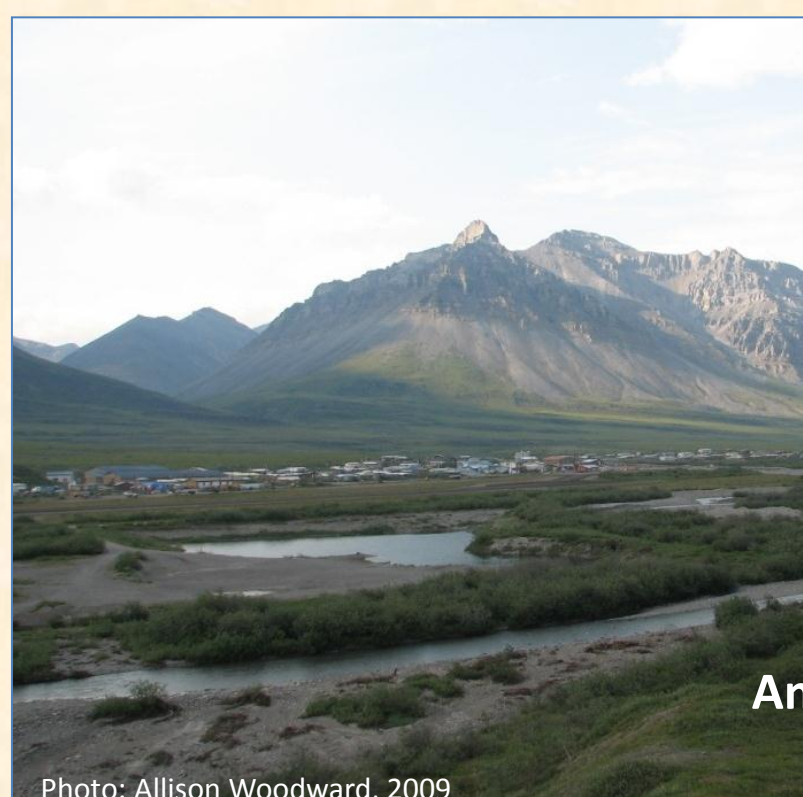
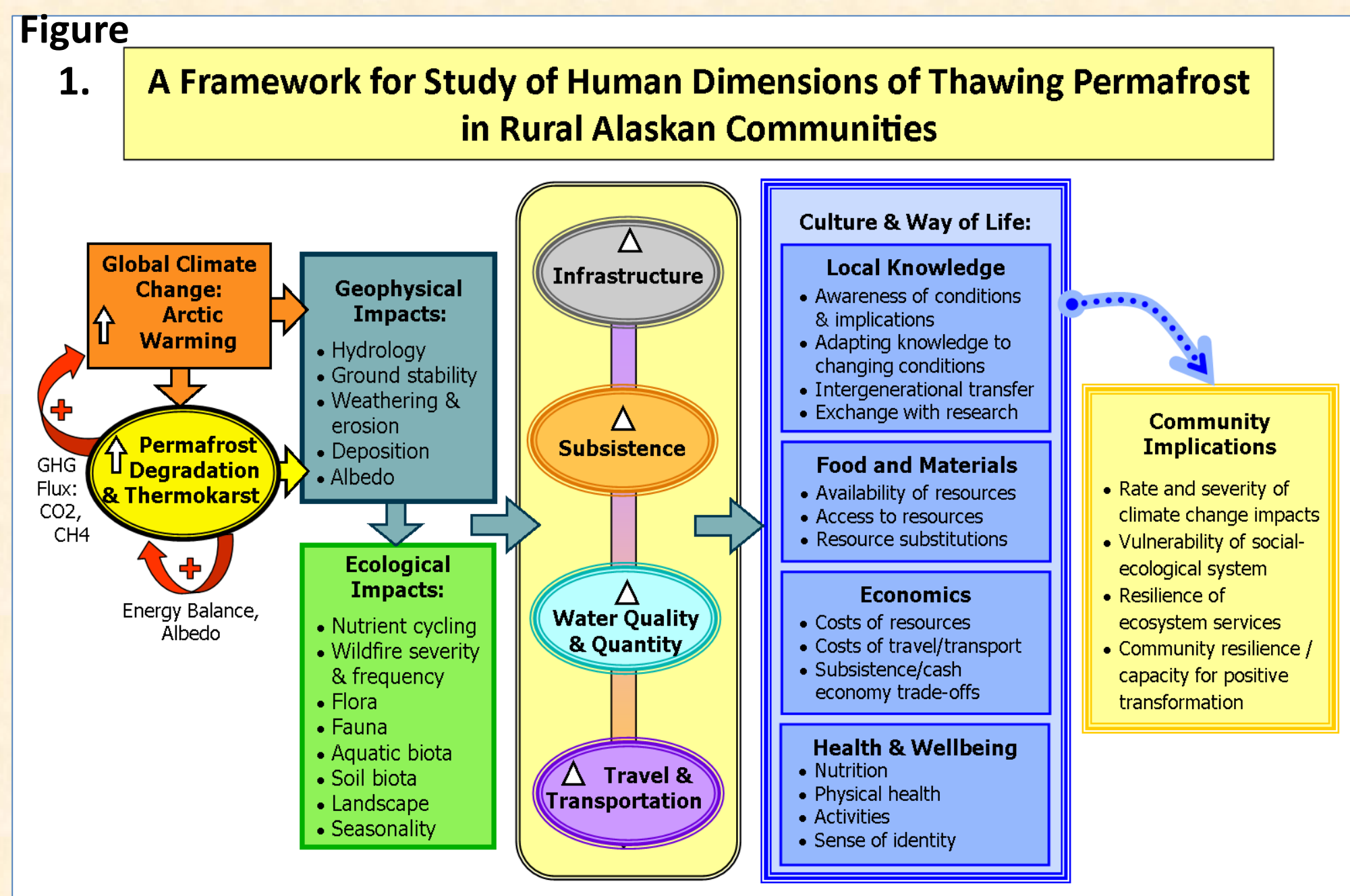


# Climate Change and Thawing Permafrost in Iñupiat Communities of Alaska's Arctic: Observations, Implications, and Resilience



## Abstract

Permafrost is thawing in many regions of Alaska. As climate warms social-ecological systems that co-evolved in colder regimes are exposed to new conditions and unpredictable feedbacks. Heavy reliance on local ecosystems for material and cultural resources makes Iñupiat communities particularly vulnerable to climate change impacts. Using the transdisciplinary approach of resilience theory, we investigated current and potential effects of thawing permafrost in two Iñupiat communities in Alaska's Arctic. Anaktuvuk Pass is situated on consolidated gravel permafrost in the mountains. Selawik rests on ice-rich permafrost in lowland tundra. We hypothesized that residents of both villages will report permafrost change, and that the impacts and perceived implications of thawing permafrost will be greater in Selawik. We measured active layer thaw depths and documented residents' local knowledge about climate and permafrost change. Thaw depths were greater overall in Selawik. Most research participants in both communities reported changes in climate and permafrost. Selawik residents expressed higher degrees of certainty that change is occurring, and anticipate larger and more negative impacts. Of the two villages, Selawik faces greater and more immediate challenges to the resilience of its social-ecological system.

