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Generic and specific facets of vulnerability for analysing trade-offs and synergies in natural resource management

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Abstract

1. The concept of vulnerability as the combination of exposure, sensitivity and adaptive capacity to a stressor is gaining traction outside of the climate realm, opening new avenues to address contemporary sustainability issues more holistically. Yet, critical notions that underpin vulnerability have yet to be integrated into its application to natural resource management and non-climatic stressors. In particular, the way generic and stressor-specific facets of vulnerability interact and can inform decision-makers about how interventions combine and/or trade-off remains unexplored.
2. Here, we investigate the salience of the generic/specific framing in the context of Chilean artisanal fishing communities engaged in rights-based co-management and experiencing pressures from two stressors: poaching and market volatility. Specifically, we draw on market data combined with socio-economic surveys conducted with 446 members and leaders from 42 fisher unions to quantitatively investigate potential trade-offs and synergies between facets of vulnerability to poaching and markets.
3. Generic adaptive capacity (i.e. flexibility, assets, learning, organization and agency) likely facilitated stressor-specific adaptive capacities to both stressors. High levels of specific adaptive capacity to one stressor neither increased exposure nor undermined specific adaptive capacity to the other stressor. However, adaptive capacity did not translate into exposure reduction as expected, suggesting that adaptation barriers may prevent fishers from mobilizing adaptive capacity into effective adaptive action.
4. This study illustrates how breaking down vulnerability into generic and specific facets can help us better anticipate important trade-offs and synergies in management interventions. More generally, it highlights the potential of the climate

adaptation and vulnerability literatures in informing place-based management of natural resources.

KEYWORDS
barriers to adaptation, co-benefits, maladaptation, markets, place-based management, poaching, social-ecological systems, trade-offs

1 | INTRODUCTION

Increasingly, communities around the world are experiencing a wide array of interwoven socio-economic and biophysical changes, including shifting market conditions, governance transformations, environmental degradation and climate change (Cottrell et al., 2019; O'Brien & Leichenko, 2000; Scheffers et al., 2016). Yet, when communities are exposed to multiple stressors, identifying synergistic leverage points, and avoiding antagonistic ones, is critical to effectively reduce vulnerability—that is, the degree to which an entity is likely to experience harm as a result of exposure, sensitivity and adaptive capacity to a driver of change (IPCC, 2001; 2007; Adger, 2006).

The concept of vulnerability has contributed to an emerging body of research and practice built on managing social–ecological systems more holistically. Although developed by the linked literatures of risk and hazard, political ecology, and resilience to address issues about risks and potential impacts of climate-related stressors (Adger, 2006; Eakin & Luers, 2006; Kasperson, Kasperson, & Turner, 2005; Turner et al., 2003), vulnerability has recently been applied to other key themes of the contemporary sustainability discourse. The vulnerability construct has, for example, been operationalized in the context of globalization, based on a convergence of language and approaches between climate and economic changes (Leichenko & O'Brien, 2002; O'Brien & Leichenko, 2000; O'Brien et al., 2004). Likewise, the incorporation of vulnerability perspectives with ideas from commons scholarship has provided practical insights to address problems surrounding management changes (Chen & Lopez-Carr, 2014; Chen, López-Carr, & Walker, 2014; Tilley & López-Angarita, 2016) and resource exploitation (Thiault et al., 2018a; 2018b). The momentum around the possibility for managing vulnerability by targeting each dimension (i.e. reducing exposure, decreasing sensitivity, building adaptive capacity, or a combination of those) has opened an exciting space for managers and policy makers to contribute towards more integrated management of social-ecological systems.

