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Applying the food–energy–water nexus concept at the local scale

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The food–energy–water (FEW) nexus describes interactions among domains that yield gains or trade-offs when analysed together rather than independently. In a project about renewable energy in rural Alaska communities, we applied this concept to examine the implications for sustainability and resilience. The FEW nexus provided a useful framework for identifying the cross-domain benefits of renewable energy, including gains in FEW security. However, other factors such as transportation and governance also play a major role in determining FEW security outcomes in rural Alaska. Here, we show the implications of our findings for theory and practice. The precise configurations of and relationships among FEW nexus components vary by place and time, and the range of factors involved further complicates the ability to develop a functional, systematic FEW model. Instead, we suggest how the FEW nexus may be applied conceptually to identify and understand cross-domain interactions that contribute to long-term sustainability and resilience.

Food, energy and water are essential components of sustainability, emphasized as three of the 17 Sustainable Development Goals of the United Nations[1]. The direct and indirect connections among food, energy and water systems have accordingly given rise to the concept of the food–energy–water (FEW) nexus (also called the WEF or EWF nexus)[2,3]. This concept has attracted great interest among scholars[4–12] and practitioners[13], drawing attention to the potential pitfalls of ignoring trade-offs among these systems—for example, unsustainable demands on available water supply[9]—as well as the potential gains to be obtained from mutually beneficial interactions: for example, power generation that supports water treatment and food processing and storage[14,15]. While the FEW nexus has been critiqued for a variety of perceived shortcomings in concept and practice[5,6,9,16], it nevertheless remains a popular concept for identifying and acting on the connections and interactions that support or constrain human environmental security and well-being[17–19], including both sustainability and socio-ecological resilience[20].

As part of a project looking at current and future renewable energy use in small, remote, rural Alaska communities (Fig. 1) in the context of food, energy and water security, our team of engineers, social scientists and an Indigenous community leader used the FEW nexus as a conceptual framework for identifying and analysing anticipated interactions among these domains. We examined the characteristics of the FEW nexus in several communities around the state that lack road access or electrical grid connections to other communities. These communities obtain some food locally through hunting, fishing, gathering and limited agriculture, whereas fuel and the remaining food are transported in by air or water. Part of the initial impetus was to add to practical scholarly understanding of the FEW nexus through case studies in relatively simple, isolated systems, responding to calls by others working in this area to better connect theory with practice[10,12] and to examine local systems as well as national and regional ones[21]. Alaska is part of a wealthy, industrialized nation but socioeconomic conditions in rural Alaska prominently include poverty and limited infrastructure[22,23], leading to considerable variation in community-level estimates of food insecurity[24] and a lack of food sovereignty[25,26] despite high traditional harvests of wild animals and fish[27], as well as inadequate water and energy security[28–30]. These conditions are analogous to scarcities found in less-developed communities elsewhere in the world where electricity may be unreliable or unavailable[31], food may be scarce and clean water in short supply.

Our findings in rural Alaska communities support the idea that the FEW nexus is a useful heuristic for identifying cross-domain interactions and the influences of other factors. However, the contextual nature of the connections and influences we documented suggests that a 'grand theory' of the FEW nexus[6] may not be achievable. Instead, we agree with those who suggest that the broadly applicable value of the nexus may be in its role as a way of thinking[32] rather than solely as the basis for a systematic model capable of characterizing and quantifying relevant components and relationships[33].

The characteristics of a nexus

Sustainability and resilience both require thinking about a system in terms of connections among and across domains rather than just