## Introduction

The Iñupiat have adapted to and coevolved with the northern Alaskan landscape (Fig. 5), demonstrating great resilience and adaptability for millennia. Now, rapid warming is transforming both permafrost and social-ecological systems in northern Alaska. As permafrost warms, subsidence and thermokarst erosion of thaw-susceptible soils may destabilize infrastructure and affect hydrology, travel on land and waterways, and subsistence activities vital to rural Alaskan communities. Many Iñupiat communities may soon need to employ new adaptation strategies to cope with impacts of thawing permafrost. Two Iñupiat communities collaborated in this research (Fig. 4a & b). Anaktuvuk Pass is built on thaw-stable consolidated gravel in a broad pass high in the Brooks Range. Selawik lies in a region of thaw-susceptible ice-rich permafrost on lowland tundra interwoven with rivers and lakes. We hypothesized that changes in climate and permafrost would be 1) observed by residents and cause concerns about implications to subsistence, hydrology, and travel in both villages, and 2) perceived as greater threats to infrastructure and livelihoods in Selawik, due to its higher vulnerability to erosion, subsidence, and other effects of thawing permafrost. Objectives of the research were to 1) learn from residents' observations and perceived effects of climate and permafrost change; 2) obtain baseline permafrost thaw depth data; 3) assess current and potential impacts of permafrost change on communities; 4) share relevant information among residents and researchers; and 5) provide useful information to aid rural Alaskan communities in adapting to thawing permafrost. This research is the human dimensions component of the collaborative project, *Spatial and Temporal Influences of Thermokarst Failures on Surface Processes in Arctic Landscapes*, sponsored by the National Science Foundation's Arctic System Science Program.

## Research Methods

Active layer thaw depths were measured at 1 – 1.5 meter intervals to a maximum probe depth of 2.5 meters along transects ranging from 40 to 400 meters, depending on location-specific questions and constraints. When possible, comparative transects were run through relatively undisturbed areas versus similar areas with various human disturbances including buildings, roads, ATV trails, and boardwalks. Surveys and semi-structured interviews were administered to village residents, asking about climate and permafrost changes and their influences on land, water, flora, fauna, subsistence activities, infrastructure, local travel, transportation, and other aspects of community life. In Selawik (n=13) active subsistence users and/or Elders were interviewed, with spatially-referenced data recorded on local maps (Fig. 7). Surveys were given in Selawik (n=42) and Anaktuvuk Pass (n=39). Repeat photography (Fig. 8a & b) was used to document temporal change at recognizable locations. Videography was used to capture residents' narratives and to document physical examples of change observed on site visits led by key informants in both villages.

*It's a lot of different than it was back in the 70's. The river is getting wider, and the lakes are eroding. Like that big lake - Inland Lake - eroding real bad. I was thinking about maybe from too much wind, or something like that. But then I believe that global warming is melting away all this permafrost and start eroding away.*  
- Selawik resident, b. 1932

*Change is too fast - too much turmoil. Land, animals, everything is changing. Even time is faster and faster.*  
- Anaktuvuk Pass resident, b. 1930

*I know it's there - thawing permafrost and climate change - and we see the changes. Makes me concerned and scared. We have no sure way of dealing with it. All we live on is permafrost.*  
- Anaktuvuk Pass resident, b. 1972

