Communities ready for takeoff

Integrating social assets for biofuel site-selection modeling

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Abstract. **Although much of the social science literature supports the importance of community assets for success in many policy areas, these assets are often overlooked when selecting communities for new infrastructure facilities. Extensive collaboration is crucial for the success of environmental and economic projects, yet it often is not adequately addressed when making siting decisions for new projects. This article develops a social asset framework that includes social, creative, and human capital to inform site-selection decisions. This framework is applied to the Northwest Advanced Renewables Alliance project to assess community suitability for biofuel-related developments. This framework is the first to take all necessary community assets into account, providing insight into successful site selection beyond current models. The framework not only serves as a model for future biorefinery projects but also guides tasks that depend on informed location selection for success.**

Key words: Social asset framework, community capital, social capital, site selection, bio-fuel facilities

Concerns over climate change and other environmental issues have spurred public interest in and research into alternatives to fossil fuels. Despite the potential economic and environmental benefits of biofuel production and use, numerous concerns, including increased emissions, land-use change, feedstock competition, wildlife habitat, and other community issues, can prohibit successful implementation of biofuel production.[1,2,3] In order to reduce conflict over these concerns and improve success, site decisions for biofuel production ideally should be a two-stage process: (1) identifying biogeophysical assets as the "primary drivers"[4,5] and (2) assessing community characteristics (e.g., availability of local incentives and community enthusiasm).[6] However, community characteristics and other social assets are often inadequately addressed and, even worse, sometimes blatantly ignored. Considering that numerous studies have found community characteristics, such as social capital and participation, to be significant for sustainability,[7,8,9] examining these assets only superficially can be detrimental to successful sustainable biofuel production. This article adds a social dimension to the process of site-selection decisions, measuring both the suitability and readiness of communities to support biofuel infrastructure projects.

Building on the Community Capitals Framework (CCF) developed by Emery and Flora,[10] we argue that social assets, including social, human, and cultural capital, are vital to the success of highly technical environmental projects, including biofuel supply chain development, and must be included in site-selection analysis. Although we acknowledge that social assets do not ensure success on their own, they increase the likelihood of project success. Therefore, they should be considered by relevant stakeholders when selecting communities. However, social assets are often difficult to measure and assess. The goal of this research is to bond scientific disciplines and provide decision makers with the tools necessary to make more informed decisions on site selection for various projects. Our development of social asset benchmarks can be easily

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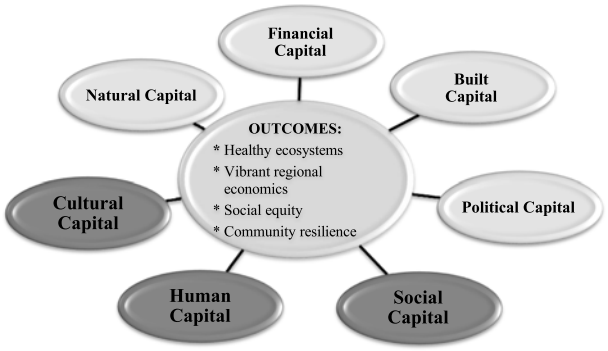

Figure 1. Community capitals framework. *Note:* Darker circles are the areas of interest in this study. Based on Emery and Flora, 2006, p. 21.

combined with other assets and offers an innovative, theoretically driven, and comprehensive instrument to make more successful site-selection decisions.

This work is organized as follows: First, we discuss the relevance of the CCF in site selection. Next, we discuss the three types of capital (social, cultural, and human) that are the focus of this project, reviewing the pertinent literatures for each. Third, we apply our approach for examining social assets to a current project, the Northwest Advanced Renewables Alliance (NARA), that seeks to develop a viable biomass-to-biofuel supply chain in the Pacific Northwest (PNW). Considering how vital site selection is to the sustainability of emerging biofuel and other alternative energy ventures, we conclude with a brief discussion as to how this article, which utilizes substantial interdisciplinary research to construct measures of community assets, supplies a meaningful guide for future site selection and successful implementation of sustainable projects.

Social assets and the Community Capitals Framework

Site decisions are vital to the success of environmental and economic projects, requiring consideration of various assets. While social assets are important for success, they have been difficult to incorporate and assess in terms of availability. Such concerns are not limited to social assets, as all resources need to be carefully examined. Although this can be an extremely daunting task for decision makers, the CCF provides a useful model for categorizing and assessing necessary resources for site selection.[11]

The CCF models community assets using seven types of capital, combining financial, biogeophysical, and social community resources (Figure 1). Providing a means to analyze community suitability for complex projects, the CCF uses a systems perspective that identifies important assets or types of capital. This framework provides substantial insight into the resources necessary for successful site selection, including natural, built, and financial capital, on which most analyses rely.