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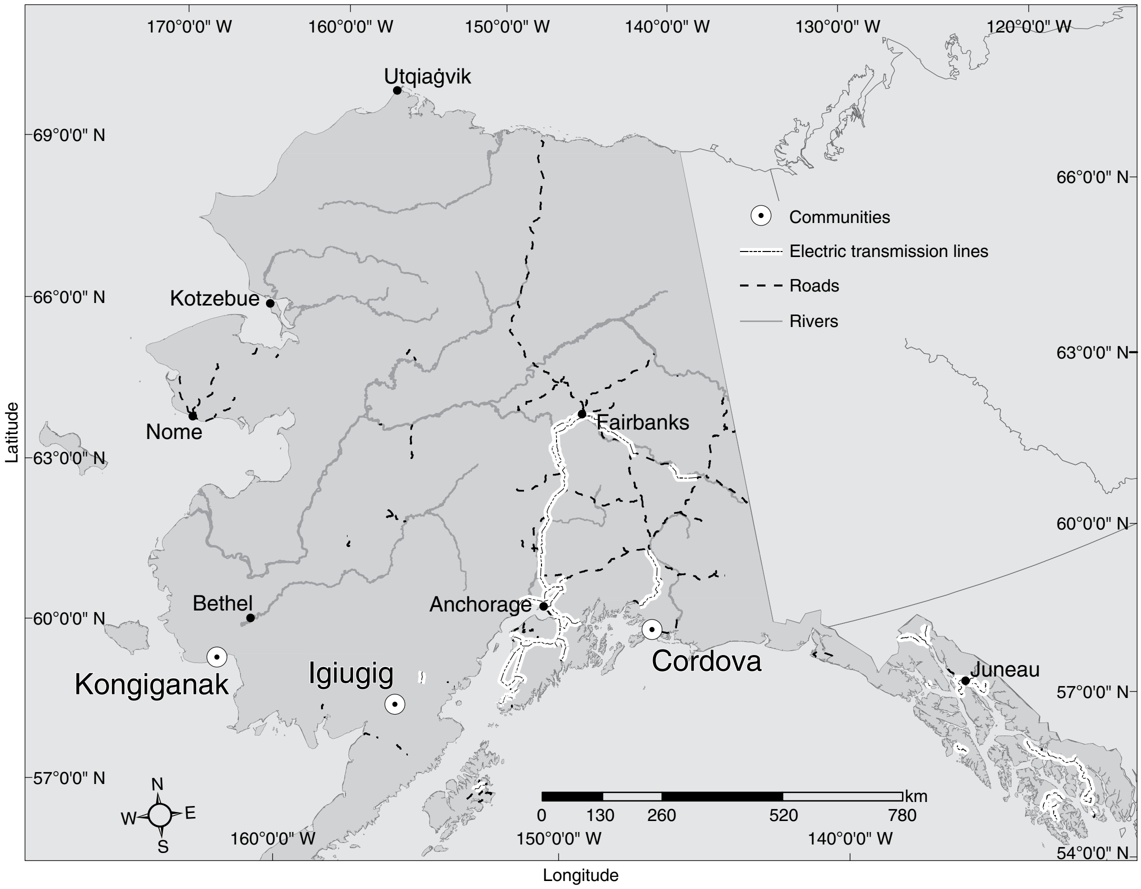

Fig. 1 | Study location. Map of Alaska with the study communities of Cordova, Igiugig, Kongiganak and Tanana, and major roads and electrical grids.

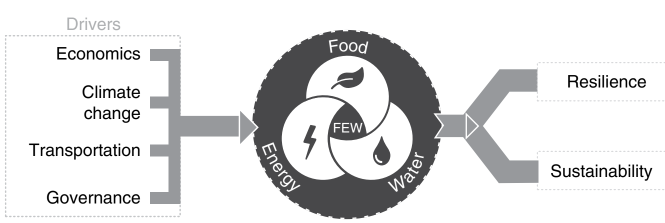

Fig. 2 | The FEW nexus. The concept captures a range of drivers; the cross-domain interactions among food, energy and water; and outcomes in terms of sustainability and resilience.

as individual components. Cross-domain thinking aids sustainability by identifying how an action can have unintended negative consequences or how an action may be harnessed for wider benefit[34]. With respect to environmental security, such thinking can aid resilience by revealing weaknesses in the supply of food, energy and water, as well as functional redundancy that promotes resistance to disturbance[14,35]. FEW nexus thinking is based on the idea that food, energy and water form a hub of connections that provides useful insight[11] (Fig. 2). The three resources are necessary for human life and typically depend on supply chains[6]. In contrast, oxygen is also necessary for human life but does not depend on a supply chain, nor is it limited in relation to human demand, so neither sustainability nor resilience is limited at present by access to oxygen.