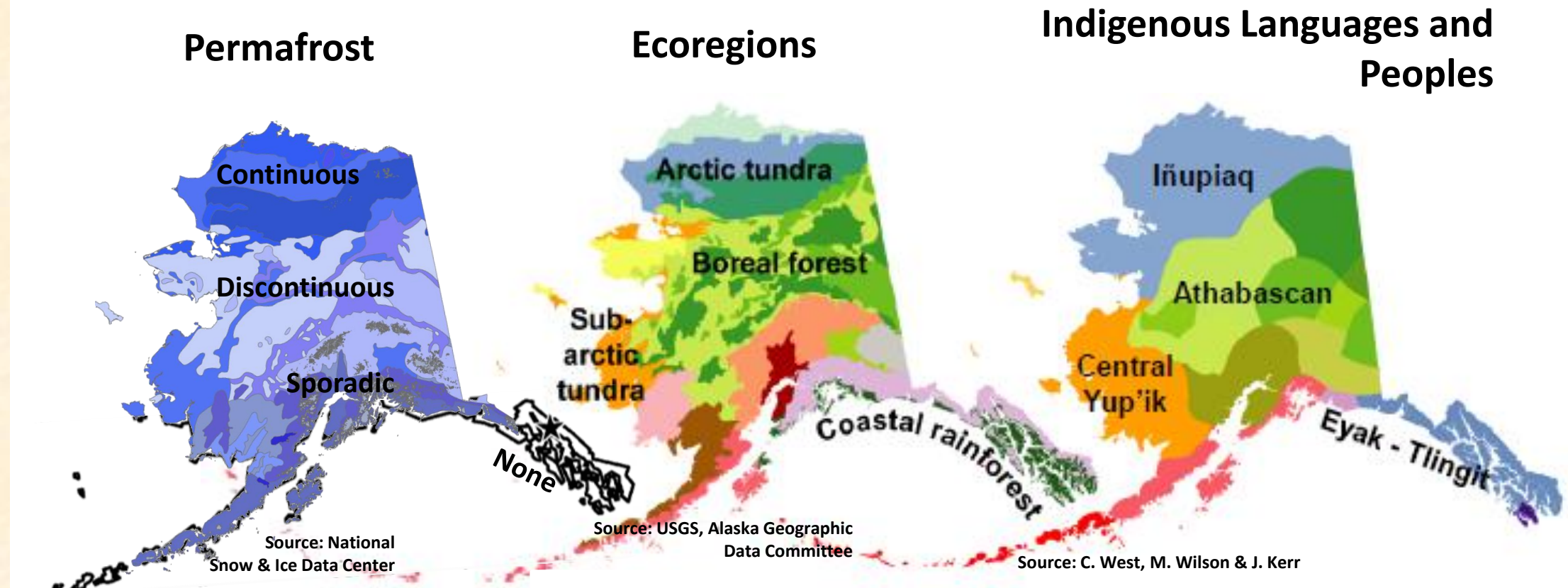
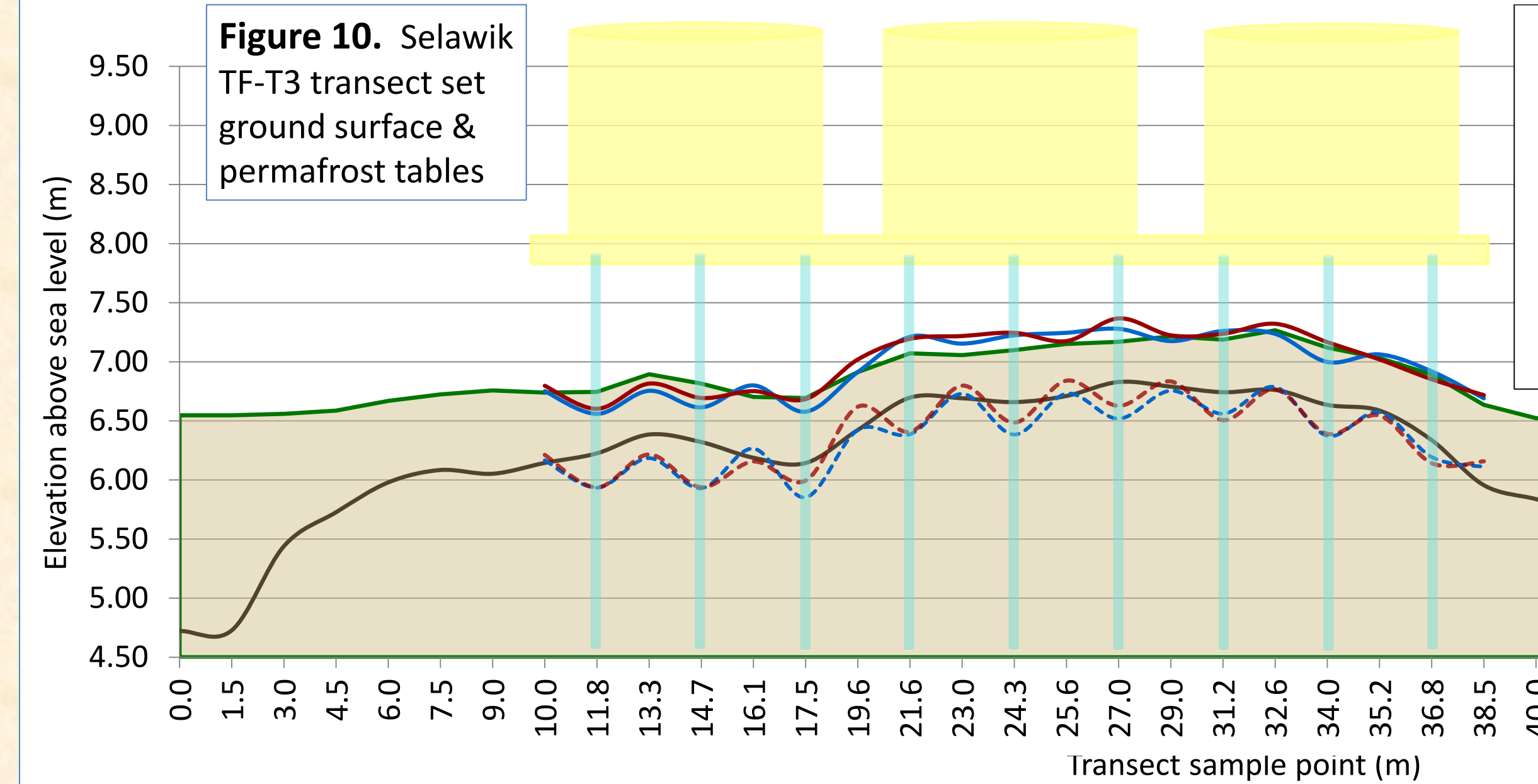
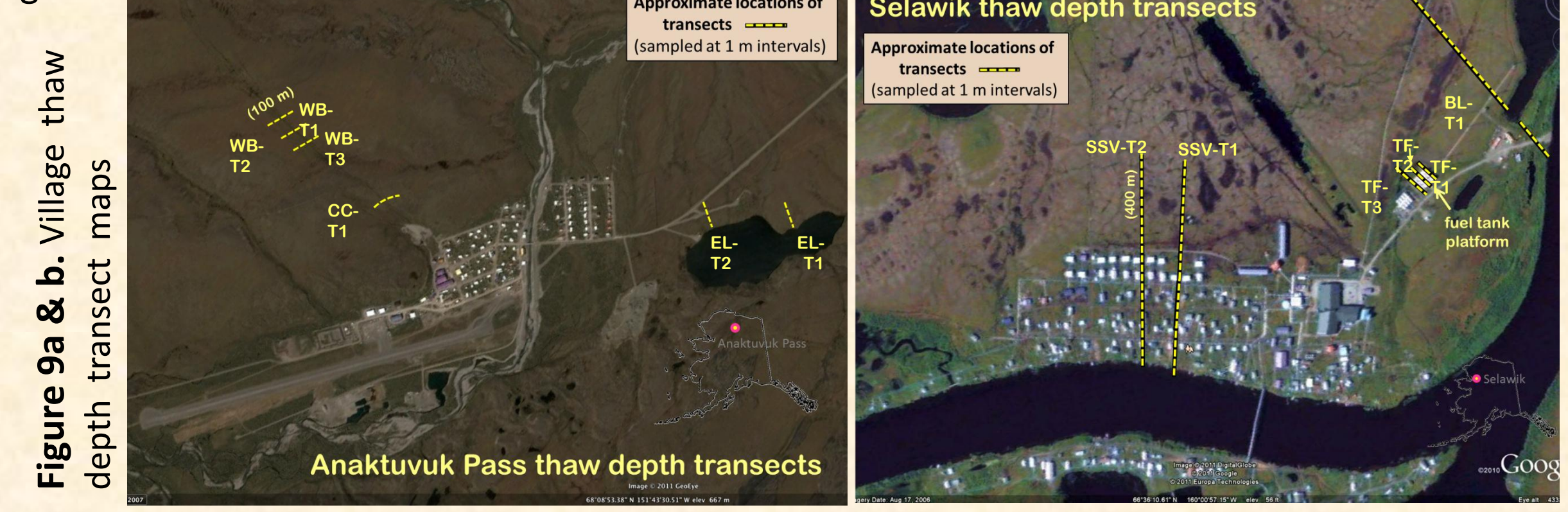


Figure 5. Alaska's permafrost, ecoregions, and indigenous cultures have co-evolved as an integrated complex system in which all components are now being affected by climate change.