While consideration of these types of capital is necessary to ensure project sustainability and success, social, cultural, and human capital often are minimized or excluded completely when making these important decisions. Excluding these types of capital when making complex decisions may risk failure of the overall project. Indeed, communities have successfully organized against other alternative fuel facilities despite the perceived economic benefits of these facilities.[12] We use the CCF to elaborate on these three very important types of capital, which, if present in sufficient levels, contribute to community innovation and success.

Lending support to our assertion that social, cultural, and human capital must be included in site-selection decisions, Emery and Flora stress that of the seven types, cultural capital is very important for predicting successful outcomes. In addition, they contend that social capital is the foundation for a community to "spiral up," producing an increase in the other forms of capital.[13] Therefore, providing a tool for government actors, business leaders, and other important stakeholders to include these three types of hard-to-measure capital in their site-selection decisions will aid in the successful implementation of environmental and economic projects.

We provide detailed information about our measures of the three types of capital in the Methods section and in Table 1. With regard to the other types of capital, we provide some examples of measures used and applied in the NARA project. For built capital, we refer to infrastructure, roads, transportation, and existing usable buildings (e.g., located within one mile of roads and near a petroleum refinery). Financial capital includes all monetary resources that are available for investment. Within the site-selection decisions for biorefineries in the NARA project, natural capital includes natural resources and the environment, specifically, the proximity to appropriate material such as woody biomass (e.g., >50 kilo tonnes dry matter). Our model allows for implementation in other projects, and researchers are encouraged to use the values and measurements of built,

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Table 1. Measures of social, cultural, and human capital.

Community assets	Community asset assessment model
Social capital • Rupasingha, Goetz, and Freshwater, 2006	# Rent-seeking groups: political, labor, professional, and business organizations #Non-rent-seeking groups: civic organizations, bowling centers, golf clubs, fitness centers, sports organizations, and religious organizations # Nonprofit organizations % Voter turnout
Cultural capital • WESTAF	# Arts-related organizations # Arts-related businesses #Occupational employment in the arts $Revenues of arts-related goods and services
Human capital* • County Health Rankings	Health: % Low birth weight % Premature deaths % Obese (BMI >30) % Self-reports of poor health condition (physical and mental) Poverty % Poverty (and % children in poverty) % Uninsured % Unemployed % No access to health due to costs Education: % Between ages 25 and 44 with some postsecondary education Language: % Nonproficiency in English

Note: Table shows which variables were used to measure the community assets. All counts (#) and amounts ($) are calculated as a rate of the population per 10,000.
*We reversed the scores for human capital so that higher scores indicate more human capital. This was done for ease of interpretation and continuity among the three types of capital of interest.

financial, and natural capital that are appropriate and applicable for the project at hand.[14,15]

Social capital

Emery and Flora's contention regarding the importance of social capital receives much support in scholarly literature. Although the concept of social capital has long existed, Putnam's analysis of civic engagement and political involvement spurred more interest in it. Putman's arguments regarding social capital's positive influence on communities through cooperation and mutually supportive relations received attention as a key component in building and maintaining democracy.[16,17] Many scholars agree that social capital positively influences economic growth, promotes trust, and increases collective action through social networks and cooperation between individuals and groups.[18,19,20,21] Studies conducted within the Pacific Northwest confirm that social capital and other social assets contribute to community cooperation, successful project outcomes, and the implementation of new policies and procedures.[22,23,24] Social capital has been found to contribute to sustainability in U.S. cities[25,26,27] and to natural resource management,[28,29,30] and it is a predictor of environmental policy success variation.[31] While the influence of social capital depends on the policy instrument being utilized,[32] social capital is nonetheless an important factor in successful implementation of environmental policies.

While prior studies lend support to the hypothesis that social capital is important for project success,[33,34,35,36] one major obstacle is the lack of consensus on the definition and measurement of the concept. Because of this disagreement, a variety of measures are used to provide information about the level of social capital in a community. Several scholars have argued that social capital can be measured at the individual level.[37,38,39,40] However, Putman insists that such measures must be conducted at the community level and warns against aggregating individual-level measures.[41]

Similar to Putman, Rupasingha, Goetz, and Freshwater argue that the concept should be measured at the subnational or local level because social capital facilitates collective action, which is more prominent at these levels.[42] Providing one of the most complete and sophis-

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ticated measures of social capital at the county level, the authors give information on the density of associations within counties, the different types of organizations, voter turnout, and census response rates for the United States. They argue that education, racial homogeneity, the presence of family households with children, and community attachment all contribute to social capital at the county level.[43] Others emphasize the importance of social capital for economic development, building trust, and collective action.[44,45,46,47] Accordingly, social capital is a characteristic of the community as a whole, and therefore it is embodied in the community-level analysis used in this article.