For the nexus to provide such insights, components must be coupled in a functionally meaningful way and not merely connected. For example, agriculture requires water, so a connection between food and water clearly exists; but, from a diagnostic perspective, recognizing this connection is only helpful if expected changes in one domain are likely to cause changes in the other. Without the possibility of a trade-off or a mutual gain across domains, each system is functionally independent despite any actual connection. A trade-off would exist if the water supply were insufficient for both needed irrigation and household use, forcing a choice between the two. A mutual gain would exist if water recycling methods were adopted that could reduce or maintain overall consumption while making more water available for both households and agriculture.

Even when there is substantive coupling across two or three of the FEW domains, there may also be other factors that have as great, or greater, influence on sustainability and resilience. To continue the water and food example, climate change may reduce the overall water supply, making trade-offs more severe and reducing the prospects for mutual gains. Government policies may promote or constrain the ability to add water re-use systems or available technology may be unaffordable for the community in question. The inclusion of these factors creates a complex web of interactions far beyond the resources of food, energy and water[35], requiring more data and analysis. The challenge is to retain the useful simplicity of the FEW nexus without losing sight of the complex societal system of which it is a part.

The MicroFEWs project

The MicroFEWs project examined the direct and indirect connections between renewable energy generation in isolated microgrids and FEW security in four rural Alaska communities: Cordova (population estimated at 2,343 in 2019[36]), Igiugig (population 56), Kongiganak (population 523) and Tanana (population 216)[37]. Specifically, the project sought to develop a FEW framework for

Table 1 | Illustrative examples from rural Alaska of FEW connections involving trade-offs or synergies within the FEW domain

Components	Interaction	Implications for sustainability and resilience
Energy–food	Excess electricity from wind turbines or hydropower to heat greenhouses, extending the growing season (contemplated in Igiugig)	Greater availability of local foods and renewable energy (++)
	Harvesting and burning local wood for heating greenhouses (Tanana)	Decreased dependence on fossil fuels, both for transport of food and for local energy use (+)
Water–energy	Competing demands for water, for hydropower and the municipal water system that also supplies the high-demand fish-processing plants, an economic rather than nutritional mainstay for the community (Cordova)	Approaching or exceeding the limits of the hydrological system, perhaps requiring greater fossil fuel use to make up the difference (−)
		Greater demands on limited supply chains, straining or exceeding local capacity (−), or prompting greater use of solar or wind power to reduce the demand for water (+)
Water–food	Availability and cost of water affect the types of food purchased and cooked (Kongiganak, Igiugig)	Lower-quality food undermining health (−)
	Labour of manual water hauling limits willingness to maintain a food garden (Tanana)	Lower capacity for sanitation increasing the risk of food-borne disease (−)

++, +, − and −− indicate the direction and qualitative magnitude of the implications.

each community; collect relevant community-level data; investigate modular systems related to FEW security; develop energy distribution models; synthesize an overall MicroFEWs model; and conduct outreach and capacity development activities. This paper is concerned primarily with the FEW framework, community-level data and the attempt to create an overall synthesis model. We were able to identify important couplings and influences within the FEW nexus but the creation of a systematic synthesis model was elusive because conditions varied greatly from one community to the next and over time, even within Alaska where many features of the political-economic system are consistent statewide.

Couplings within and beyond the FEW nexus

Through observations and interviews in rural Alaska, we identified several qualitative examples of interactions involving food, energy, water and other factors. Our previous work[37] and experience suggest that the examples we present here are broadly typical of rural community systems around Alaska and thus illustrative of the potential of the nexus approach at the local level.

In Table 1, we present pertinent, but far from comprehensive, examples of couplings within the FEW domains and their implications for sustainability and resilience in rural Alaska. To illustrate the issue noted above about theoretical connections versus functionally meaningful couplings, the Kvichak River in Igiugig, Alaska, provides food (salmon), household water and energy (via a hydrokinetic turbine). However, the village has fewer than 60 residents. At that scale, water removal from the river is imperceptible, meaning that there are no trade-offs regarding water use. In other words, water supply is colocated with food and energy supply but not coupled to either. Likewise, a 40-kW hydrokinetic turbine is located on the central streambed, where one or two such devices have little or no effect on migrating salmon. It would take a major disruption, such as the complete damming or divergence of the river, to manifest a functional coupling between the two. The choice of such technology by the Igiugig Village Council is an example of nexus thinking in practice, in this case avoiding a potential maladaptive coupling of food and energy, which would have forced a trade-off between salmon and electrical generation, while further boosting sustainability and resilience by reducing demand for fossil fuel.