Survey respondents and interviewees expressed high degrees of certainty that climate is changing in each of their homelands. Selawik residents anticipate more significant and more negative effects of climate change than residents of Anaktuvuk Pass (Fig. 14a). All Selawik respondents and 98% in Anaktuvuk Pass reported that permafrost is changing locally. Selawik residents expressed greater certainty about permafrost change and expect more pronounced and negative effects (Fig. 14b). Residents in both communities voiced concerns about the impacts climate and permafrost changes may have on their subsistence practices. Both communities reported increased shoreline erosion and turbidity of water bodies, with greater concern in Selawik. Most Selawik respondents believe their community will need to modify drinking water systems, change ways of local travel, and relocate buildings to adapt to thawing permafrost (figs 15a-c). "We are sinking" was a phrase commonly expressed in Selawik. Only Selawik residents voiced concerns about the potential need to relocate their settlement due to subsidence and inundation (fig. 15d).

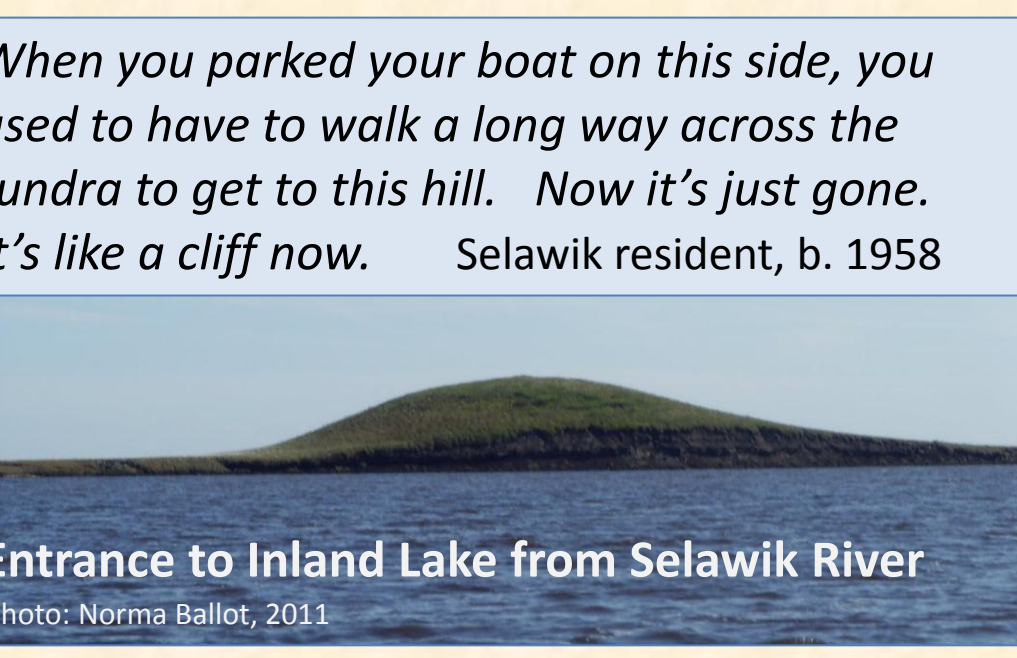
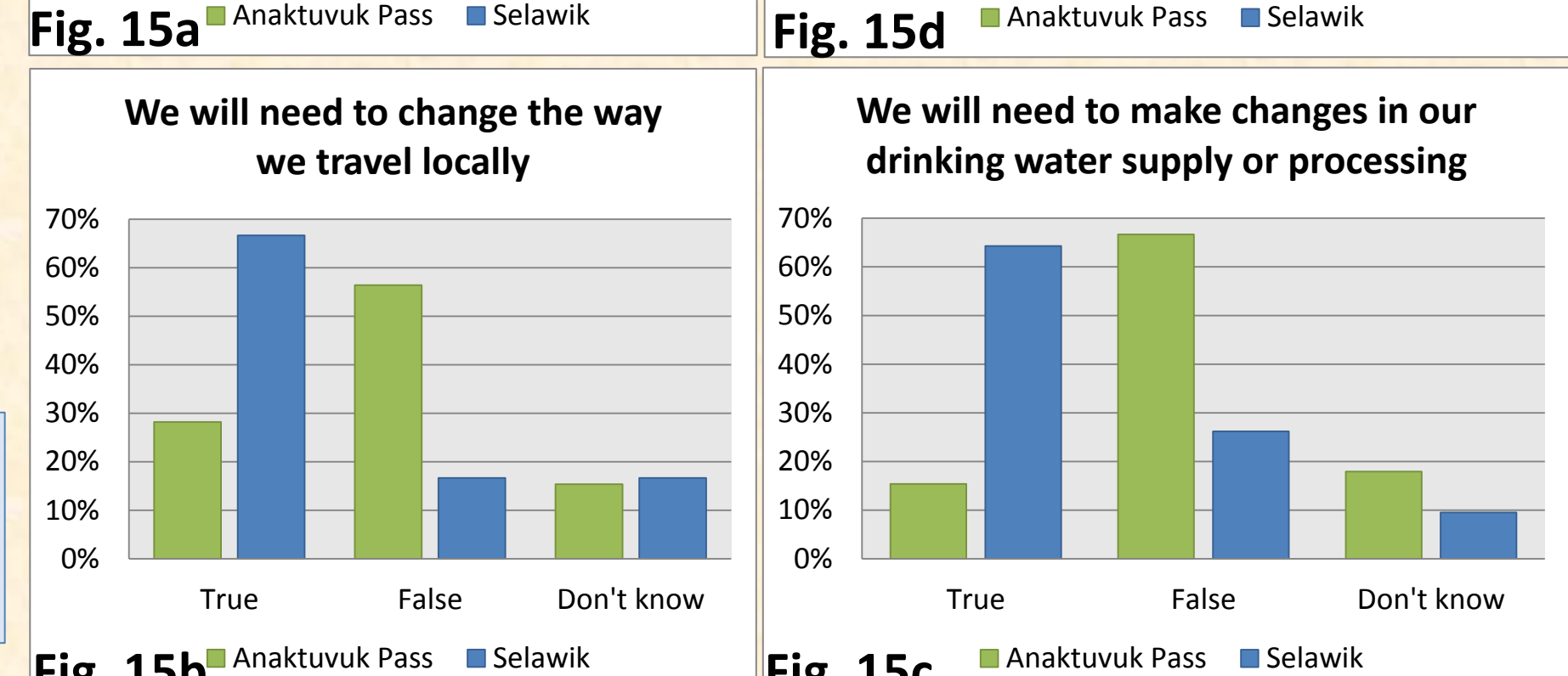
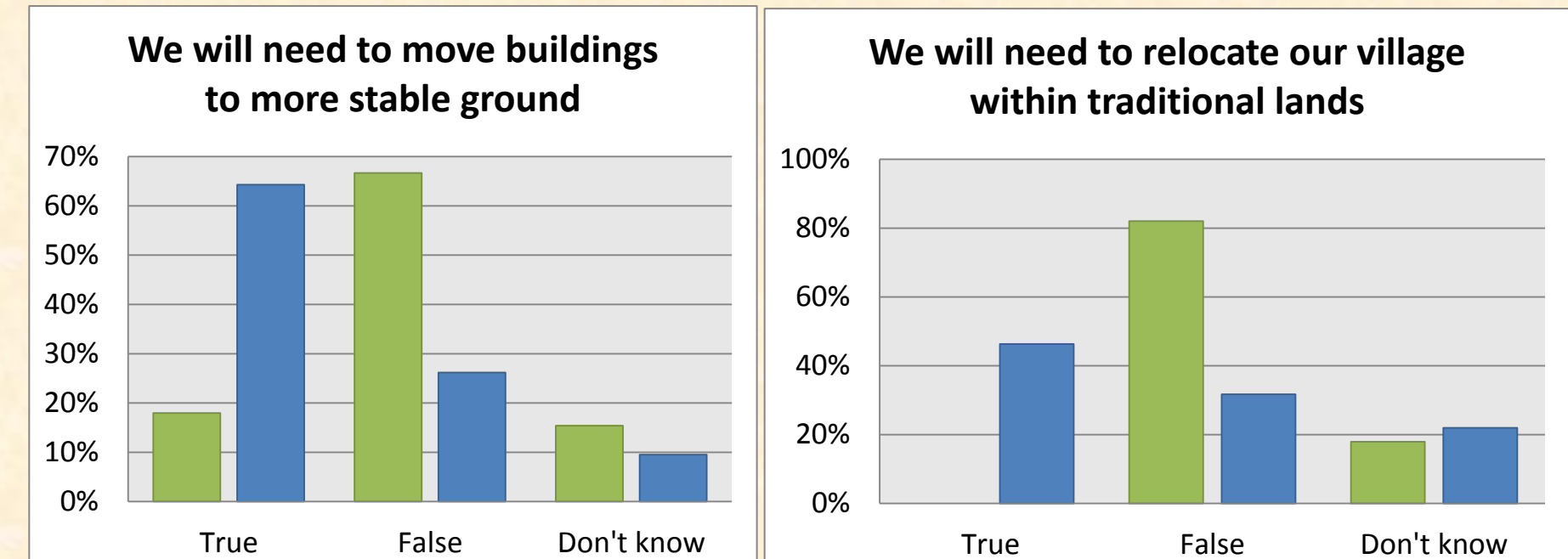
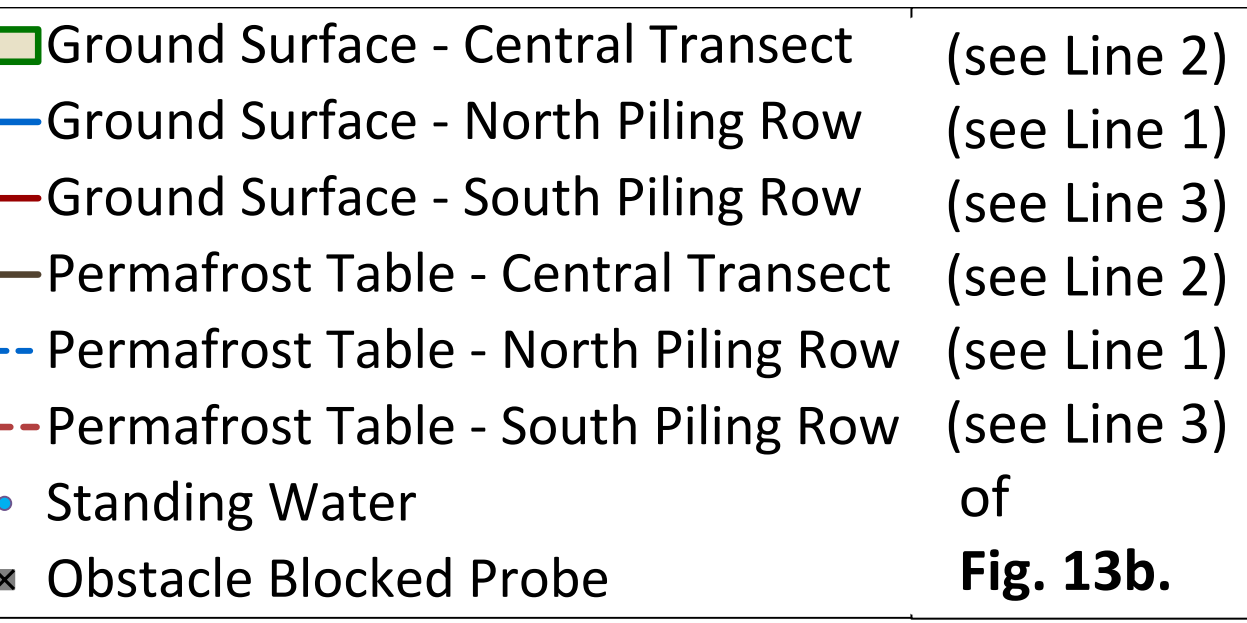
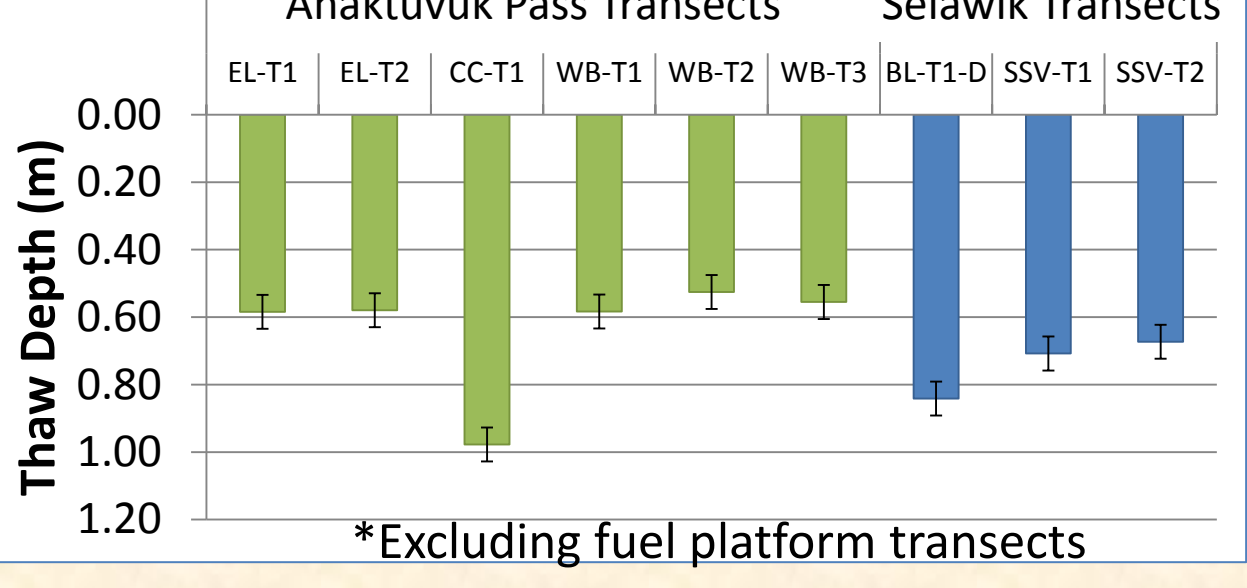
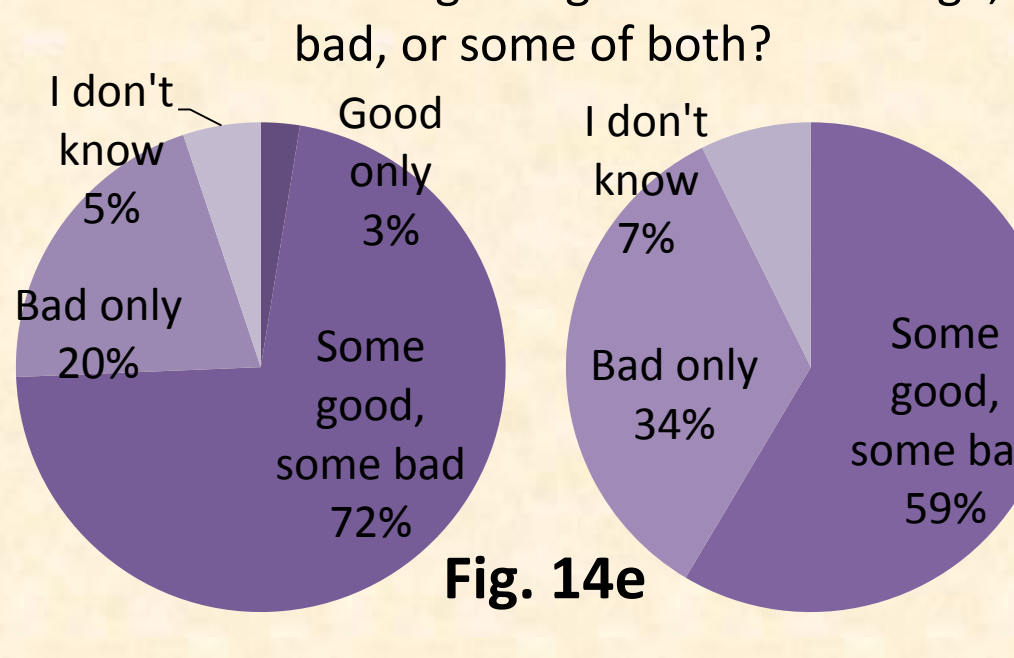
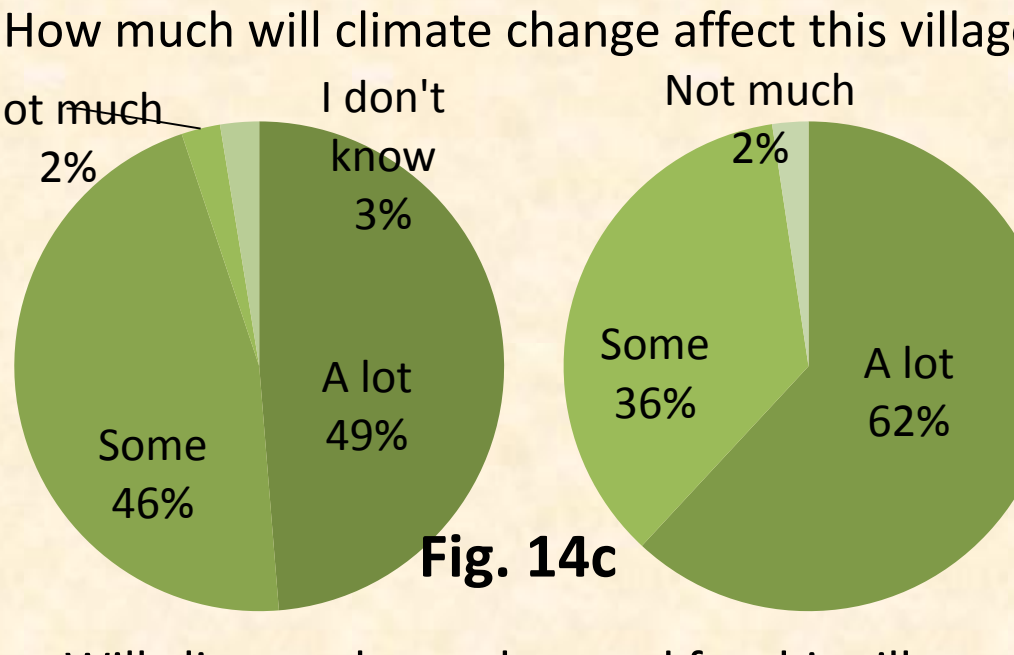
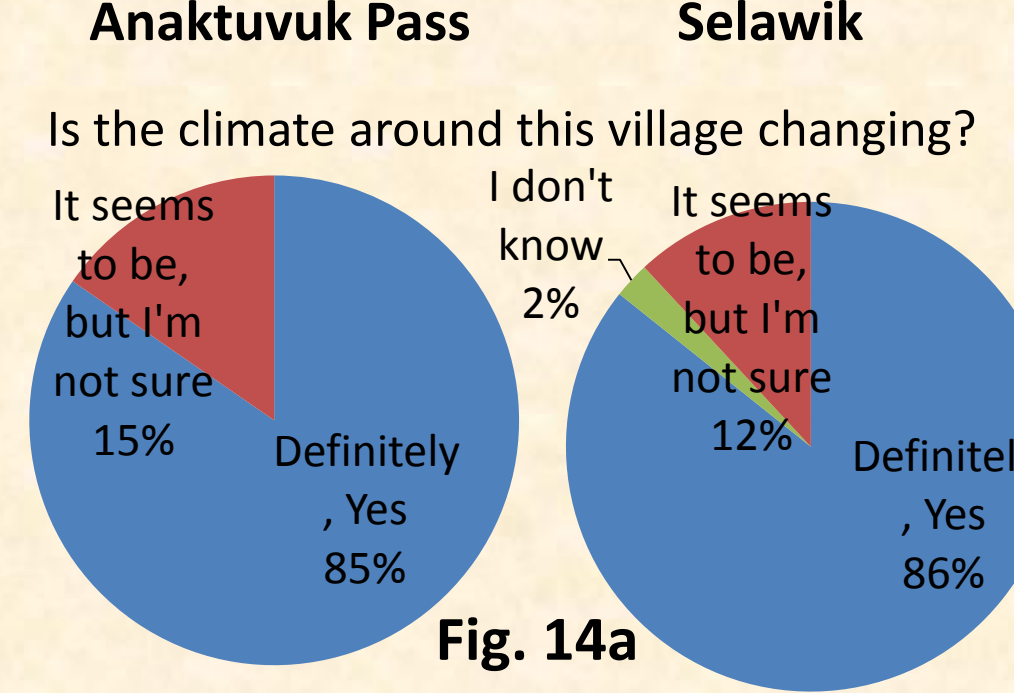