Cultural capital

Emery and Flora also emphasize the importance of cultural capital to community success. It refers to traditions and languages of the community and influences creativity and innovation.[48] As with social capital, creativity and innovation can be difficult to measure and observe. Florida argues that creative communities are centers of diversity, innovation, and economic growth.[49] He develops a multifaceted measure of community creativity, the creative vitality index (CVI), which consists of four core attributes. The first attribute, the creative class, encompasses groups of people with jobs that require creativity, for instance, scientists, engineers, writers, poets, graphic designers, architects, and performers. Creative professionals in business, finance, law, health care, and related fields are also included in this measure.[50] The second critical attribute of creative vitality, innovation, is measured by analyzing the number of patents per capita. The third important trait is high-tech industry. Lastly, Florida includes diversity, measured by the "gay index" developed from census data, which the author argues is a reasonable proxy for an area's openness to different kinds of people and ideas. In Florida's overall county-level CVI, these four dimensions are weighted equally.[51]

Research examining sustainability projects has found creativity to be important for success.[52,53,54] However, while previous research only used certain components of the measure, we use the full CVI as a measure of cultural capital in order to assess creativity at the county level. The index, which includes all the components of creative vitality, will more fully capture creativity and innovation in the counties of interest.

Human capital

The last important social asset that needs to be considered in site selection is human capital. Human capital addresses the abilities, skills, and educational levels of people within the community.[55] Human capital, in combination with social capital, has been argued to be important for natural resource management.[56] According to Pretty and Ward, social and human capital have been "central to equitable and sustainable solutions to local development problems."[57] Others have argued for the inclusion of health measures (physical and mental) in relation to their work.[58,59] In conjunction with this literature, we include measures of community health, level of poverty, rate of unemployment, and level of education as indicators of human capital.

Clearly, much interdisciplinary research indicates that social, cultural, and human capital are vital to the success of community-level projects that require extensive collaboration. Increasingly, environmental and economic projects require collaboration among business and industry, government actors, nongovernmental organizations, and several other stakeholders to ensure success. These actors can use our tool to incorporate social assets into citing decisions which increases the likelihood of success. A previous study attempted to incorporate some CCF forms of capital to inform site selection of alternative jet fuel.[60] However, they utilized incomplete measures that do not fully capture these important social assets. Furthermore, their measures were not easily comparable across regions.

Following Martinkus *et al.*, we calculated reliability scores for a single social asset factor score based on their measures of the three types of capital. However, this scale was unreliable. Therefore, we argue that the three types of capital are distinct, and capital scores must be kept separate. Furthermore, the social capital score by Martinkus *et al.* included the sum of Olson groups — political organizations, labor organizations, business organizations and professional organizations — divided by the population in 1997. This excluded the Putnam groups, voter turnout and nonprofit organizations, which are important indicators of social capital. Their measure of creative leadership is also incomplete, excluding 60% of the complete CVI index. Lastly, the health measure combined three scores: the percentage of adults reporting fair or poor health, the number of reported physically poor days per month, and the number of reported mentally poor days per month for 2012. These three were combined into one added score

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without standardizing the original variables, which unfortunately leaves potential users of the model without any comprehensible or interpretable scores.

Our study moves beyond past research by providing a tool that can be used by all stakeholders to determine which communities are best situated to ensure the success of their projects. We develop more complete measures of social, cultural, and human capital that can be utilized for better decision making and better collaboration between various actors, which has been largely ignored or inadequately addressed in other studies. Although scholars have to collect appropriate data for the remaining types of capital in the model (political, financial, built, and natural capital), our tool provides the data necessary for social, cultural, and human capital.[61]

Case study: Northwest Advanced Renewables Alliance

NARA is researching the viability of a biomass-to-biofuel supply chain in the Pacific Northwest. The goal of the NARA project is to provide resources to inform the process of using Pacific Northwest forest residuals to create biofuels. The NARA team features cooperation between academia, government officials, and industry to develop an economically and environmentally sustainable biofuel industry in the Pacific Northwest. It offers a unique and interdisciplinary approach that combines insights from both natural and social sciences as a basis for site selection and project development.

In order to aid a more fine-grained analysis of the potential viability of supply chains, the project divides the Pacific Northwest into three subregions: the Western Montana Corridor (WMC), the Columbia Plateau, and the Mid-Cascade to Pacific (NARA, 2014). Each of these subregions has well-established and successful forest industry histories with sufficient forest residue to support and maintain a biomass-to-biofuel supply chain.