In Table 2, we again present pertinent but not exhaustive examples of connections extending beyond the FEW domains and their implications for sustainability and resilience. Although the communities in our study are geographically isolated, they are part of a much larger system of connections that affect their FEW security in ways large and small. State and federal policies provide subsidies and other support, the loss of which would greatly undermine the viability of rural Alaska communities[22]. Transportation, too, plays a major role, as would be expected in remote communities and also in any community obtaining supplies from outside its immediate area (Fig. 3). For example, direct air service from Anchorage to Igiugig increased food options and reduced prices. Conversely, loss of ferry service to Cordova in 2020 directly and rapidly reduced food and energy security. Air transportation, however, is more energy intensive, resulting in increased greenhouse gas emissions. An analysis of the carbon footprint of remote Indigenous communities is beyond the scope of this paper but long-term sustainability will require alternatives to carbon-intensive systems.

These connections also raise the idea of cross-scale interactions. For example, the Alaska Power Cost Equalization (PCE) programme subsidizes rural electricity prices but is managed statewide[38]. Effects in one community are unlikely to substantially affect the overall programme. Furthermore, savings in power generation costs will accrue at the state rather than local level, in the form of reduced subsidies resulting from reduced costs. Thus, the benefits of switching to cheaper power sources will be gained largely at the state level, with no guarantee of any local economic benefit.

Applying the FEW nexus in practice

The FEW nexus is a useful spur to thinking beyond the limits of typical disciplinary, agency and practitioner domains[8]. However, placing the connections among food, energy and water at the centre of the system[2,3,17] may imply that such connections are central to understanding community well-being, when in fact other parts of the system may be the strongest drivers and determinants[19,39]. To that point, at the scales of the rural settings we examined, the role of other factors such as transportation and governance require as much, or more, attention. However, quantifying those factors to create a systematic model was impractical given limitations on available data and time.

Our investigation of the FEW systems in rural Alaska identified many connections and couplings among the structures and processes that provide these necessities of life to rural residents. The nature and extent of these connections suggest that cross-domain thinking is essential for getting the most out of policies and practices designed to improve well-being. Sometimes, such thinking involves two or all three of the components in the FEW nexus. Often, however, other influences such as transportation, policy and governance may play a major role in determining security within only one of the FEW domains. While the FEW nexus as a concept includes such relationships, the system in practice is more

Table 2 | Illustrative examples from rural Alaska of other influences on FEW systems

Components	Interaction	Implications for sustainability and resilience
Transportation–food	Direct flights from Anchorage to Igiugig allow shipping of fresh or frozen food, increasing food security	Changes to cost, availability and choice of purchased food, affecting diet and health as well as household budgets (++)
	A new road to Tanana provided cheaper access to store-bought food but access is limited when road conditions are poor	Potential increases in greenhouse gas emissions (−)
	Loss of ferry service to Cordova increased shipping costs and reduced volume, threatening food security	
Energy–money	Excess electricity from wind turbines in Kongiganak is used to heat thermal stoves, reducing home heating bills	Lower costs to residents, allowing more money to be spent elsewhere (+)
Policy–energy	The PCE subsidy reduces the price consumers pay for electricity in rural Alaska, increasing energy security but decreasing incentives to innovate	Lower costs to rural ratepayers are a benefit, so long as the programme is funded (++) but reduced innovation increases overall costs (−)
Governance–food	Subsistence activities are major food sources in rural Alaska but regulations on harvests and access reduce opportunities and thus food security in some cases	Restrictions of food gathering, limiting options and increasing inefficiencies (−−)
Governance–water	The Igiugig Village Council subsidizes water treatment with funds from for-profit activities	Tribal government choices supporting public health, well-being (+)
Governance–energy	The City of Tanana pays residents to harvest wood for biomass boilers	Increased energy security, reduced fossil fuel use, income for residents (+)
Policy–food	The US Post Office subsidizes rural mail delivery, providing rural residents with cheap access to mail-order goods including food, thereby increasing food security	Lower transportation costs benefit rural residents, so long as the subsidy continues (++)
		Potential increases in greenhouse gas emissions (−)