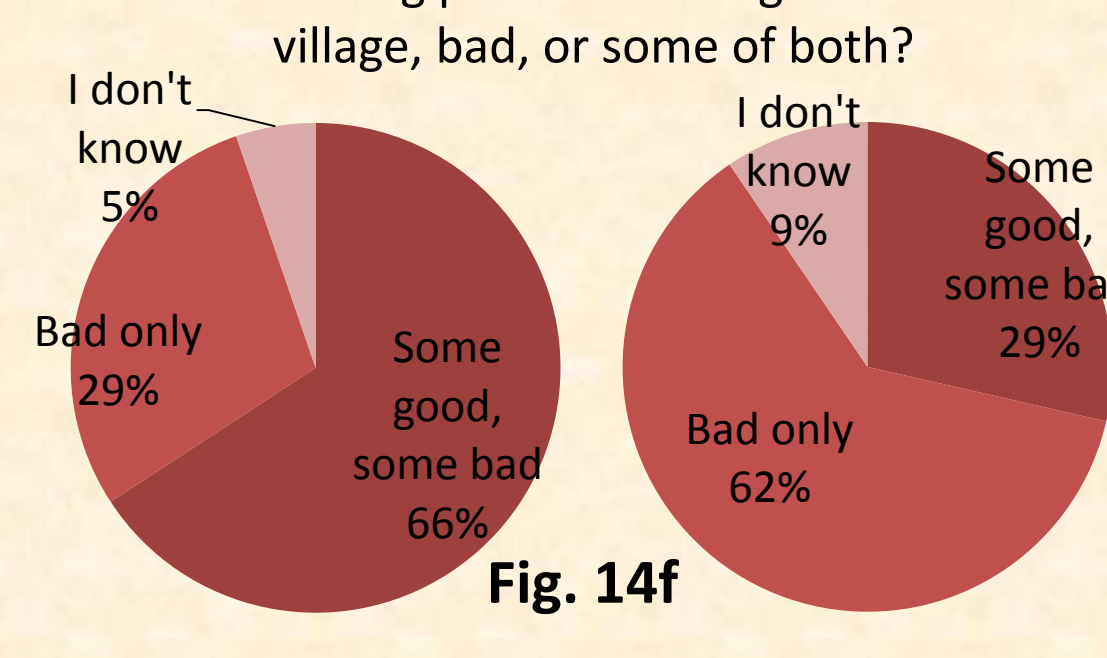
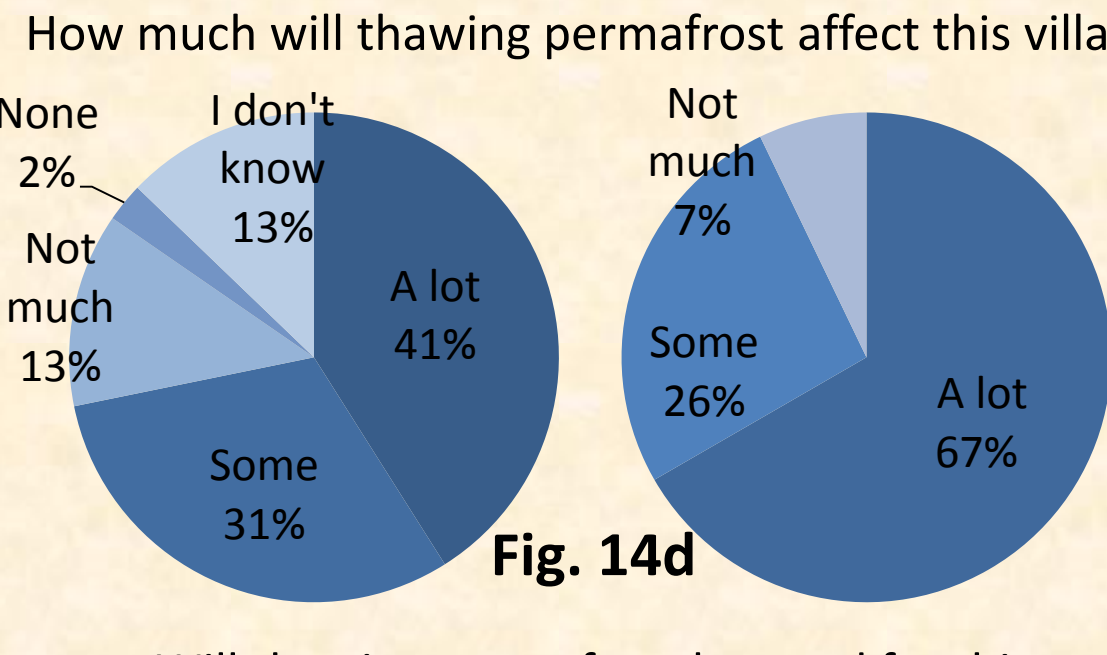
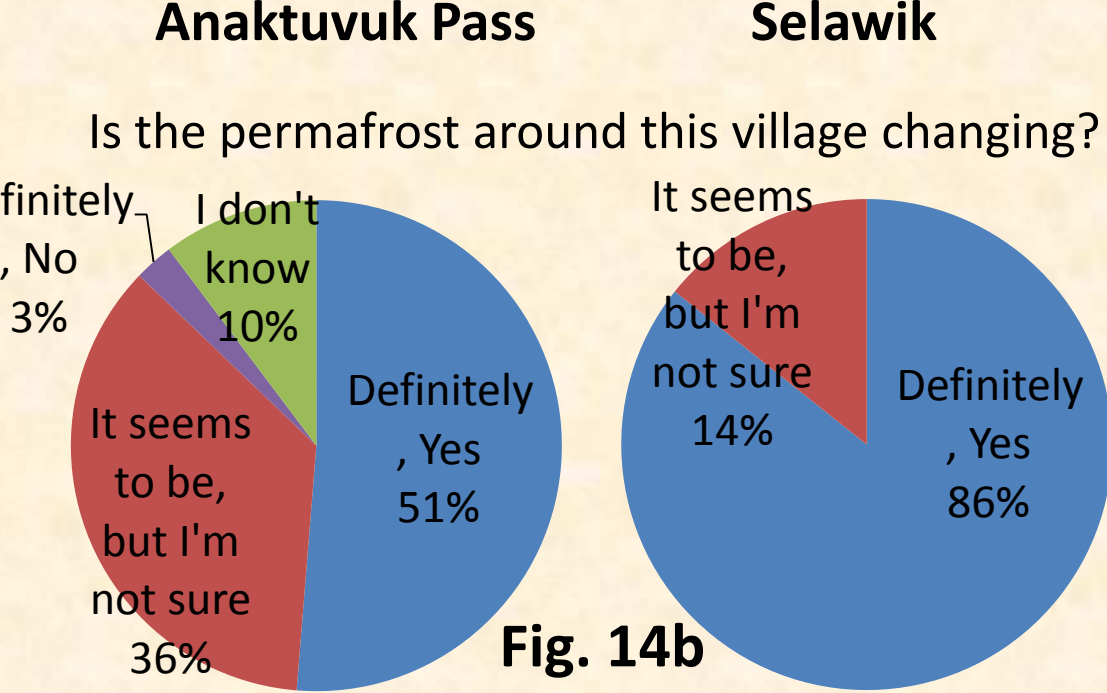
Figure 11. Guided site visit