Despite the important potential of this emerging body of work, the use of the vulnerability construct outside of the climate circles still lacks empirical demonstrations. In particular, it is all too often assumed that any action targeting a particular source of vulnerability will invariably contribute to vulnerability reduction. However, this omits the possibility that, depending on socio-economic conditions, structural factors, and the specific stressors at stake, different features can have different implications for vulnerability. The climate vulnerability literature points to two forms, or facets, of vulnerability and its dimensions. *Generic* facets are a core set of determinants that make people more (or less) vulnerable across a multitude of stressors. At the community scale, they are generally related to structural properties within societies, with examples such as assets, social organization or flexibility (Cinner et al., 2018; Eakin & Lemos, 2006). These contrast with *specific* facets that reflect the conditions and factors enabling people or communities to confront a particular stressor. In the context of climate change, these are elements critical for effective risk management such as the use of local low-yielding but climatically robust plant varieties (Eakin, Perales, Appendini, & Sweeney, 2014), diversification of resource or livelihood portfolios (Cline, Schindler, & Hilborn, 2017), or flood dikes (Næss, Bang, Eriksen, & Vevatne, 2005).

Understanding how generic and specific facets of vulnerability interact can reveal key avenues to sustainability and help avoid redundant or conflicting interventions (Eriksen & Brown, 2011). While sustainable adaptation to a particular stressor requires high levels of both generic and specific adaptive capacities (Eakin, Lemos, & Nelson, 2014), avoiding trade-offs between these two facets remains a key challenge. Weak institutions and poverty (i.e. low generic adaptive capacity) can for instance undermine or prevent proactive risk management locally (i.e. specific adaptive capacity). Conversely, building generic capacity does not automatically guarantee that people will adapt effectively. Indeed, communities may be too reliant on these generic safety nets and become complacent, may not perceive the need to invest in stressor-specific capacity, or may be unable to mobilize their capacity into effective action due to adaptation barriers (Adger & Barnett, 2009; Barnett et al., 2015; Eakin & Bojórquez-Tapia, 2008; Lemos et al., 2013; Næss et al., 2005; Pomeroy, Ferrer, & Pedrajas, 2017; Saldaña-Zorrilla, 2008). Further, adaptation strategies aiming at reducing vulnerability to one stressor may also influence vulnerability to other stressors (McDowell & Hess, 2012) because it can increase exposure to new stressors, or erode or redistribute means available for other specific adaptation (Bacon, Sundstrom, Stewart, & Beezer, 2017; Belliveau, Smit, & Bradshaw, 2006; Roncoli, Ingram, & Kirshen, 2001). Despite its critical relevance to evaluate potential trade-offs and synergies between various interventions, the generic/specific framing in assessments of vulnerability to non-climatic stressors and natural resource management has remained largely unexplored.

To address this gap, we investigate multiple vulnerabilities in relation to Chilean fisher unions, which are considered as one of the world's first artisanal fisheries co-managed at the national level, but which are critically undermined by two key non-climatic stressors:

poaching and market forces. Indeed, costs associated with surveillance and poaching, and resource price fluctuation, which were perceived as the two most important problems by fishers (Gelcich et al., 2017), highlight the pressing need for tackling these issues in order to improve management. Using a combination of market data and 446 semi-structured interviews with leaders and fishers from 42 unions, we examined the associations between generic and specific facets of vulnerability in the context of poaching and markets. Specifically, we asked three linked research questions that are critical for informed decision-making: (a) Does generic capacity building translate into specific adaptive capacity? (b) Does specific adaptive capacity lead to direct adaptive action that reduces exposure? and (c) Does building adaptive capacity to one stressor increase vulnerability to the other? Our overarching goal is to move towards more robust and empirically grounded vulnerability-based management approaches in the context of non-climatic stressors, and more generally to stimulate thinking on how concepts from the climate literature can inform natural resource management.

2 | MATERIALS AND METHODS

2.1 | Case study

The Chilean artisanal fleet lands more than 50% of overall marine resources in the country. A subset of the artisanal fleet composed by approximately 35,000 fishers operates a Territorial Use Rights for Fisheries (TURF) system, possibly one of the best examples of a nationwide implementation of co-management principles (Gelcich et al., 2010). This system provides fisher unions with exclusive rights to exploit marine resources in geographically defined management areas, but also to access to the sea, land boats and construct certain buildings on the coastline (Gelcich, Edwards-Jones, & Kaiser, 2005). Resources harvested from the TURFs are subject to total allowable catch defined by the government, and unions are accountable for the stock assessments. While TURFs can provide the conditions for long term sustainability in Chile (Castilla, 2010; Gelcich, Godoy, Prado, & Castilla, 2008; Gelcich, Martínez-Harms, Tapia-Lewin, Vasquez-Lavin, & Ruano-Chamorro, 2019), a number of challenges remain (Figure 1).