++, +, − and −− indicate the direction and qualitative magnitude of the implications.

complicated and complex, with varying roles from one case to another and shifting configurations over time. These characteristics make it difficult or impractical to achieve a general model at the local scale that is simple enough to populate with data and to use, and detailed enough to provide a reasonably accurate picture of what actually occurs[16].

As an example, consider the role of money as a means of comparing the costs and benefits of different courses of action. Renewable energy may produce savings to households, communities and regions. Those savings could be invested in additional measures to promote FEW security: for example, heating greenhouses to provide more locally grown food or simply purchasing better-quality food. But the saved money could also be used for many other purposes, such as upgrading one's mobile phone service or visiting relatives in another place. A city or tribal council might invest in improved water treatment and distribution or instead in a community centre. Decision-makers are likely to consider their preferred outcome as an improvement to well-being but the particular choice will vary from person to person, community to community and time to time. Thus, it is difficult or impossible to predict how people will use the benefits from renewable energy and whether those benefits are to be found within the FEW domains or elsewhere.

Furthermore, savings may not accrue locally, creating multiscale interactions[19]. If electricity is subsidized, as is the case through Alaska's PCE programme, reductions in cost from renewable energy may simply reduce the subsidy without affecting local prices. The geographic and institutional scale of the nexus may thus be an important consideration; however, as the nexus becomes larger and more complex, a systematic model or even a heuristic approach must account for additional factors that may steer the overall supply system further from local influence

It is also important to note that nexus conditions are likely to vary through time, as relative scarcity changes. During winter in Alaska, when rivers are frozen and water flow is low, competing demands may be more substantial than at times when water levels are high. Modest demand for hydroelectric power may not threaten salmon runs but longer-term, large-scale projects may force a choice between energy and food. Transportation systems that function smoothly may be taken for granted, until they are interrupted, potentially harming FEW security or forcing choices to be made among these and other components of community well-being. Thus, any nexus approach should be dynamic through time[10], recognizing that the constraints on the system are unlikely to remain constant.

When we discussed our original idea of developing a systematic synthesis model of FEW security with our partner communities, local leaders made it clear that information about renewable energy options and the potential for trade-offs and mutual gains would be far more useful. In the complex and complicated community context, local leaders would be far better able than visiting researchers to understand the implications of renewable energy and FEW couplings in terms of sustainability and resilience, as well as the prospects for local support for or opposition to alterations to FEW systems. Any model we produced would probably fall far short of capturing what was important locally, whereas exploring the potential for previously unrecognized trade-offs and mutual gains across domains would be a useful contribution to locally led efforts to improve sustainability and resilience. In Fig. 4, we show a cycle of this type of FEW nexus thinking for use at local scales, illustrating the questions that may be asked at each step. Data are unlikely to be available for all components and relationships but the understanding of community leaders and other experts may be sufficient to achieve some of the benefits of FEW nexus thinking.

Our examples from rural Alaska have some commonalities with other parts of the globe, especially remote communities where FEW systems are small in scale and FEW insecurity is an impediment to sustainability and resilience[40–43]. For example, at least 840 million people worldwide lack access to electricity[44], not counting energy-disadvantaged communities whose power sources are unreliable or unconnected to major electrical infrastructures[31]. We suspect that using the FEW nexus concept to produce a systematic model of local systems elsewhere will encounter similar challenges to those we found when attempting to do so in rural