While the goal of NARA is to examine the potential for a biomass-to-biofuel supply chain in all four states, this study focuses on one subregion of NARA, the WMC, which includes selected counties in Montana, Idaho, and Washington (see Figure 2). The goal of this research is to apply and refine our community assets model prior to implementing it for other NARA regions and the entire United States.

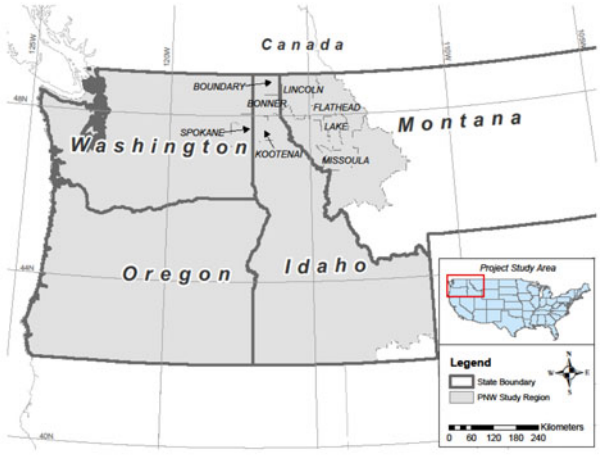

Figure 2. NARA regions: Western Montana Corridor, Cascades to Pacific, and Columbia Plateau, including the eight counties of interest in this study.

Methods

First, we develop cutoff points, or benchmarks, for each of the three types of community capital for the WMC. To examine the effectiveness of the model, we then conduct a retrospective analysis of similar projects in the Pacific Northwest that required a high level of community involvement and support for successful implementation. Essentially, we study "backward" to find factors that produce successful outcomes. Lastly, we apply our scores to a biogeophysical analysis conducted in previous research to identify potential communities for biofuel production facilities in the WMC.

In order to examine social, cultural, and human capital, we use existing datasets that include measures at the county level. We use publicly available datasets, namely, the County Health Rankings from 2013 (human capital),[62] the creative vitality index (CVI) from WESTAF 2010 (creative capital),[63] and the dataset collected by Rupasingha, Goetz, and Freshwater, which incorporates data for 1997, 2005 and 2009 (social capital).[64,65] We calculated scores for each social asset per county for the years available in our dataset. Table 1 provides more information on the indicators for each concept utilized in our study.[66]

The CVI measure, our indicator of cultural capital, is essentially a nationwide comparison measure set to 1; scores below 1 indicate that a county underperforms nationally, while scores above 1 indicate that a county outperforms. However, this prevents easy comparison among counties. Thus, we calculate how each region

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performs in comparison to the nation as a whole. Mean CVI index scores for each region of the United States (Northeast, Midwest, West, and South) were calculated, and the average scores for the West region were used as the lower acceptable boundaries for the counties in our analysis.

For parsimony, we calculated an aggregate *social capital* score per county based on data from Rupasingha, Goetz, and Freshwater.[67] The social capital score for 1997 consists of a combination of organizations, voter turnout, and nonprofit organizations (Table 1). This scale was reliable (Cronbach's alpha = 0.75), and an exploratory factor analysis resulted in a single factor solution (eigenvalue = 1.60) explaining 53.44% of the total variance. Factor loadings were acceptable ranging from 0.588 to 0.943. The same procedure was used for the measures of social capital in 2005 and 2009. Each county score of the three indicators was multiplied by its factor loading and added to represent one social capital score.

For *human capital* assets, we utilize data from 2013 to calculate two different scales, health and poverty. The original scales are based on indicators of negative assets (lack of health and lack of wealth), thus higher scores on the health scale indicated unhealthier counties while higher scores on the poverty scale indicated poorer counties. In order to make it easier to compare scores for each type of capital, we report reversed scores so that higher scores indicate healthier and richer counties. The six health indicators (obesity, low birth weight, potential years of life lost, and three different perceptions of health) formed a reliable health scale (Cronbach's alpha = 0.86) and an exploratory factor analysis resulted in a single factor solution (eigenvalue = 3.17) explaining 52.77% of the total variance. Factor loadings were acceptable ranging from 0.561 to 0.916. Again, for each county, the scores of the individual indicators were multiplied by their respective factor loadings and then added to arrive at one health score per county.

The poverty scale was created in a similar way. Four indicators were combined to represent the level of poverty in a county: percentage of the population uninsured, unemployed, children in poverty, and with no access to health care because costs. This scale was also reliable (Cronbach's alpha = 0.81), and an exploratory factor analysis resulted in a single factor solution (eigenvalue = 2.14) explaining 53.54% of the total variance. Factor loadings were acceptable ranging from 0.597 to 0.868.