Perhaps the most salient and persistent challenge relates to poaching and enforcement costs within TURFs, which is considered as a widespread problem by unionized fishers across Chile (Gelcich et al., 2005;). Illegal fishing within TURFs concerns free riders who are not part of the union (external poaching), but also union members (internal poaching) that engage in resource extraction under the minimum legal size, beyond quota limits or during fishing closures (Oyanedel, Keim, Castilla, & Gelcich, 2018). Internal poaching is overseen by the unions themselves, which monitor, apprehend and apply penalties to members that infringe federal management and collectively agreed-upon internal rules. Enforcing external poaching, on the other hand, involves a two-tier scheme in which unionized fishers notify the government agencies of any observed breaches, with the latter being responsible for apprehending and penalizing poachers. In practice, most of the high economic and social costs associated with poaching prevention are shifted to the fishers, which combined with a weak enforcement agency and sanctioning

FIGURE 1 Many artisanal fishing communities in Chile are organized into unions through Territorial Use Rights for Fisheries (TURF) (a). Poaching within TURFs from union members and outsiders, however, represents a significant challenge to the sustainable management of the resources (b). The majority of catch is landed for sale to markets, which makes selling prices tightly linked to market fluctuations (c). The vulnerability of fisher unions to these two key stressors ultimately depends on their exposure, sensitivity and adaptive capacity

system, can lead to ineffective enforcement that ultimately undermines TURF outcomes and fishers livelihood (Gelcich et al., 2012). Design principles for community-based natural resource management suggest that conflict resolution mechanisms, clear boundaries and graduated sanctions represent an effective response to poaching (Cox, Arnold, & Villamayor, 2010; Ostrom, 1990). Empirical work in Chilean artisanal fishing communities also highlighted the pivotal role of surveillance effort, involvement of union members in monitoring, and communication with government agencies as key adaptation pathways to poaching at the union-level (Davis, Kragt, Gelcich, Burton, et al., 2015; 2015; Gelcich et al., 2017; Oyanedel et al., 2018).

Another pervasive stressor is market forces. Chilean artisanal fisheries are typically based on high-value species, 95% of which are sold to markets. As a consequence, prices for most resources are directly coupled with the international seafood trades (Castilla, Espinosa, Yamashiro, Melo, & Gelcich, 2016; Defeo et al., 2016) and may easily increase or decrease threefold from one year to another, depending on global market conditions. High market price volatility directly exposes fishers to the inconsistency of new markets and demand and often coincides with exposition to unmanageable price fluctuations, ultimately impacting fishers' income (Béné & Doyen, 2000; Crona et al., 2016). In addition, fishers typically have a choice between transporting their catches to the nearest marketplace, and selling them to middlemen who travel between unions and markets. For remote unions, uncertainty about market prices is usually high and middlemen may take advantage of fishers' ignorance over market prices and extract a rent from them by offering very low prices for their catch. The linkages between the fishery and global trade can also result in strong and persistent price drops that can significantly influence benefits union members get from their TURF. For example, Chilean export prices of key TURF species such as the loco (*Concholepas concholepas*) have dropped considerably following the development of aquaculture farming for the abalone (*Haliotis* spp.), a substitute species in the global market (Castilla et al., 2016). In response to market changes, and although long- and short-term prices fluctuations are decoupled from direct local management practices, unions can invest in various strategies to reduce their exposure to markets impacts. For instance, they may diversify catch and gear to adapt their catch to price changes (Aguilera et al., 2015; Cline et al., 2017; Defeo et al., 2016), improve communications with marketplaces (Jacinto & Pomeroy, 2011), and develop trust and reciprocity with the middlemen to increase their bargaining power when selling products (Pomeroy & Andrew, 2011; Ponte, Raakjaer, & Campling, 2007).