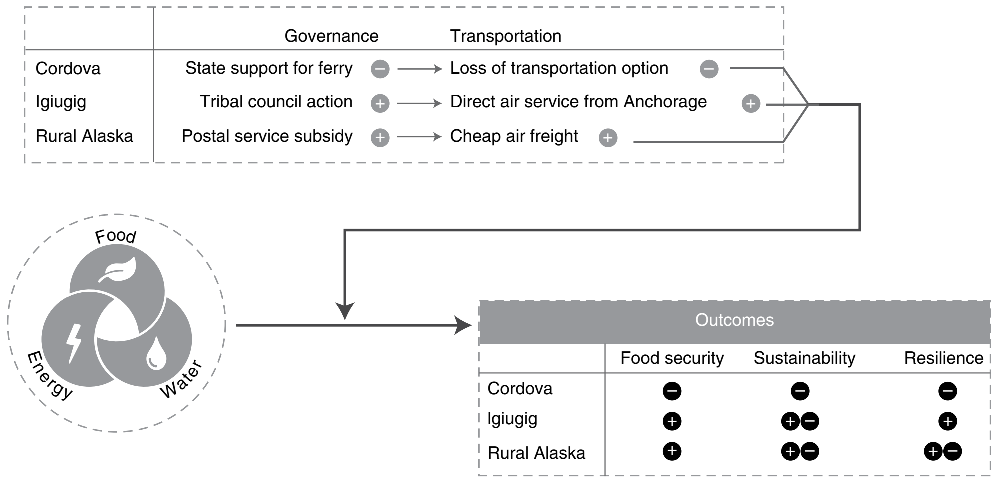

Fig. 3 | Pathways to FEW outcomes in rural Alaska. These illustrative examples show the influence of governance on transportation options and thus on food security, sustainability and resilience.

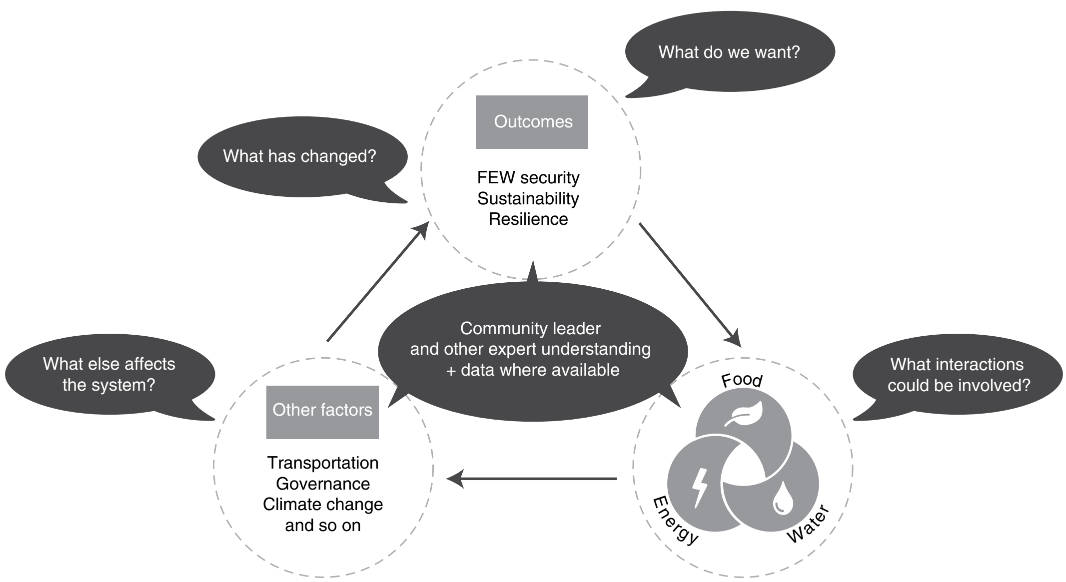

Fig. 4 | FEW nexus thinking at the local scale. The proposed conceptual approach shows a cycle from determining desired outcomes to identifying FEW interactions to assessing other factors to measuring actual outcomes, and then repeated. Note that data may not be available for many aspects of the system, but nexus thinking is still possible and relevant.

Alaska. Quantitative models are undoubtedly useful but are also data intensive[45] to the point of being impractical for widespread use at local levels where there is much diversity in culture, geography, ecology and other characteristics as is the case for rural Alaska (despite being part of one broad economic and governance system). Others may find, as we did, that it is easy to speculate about hypothetical FEW nexus interactions but harder to identify and quantify the real interactions that produce specific local outcomes.