In addition to the health and poverty scales, we included the percentage of adults with some postsecondary education and the percentage of people within the county who are not proficient in English. We kept these two indicators of education and language separate from the health scale because they relate to a different part of human capital. Once again, for ease of interpretation, we reversed the scores so that higher scores indicate higher human capital.

Our community asset assessment model assumes specific minimal boundaries for each type of capital in the framework. We calculated the lower limits of the capital scores by equating them to the average score within a geographic region. For these four main scales, we calculated lower minimal boundaries or cutoff points based on the average scores for the West census region (the location of our test cases). Because social capital fluctuates during the observed years, we included a cutoff point per capital per year. As our measures are based on the county level, we argue that a county has to score higher than the minimal boundary for each type of capital in order to qualify as a potential site for biofuel facilities. In other words, counties need to score higher than the average for their respective region for all social assets. We see this as a necessary condition that counties have to fulfill, but it is not a sufficient condition, as success is more likely but not guaranteed. We calculated different cutoff scores for various regions and selected the most appropriate average for our benchmark.[68] Because all our counties fall within the West census region, we selected the average score for each type of capital for the West census region as our minimal boundary. This selection makes it easier to compare across regions as well. The values of these scores are presented in Table 2, along with the minimum and maximum scores per capital. For ease of interpretation of the county scores in relation to their benchmarks, we normalized the scores in the results tables.

Analysis

Retrospective analysis

The retrospective analysis included past community-level projects occurring in the WMC region that required a high level of collaboration to succeed. The cases chosen, community-oriented policing projects, public health improvement, and enforcement of the Endangered Species Act, were evaluated by the Division of Governmental Studies and Services (DGSS)

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Table 2. Benchmarks/cutoff points of all types of capital.

Variable	Mean national $N = 3{,}108$	Mean west $N = 413$	Mean NARA region $N = 175$
Soc Cap 1997	−0.0008	0.3730	0.9540
Minimum	−5.18	−3.20	−1.87
Maximum	12.19	7.44	7.05
Soc Cap 2005	−0.0026	0.1099	0.6800
Minimum	−4.17	−3.25	−2.35
Maximum	21.56	10.20	5.69
Soc Cap 2009	−0.0043	0.0413	0.5660
Minimum	−4.29	−3.06	−2.51
Maximum	23.08	7.88	5.14
Health 2013	0.0838	−1.4247	−1.5405
Minimum	−7.66	−7.66	−6.18
Maximum	12.50	6.21	4.51
Obesity 2013	30.3%	25.8%	27.3%
Poverty 2013	−0.1473	0.3337	0.3319
Minimum	−5.65	−5.65	−3.76
Maximum	7.82	7.82	4.07
Education 2013	54.2%	58.0%	57.7%
Language 2013	1.8%	3.2%	2.2%
CVI Value 2006	0.484	0.673	0.525
CVI Value 2007	0.492	0.689	0.527
CVI Value 2008	0.493	0.699	0.543
CVI Value 2009	0.499	0.705	0.560
CVI Value 2010	0.491	0.686	0.542

Notes: Numbers represent averages based on raw scores. For ease of interpretation, we normalized these benchmarks by dividing them by themselves so that each benchmark is 1. Due to missing data in the health scale, we include the obesity raw scores (percentage of the population with a BMI of 30 or higher) as comparison. *Education* is the percentage of the population having some secondary (college) education, *language* is the percentage of the population that is not proficient in English. CVI data are derived from WESTAF. All are compared with a score 1, which reflects the nation as a whole (not to be confused with the national average). A score of 0.7 indicates that a county underperforms the nation as a whole by 30%, while a score of 1.3 indicates that a county outperforms the nation as a whole by 30%.

at Washington State University, a research unit that conducts project evaluation for entities in the Pacific Northwest. DGSS maintains detailed records of each evaluation, which enables an extensive examination of the factors that impact success. A team of coders examined each case and developed a protocol for determining how to measure success, which is typically gauged by qualitatively assessing whether community policing implementation improves disorder, crime, citizen attitudes toward police, and police–citizen relations, followed by an analysis of relevant capital scores for each community and average scores for the WMC region, the NARA region, and the nation.

The first set of cases for the retrospective analysis involves assessments of community policing in law enforcement offices in the Pacific Northwest. Executed by the Western Regional Institute for Community Oriented Public Safety (WRICOPS), 32 case studies were conducted between 1998 and 2006. Based on the reports of each case study, a team of coders rated each case as either a success or a failure based on five set dimensions of community policing. These five dimensions are vision, mission, and values of the organization; their goals; the organizational structure of the department or office; their internal climate; and the community environment. Community policing (COP) is a philosophy and an approach to policing that promotes the formation of partnerships among law enforcement, the public, and nonprofit agencies.