## Perceptions of Climate Change

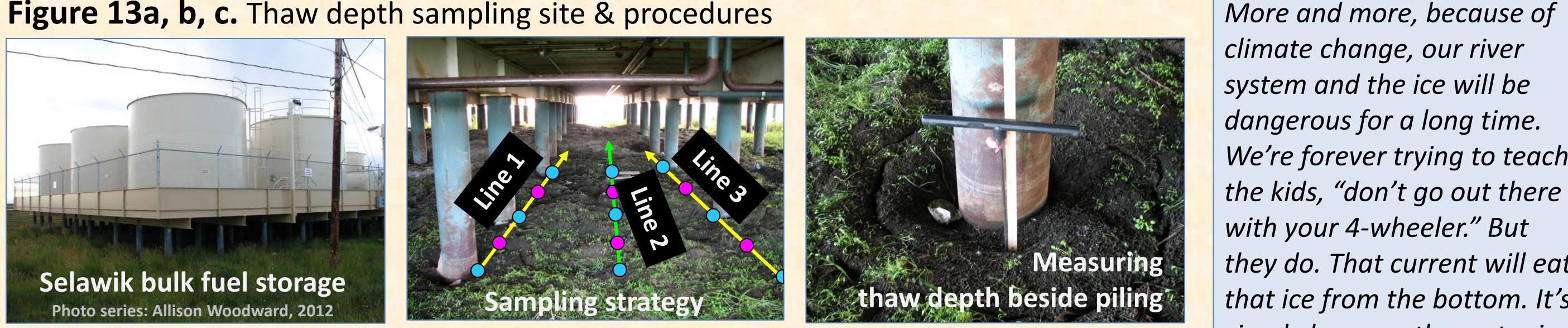


## Perceptions of Permafrost Change



## Conclusions

Thaw depth data, observations, high degrees of certainty, and anticipated negative impacts voiced by residents all point to Selawik's greater vulnerability to thawing permafrost. Residents of both villages are generally aware of the level of thaw stability of their communities and recognize the need for adaptation to rapidly changing conditions. Due mostly to thaw instability, Selawik will be forced to make earlier and more drastic responses, including planning for relocation. Selawik is fortunate to have a suitable site nearby, but currently resources for relocation are not available. Selawik's adaptive capacity is more limited by financial constraints than Anaktuvuk Pass, where oil revenues play a large role in supporting the community.



*More and more, because of climate change, our river system and the ice will be dangerous for a long time. We're forever trying to teach the kids, "don't go out there with your 4-wheeler." But they do. That current will eat that ice from the bottom. It's simply because the water is not as cold as it used to be. That's the thing that we're having to deal with now.*  
- Selawik resident, b. 1941