The value of nexus thinking

The cycle of FEW nexus thinking shown in Fig. 4 can be applied to a variety of settings and issues. Here are three examples for harnessing the power of nexus thinking at a local level, which may be relevant for any community or region:

- Synergies and trade-offs. Any individual project or policy can and should consider how it can avoid damaging, or how it can provide benefits to, other parts of the community system. For example, a renewable energy project could help reduce heating bills or warm greenhouses, whereas an additional hydroelectric dam could reduce the water available for other purposes or harm fisheries.
- Priority setting. Community and regional planning can and should consider how to prioritize projects and policies that have greater effects, such as the synergies noted in the previous point. For example, upgrades to transportation infrastructure could yield better food delivery as well as easier access to health care. Such an upgrade might rise higher on a community's priority list than an investment that provides fewer additional benefits.
- Community design. Community design can and should consider how emerging practices and technologies could reshape the structure and function of community infrastructure. For example, communities that are relocating or rebuilding could, instead of simply replicating existing infrastructure, design

housing, energy, water, transportation and other systems that better suit their location and climate. Synergies and efficiencies, which are hard to achieve when retrofitting existing infrastructure, may be more readily achieved in remodelled systems[30].

In all three cases, it is important to have the flexibility to allocate funds where most needed, rather than according to the boundaries of agencies or other jurisdictions[25,46,47]. One valuable insight from FEW nexus thinking has been the observation that FEW systems are typically managed separately[2,8], which means that joint decisions require coordination among agencies and actors that may lack a history of such practice[25]. A corollary to this idea is that it is helpful to identify the additional benefits of a particular project or policy, to set priorities and justify expenses that on their own may not seem to provide sufficient benefit. Improving sustainability and resilience will require just such efficiencies and understanding, tailored to each situation at the appropriate scale[48].

This line of thinking also includes recognizing cross-scale interactions, such as practices implemented locally but providing benefits that largely accrue elsewhere. The disconnect can discourage innovation and efficiency, undermining sustainability as local and regional actors pursue their own misaligned interests. Making connections across scales can better link actions and outcomes and create incentives for innovation and improvement. Top-down approaches are also contrary to the letter and spirit of other UN Sustainable Development Goals[1], with the strong implication that 'solutions' imposed from outside a community are far less likely to be sustainable than those that are developed in the community or via partnerships with the community[43]. The Igiugig example supports this concept, with decisions made by the tribal government that take into account all domains, allowing them to consider long-term implications of their choices regarding FEW security and other matters important to the community and its residents.

Another important feature of any system is the potential for time lags between action and outcome. Starting direct flights from Anchorage to Igiugig or removing ferry service to Cordova will have rapid but not immediate effects on food security, as people learn to take advantage of the new service or work their way through existing supplies while figuring out alternative means of transportation. Changes in hunting regulations that result in more travel and thus higher fuel costs may take time to percolate through household and community practices. Such a change could mask a link between the regulations and, say, losing municipal water supply as a result of consumers being unable to pay utility bills. Loss of mail subsidies could lead to food substitution and poorer health outcomes over time, though food security may appear unaffected in the short-term[22]. Such lags and buffers have been seen in demographic responses to economic and environmental disruptions in rural Alaska[49,50]. In our study, we found a more complex system with more subtle interactions than we had anticipated. If rural Alaska is typical in this regard, managing for FEW security, sustainability and resilience will require even greater care and attention, as the potential for unintended disruption or misunderstanding of causes and effects is even higher.

A final point about nexus thinking is that cross-domain benefits include the intangible as well as the tangible. The hydrokinetic turbine in Igiugig or the wind turbines in Kongiganak provide excess power that can be used in a variety of tangible ways. Reducing diesel use and thus the community's carbon footprint can also increase residents' sense of agency and control over their own futures, inspiring them to undertake additional measures and innovations in other areas such as language retention, health and more. Communities that act on their own behalf may tend to take further action, creating a virtuous cycle of improvements that extend well beyond the initial activity, contributing in ways large and small to community sustainability and resilience. If FEW nexus thinking is used as a vehicle for achieving such outcomes at local scales, it offers much to rural, remote communities in Alaska and beyond.