Using the five aspects of COP, the researchers evaluated whether the case could be assessed as a success or a failure in incorporating the COP philosophy and approach. Based on this analysis, two cases were selected as successes: the Post Falls Police Department in Kootenai, Idaho, and the Bellingham Police Department in Whatcom, Washington. In addition, two counties

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Table 3. Retrospective analysis of community capital, adjusted scores (raw scores divided by the cutoff score).

		WRICOPS community policing				Endangered species		Health	
Variable	Cutoff	Whatcom, WA Success 2004	Kootenai, ID Success 2000–01	Yakima, WA Failure 2006	Adams, WA Failure 2005	Walla Walla, WA Success 2005	Okanogan, WS Failure 2005	Lewis and Clark, MO Success 1999	Lake, MO Failure 1999
Soc Cap 1997	1.00	0.67	−1.42	−4.02	2.44	0.48	0.16	10.86	0.83
Soc Cap 2005	1.00	0.27	−7.10	−13.74	−1.55	−4.46	1.91	25.02	−1.00
Soc Cap 2009	1.00	−2.18	−19.37	−35.35	−13.80	−13.56	−0.97	60.53	2.66
CVI 2006	1.00	1.14	0.85	0.53	0.35	0.83	0.57	1.53	0.86
CVI 2007	1.00	1.13	0.90	0.54	0.30	0.78	0.53	1.42	0.74
CVI 2008	1.00	1.07	0.90	0.54	0.34	0.97	0.58	1.32	0.70
CVI 2009	1.00	1.08	0.79	0.56	0.24	0.84	0.60	1.34	0.69
CVI 2010	1.00	1.08	0.90	0.55	0.24	1.01	0.66	1.35	0.66
Health 2013	1.00	2.60	2.19	−0.75	−0.36	1.58	−0.53	1.35	0.14
Obesity 2013	1.00	1.02	1.00	0.91	0.85	0.96	0.98	1.03	0.98
Poverty 2013	1.00	2.79	−1.20	−6.86	−4.91	0.33	−7.79	7.37	−7.19
Education 2013	1.00	1.22	1.13	0.72	0.63	1.06	0.77	1.30	1.06
Language 2013	1.00	1.01	1.03	0.92	0.84	0.98	0.98	1.03	1.03
Population 1997		154,249	98,767	218,318	15,541	53,501	38,652	53,251	25,341
Population 2005		185,556	126,843	228,819	16,574	57,304	39,091	58,150	27,933
Population 2009		200,434	139,390	239,054	17,732	59,059	40,552	61,942	28,605
Population 2013		203,663	141,132	247,141	19,027	59,588	414,111	64,318	28,947

Notes: Numbers indicate the raw scores divided by the raw applicable cutoff score. Shaded cells represent scores that are better than the cutoff points. Cutoff scores are based on averages for the respective years and variables for the West region (U.S. census region) over 446 counties and divided by themselves so that all scores are comparable. For social capital and CVI scores, data from Alaska and Hawaii are missing. Because of missing data in the health scale for some of the counties, we added the raw obesity scores (percentage of the population with a BMI of 30 or higher) as comparison. See the online appendix for raw capital scores.

were selected as unsuccessful COP cases or failures: the Yakima County Sheriff's Office in Yakima, Washington, and the Othello Police Department in Adams, Washington.

The second project utilized in the retrospective analysis is a study conducted by Grott on projects focused on the improvement of public health through the coordination of health care services for the uninsured in Montana. The author found that interpersonal trust, civic engagement, and a strong sense of community contribute to cooperation for integrating client services and the development of access to appropriate health care education and services for the uninsured.[69] We use these findings to select an example of a successful community, Lewis and Clark County, and an unsuccessful community, Lake County.

Lastly, we examine a comparison of the success in enforcing the Endangered Species Act with respect to Pacific salmon recovery. In this study, the authors argued that social capital was a key element for success, basing this conclusion on surveys of residents, interviews with key stakeholders, and a series of focus groups.[70] Based on the authors' conclusions, we used Walla Walla, Washington, as a case of success and Okanogan, Washington, as an unsuccessful case in accomplishing fish protection actions in a collaborative process. Table 3 presents an overview of all eight case studies and their adjusted scores for the three types of capital. We normalized all the benchmarks and the scores in order to make interpretation of the scores easier. These normalized scores allow for an easier comparison of the counties and the types of capital. We equated all benchmarks or cutoff points to 1 (by dividing them by themselves) and divided all raw scores by their respective cutoff points. Scores below 1, including negative scores, indicate scores below the benchmarks, and scores above 1 indicate acceptable scores, as these counties have higher values on the types of capital than the required cutoff.[71]

Results from the retrospective analysis

The retrospective analysis shows that higher levels of each capital contribute to effective cooperation and successful project implementation. The scores in Table 3 represent the difference or portion of the county score from the cutoff point for each respective score. Scores

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Table 4. Case analysis of community capital in Western Montana Corridor, adjusted scores.

Variable	Cutoff	Bonner, ID	Kootenai, ID	Boundary, ID	Spokane, WA	Lincoln, MO	Lake, MO	Flathead, MO	Missoula, MO
Soc. Cap. 1997	1.00	0.35	−1.42	−0.38	−1.05	2.17	0.83	3.38	4.13
Soc. Cap. 2005	1.00	−2.73	−7.10	−6.64	−3.64	6.64	−1.00	8.92	19.84
Soc. Cap. 2009	1.00	−4.84	−19.37	−0.97	−14.29	18.64	2.66	16.95	45.52
CVI 2006	1.00	1.05	0.85	0.58	1.11	0.62	0.86	1.39	2.36
CVI 2007	1.00	1.44	0.90	0.44	1.10	0.64	0.74	1.50	2.30
CVI 2008	1.00	1.01	0.90	0.41	1.11	0.77	0.70	1.72	2.32
CVI 2009	1.00	0.96	0.79	0.39	1.08	0.75	0.69	1.61	2.36
CVI 2010	1.00	1.09	0.90	0.41	1.08	0.75	0.66	1.82	2.38
Health 2013	1.00	1.33	2.19	2.06	1.02	0.23	0.14	2.19	2.67
Obesity 2013	1.00	1.04	1.00	1.03	0.97	1.00	0.98	1.05	1.07
Poverty 2013	1.00	−5.27	−1.20	−7.25	2.01	−10.76	−7.19	−1.59	1.86
Education 2013	1.00	0.96	1.13	0.61	1.21	0.82	1.06	1.05	1.28
Language 2013	1.00	1.03	1.03	1.03	1.02	1.03	1.03	1.03	1.03
Population 1997		34,771	98,767	9,882	404,650	18,772	25,341	71,705	88,818
Population 2005		39,925	126,843	10,388	440,488	18,704	27,933	82,601	102,239
Population 2009		41,403	139,390	10,951	468,684	18,717	28,605	89,624	108,623
Population 2013		40,808	141,132	10,804	473,761	19,566	28,947	91,301	110,138

Notes: Numbers indicate the difference between the capital score per county and the applicable cutoff score. Shaded cells represent scores that are better than the cutoff points. Cutoff scores are based on averages for the respective years and variables for the West region (U.S. census region) over 446 counties. For social capital and CVI scores, data from Alaska and Hawaii are missing. Because of missing data in the health scale for some of the counties, we added the raw obesity scores (percentage of the population with a BMI of 30 or higher) as comparison. See the online appendix for averages of other regions and raw capital.

in gray are those that are above 1 and thus exceeded the cutoff points. In other words, these counties fulfill the requirement for success.

For the community policing cases, we see that creative vitality supports success. Even though the creative vitality in Kootenai does not exceed the cutoff point, it is much closer to the minimum boundaries than Yakima and Adams counties. The social capital scores do not seem to be as influential; however, the data do not reflect one important aspect of social capital, namely, trust and sense of community, which is also an important component of success. The indicators of social capital also reflect scores at the county level, and thus conclusions regarding the specific communities in question cannot be drawn. The lack of community-level data may explain why our scores for social capital in Walla Walla County are low, while Lovrich *et al.* concluded that social capital was crucial for success in this project.[72]

Unfortunately, we lack these individually measured indicators of social capital and therefore cannot include them in our analysis. Despite this shortcoming, our decision to take the average of the West region as the lower boundary places the social capital scores of Walla Walla County just below the cutoff point.

In contrast, the health project[73] is a great example for the community asset assessment model, as the successful county indeed shows higher levels of social capital, cultural capital, and human capital. Table 4 shows that Lewis and Clark County, the successful project, has scores above average on all three social assets, while scores for Lake County underperform.

Based on these cases and our retrospective analysis, we can conclude with caution that social, cultural, and human capital, as measured by our indicators — the CVI and the health and poverty measures — contribute to a higher likelihood of successful implementation of biofuel infrastructure development activities.