Methods

This study followed an exploratory case study methodology[51], which is generally phenomenological in nature and as such fundamentally different from variable-oriented (explanatory) quantitative research[52]. Whereas the latter seeks to disaggregate variables from cases/individuals and look for relationships (for example, causation and correlation) among them, this study sought to discern the confluence of variables that, in whatever relationship to one another and in whatever specific contexts, best characterize the phenomenon in question: in this case, the nexus among rural Alaska food, water and energy systems at the local scale.

To gather community-level data, we used purposive sampling, which is effective for gathering informative information on a specific topic with limited resources[53]. Specifically, we conducted open-ended interviews in 2018 and 2019[54] with tribal and municipal leaders in each of the four partner communities, as well as with those responsible for food, energy and water systems, such as the operators of water and power plants and the owners or managers of local stores and greenhouses. Informed consent was obtained before the interviews. We interviewed ten people in Kongiganak in February 2018, 18 people in Cordova in March 2018, 19 people in Tanana in October 2018 and seven people in Igiugig in July 2019. We also conducted site tours of water and power plants, stores, greenhouses and other local infrastructure. These were led by local leaders and operators. Site visits are effective for eliciting situated and embodied information: for example, knowledge of interconnections among engineered food, water and energy systems[55]. Some interviews were recorded with video and we also wrote reports and blogs on the basis of our community visits (Data availability). We also held numerous follow-up conversations about our emerging observations with community members as a means of member-checking our findings[56]. In addition to the interviews and site visits in the communities, we held a stakeholders' workshop in Fairbanks in April 2018, involving municipal and tribal leaders as well as power plant operators from Cordova, Kongiganak and Tanana, plus the members of our research team. The workshop functioned as an additional opportunity to gather information and to member-check our understanding.

Community visits were done by two members of the research team with interviews conducted together and independently. Regardless, each took notes and afterward the notes were compiled and reviewed for accuracy by the researchers who travelled to communities. Notes from the workshop were also reviewed by several team members and community partners for member-checking as noted above.

Following Wolcott[57], interview transcriptions, field notes and workshop notes were coded, following a deductive coding scheme, for examples of two- and three-way interactions among food, water and energy systems, as well as for evidence of feedbacks and the presence of exogenous (higher-scale) drivers in mediating food, water and energy security outcomes. We also coded for the direction (positive = beneficial, negative = detrimental) and qualitative magnitude of these interactions. We used member-checking to validate the results of our coding, including these qualitative interpretations.

We adhered to the principle of qualitative grounding[58], the analogue in qualitative research to statistical power, to ensure the rigour and reliability of our interpretations. Briefly, qualitative grounding has three components: (1) sensitivity to context; (2) evidence of a critical view to the theories and methods being applied; and (3) rich and diverse theoretical grounding. To attend to local context, we relied heavily on input from local leaders to identify appropriate local experts to serve as participants and also included a diversity of experts on Alaska's food, water and energy systems on our team. Additional information concerning FEW interactions was obtained from the published literature and from websites of relevant agencies and organizations involved in FEW provision and related services in rural Alaska. The data were used to characterize the FEW systems in each community, including their main constraints and influences. Detailed findings are presented elsewhere[37] (and in papers forthcoming) as they are beyond the scope of this paper.

To maintain a critical view, we designed the research following established practices and procedures for doing collaborative, cross-cultural research in Arctic Alaska[59–61]. We also relied heavily on member-checking, through one-on-one conversations, the workshop and multiple repeat consultations with community partners during the drafting of this manuscript. Finally, to ensure diverse theoretical grounding, we followed Loring et al.[14]. in adopting a diagnostic approach that, rather than beginning with a specific framework or theory in an a priori sense, instead sought out diverse analytical framings from the existing literature to emphasize availability of, access to, suitability of and stability in food, energy and water across scales[18,29,62–64].

Ethics statement. This study was approved by the University of Alaska Fairbanks Institutional Review Board (no. 1368554) and the University of Alaska Anchorage Institutional Review Board (no. 1093666).

Data availability

This paper is based on data available in the form of reports, videos and blogs at the project website, http://ine.uaf.edu/microfews. Upon completion of the project, the data will be transferred to a permanent archive.

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