Communities ready for takeoff

Building on these findings, we continue our analysis by combining our social asset measures with the biogeophysical research conducted by Martinkus *et al.* to identify communities in the WMC with the necessary community assets for biofuel production facilities. Clearly, social assets alone do not predict which communities will be most successful in developing and implementing biofuel facilities; it is required to confirm that these communities have the necessary materials and infrastructure to make these projects economically feasible. The authors identified four biogeophysical assets necessary for economic and environmental sustainability: location in a region rich in biomass residuals to

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minimize transfer distance, location within one mile of a major road and/or rail, and location near a petroleum refinery to minimize distance from conversion facility to refinery.[74,75] In addition to these location requirements, the community has to have a population greater than 1,000 to ensure a viable workforce. Utilizing these requirements, eight counties in the WMC region have the minimal biogeophysical resources to be considered for biofuel facilities.[76,77] We apply our model of social assets to these counties in order to identify potentially successful communities for biofuel production facilities. The results are shown in Table 4, which includes again the converted cutoff points and accompanying capital score per county. Similar to before, gray scores indicate those scores that exceed the relevant minimal boundary and indicate counties that are more likely to be successful sites.

Social capital scores for three of four counties in Montana exceed the cutoff point for the West region. However, the cultural capital scores for only two of these three exceed the minimum boundary. In addition, two other counties, Spokane, Washington, and Bonner, Idaho, show high CVI scores. Most of the eight counties outperform the region in terms of health, poverty, and education — the human capital assets. Based on the levels of forest residue, approximate distance to refineries, and exceeding all social asset scores, the two counties in Montana seem to be the counties of choice for site selection for NARA biofuel activities in the WMC.

Conclusion

Social assets are often overlooked in site selection procedures, especially for the implementation of highly technical infrastructure projects. However, community assessment is an important component of site decisions, and the incorporation of social assets in these decisions can be critical to success. The goal of this study is to provide decision makers with the tools necessary to incorporate social, cultural, and human capital to aid site selection for highly technical projects. Using the NARA project to develop and refine the model, we have selected the following counties for biofuel activities in the WMC: Missoula, Montana, and Flathead, Montana. These communities have the highest likelihood of successful cooperation and implementation of NARA biofuel facilities. While we apply our community assets model to biofuel infrastructure activities in the Pacific Northwest, we contend that highly technical projects require community support and cooperation to succeed. Therefore, it is important to examine these types of capital because they are necessary, although perhaps not sufficient, for the success of such projects.

Our analysis showed higher CVI scores were repeatedly indicative of successful projects. While the strength of the relationship between social capital and project success is weaker than the CVI, social capital is an important sign for successful cooperation. Although human capital is not viewed as a potential cause of successful implementation of biofuels and similar projects, it is a requirement for the provision of a healthy workforce for these activities.

It is also important to note that high levels of social capital and creative vitality do not guarantee successful implementation. Success requires community support for these projects and decision makers must analyze community support for these projects prior to making their final decisions. However, communities need to meet the baseline measures of each capital to ensure that they have the means to engage in the cooperation and innovation that is necessary for these projects to succeed.

This research illustrates that community characteristics matter for the successful implementation of highly technical projects. Including these assets reduces the number of communities that ultimately are considered for particular projects and increases the likelihood that these projects will succeed. These projects require high degrees of cooperation, innovation, and resilience, which are often ignored or not adequately considered when making site selections. The data collected from various national sources provides the ability to create cutoff points for each region within the United States and will provide decision makers with an important tool to aid site selection. In addition, taking into account community characteristics can help persuade these communities that they are able to successfully develop and implement these projects.

It is important to note that our measures are derived from national datasets in the United States; however, we believe the indicators used to create our capital measures can serve as guidance to other researchers, particularly outside of the United States, who would like to replicate this work for site selection. Many of these indicators are collected internationally by various organizations and can be used to develop regional and community-level measures of capital to be tested and refined in other contexts. Thus, this research serves as an important step for developing quantitative measures

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of these assets to incorporate in site selection in various regions across the globe.

The model is also highly adaptable to ensure better comparison. Researchers can determine the appropriate regions for comparison in order to develop their own cutoffs. For cases clustered in a smaller area, researchers may choose to narrow the region used to determine the average capital score, rather than the entire West census region, thus better reflecting performance on these scores in the area of interest. The adaptability of this model ensures better comparison through appropriate consideration of context based on researcher knowledge.

Our model provides an important next step in providing tools for incorporating social capital, cultural capital, and human capital into site-selection decisions. Future research will examine other regions within the NARA project to refine and test the model. We will also extend this analysis beyond the NARA region and the Pacific Northwest to test its applicability in other regions of the United States. Projects that do not utilize these important tools for identifying communities with the necessary social assets risk failure rather than optimizing the likelihood of success.

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