2.2 | Conceptualizing social vulnerability in natural resource management

To evaluate fisher unions' vulnerability to markets and poaching, we used the vulnerability framework developed in the IPCC's Third (IPCC, 2001) and Fourth (IPCC, 2007) Assessment Reports using a top-down/quantitative approach (Brugère & De Young, 2015). The IPCC framework describes vulnerability broadly in terms of exposure, sensitivity and adaptive capacity. These three sweeping concepts—or *dimensions*—are useful because they encompass the broad diversity of entities and stressors that may be considered in a vulnerability assessment (Tonmoy, El-Zein, & Hinkel, 2014). Each *dimension* is however multifaceted and potentially context-specific. Therefore, most evaluations further break down each first-tier variables (the *dimensions*) into second-tier variables, here called *domains* (Carpenter & Brock, 2004; Cinner et al., 2018; Marshall, Fenton, Marshall, & Sutton, 2007; Marshall & Marshall, 2007). The *domains* are the features of the system's *Dimension* that are most critical to conferring vulnerability in the particular context of the study. They are heuristics that help practitioners organize their inquiries of vulnerability and, while there are no 'correct' *domains*, it is crucial that they fit the context of the study, and are anchored in relevant theories. Bellow, we describe each *dimension* and associated *domains* and *facets* (generic vs. stressor-specific) with a focus on situations relevant to natural resource management and non-climate stressors.

In its most broad sense, the *Exposure* dimension assesses the magnitude, frequency, duration and/or extent in which people are in contact with, or subject to, a particular stressor (Kasperson et al., 2005). Therefore, exposure is by essence stressor-specific. People can be exposed to stressors in a direct manner, for example in the case of earthquakes, diseases or fire risk. In most cases relevant to natural resource management, however, stressors are considered via their impact on one or more elements linking ecosystems to users' well-being (Daw et al., 2016). In our case for example, exposure to poaching, which includes all forms of illegal fishing within TURFs, does not affect fishers directly but instead alters the condition of the resource fishers depend upon. Likewise, market price variability may affect fishers' well-being indirectly via impacts on the benefits (i.e. income) fishers derive from catch sell.

The *Sensitivity* dimension captures the set of conditions and characteristics that mediate people's propensity to be influenced by the *Exposure* (Bousquet et al., 2015). When exposure involves a direct pathway, sensitivity is not separable from exposure and is thus stressor-specific (Smit & Wandel, 2006). For example, sensitivity to earthquakes, diseases or fire exposure are not determined by the same features. When stressors affect people indirectly via impacts on the chain linking ecosystems to human well-being (Daw et al., 2016), sensitivity is primarily determined by the degree to which people rely upon this chain (Daw et al., 2016; Depietri, 2019; Thiault et al., 2018b), or ecosystem services dependency. Dependency is multifaceted and, depending on the focus of the study, may include nutritional, economic, social, cultural, psychological *domains*, or a combination of those (Marshall et al., 2017; Selig et al., 2019). Where is the appropriate place to draw the line between *Sensitivity* that is generic or stressor-specific? This needs to be defined with reference to the scope of research being undertaken: a broad perspective on vulnerability would consider sensitivity as stressor-specific (for example, markets and poaching could be considered separate stressors and thus sensitivity could be specific to each). Alternatively, a natural resource management perspective would consider stressors as specific or generic based on whether they have similar or different impact pathways (i.e. chain of elements linking ecosystems to human well-being), respectively (Allison et al., 2009; Cinner et al., 2013, 2012; Hughes et al., 2012; Islam, Sallu, Hubacek, & Paavola, 2014; Marshall, Marshall, & Abdulla, 2009; Thiault et al., 2018b). In our case, we adopt the latter perspective, and treat sensitivity as generic to the two stressors we examine (because they both occur through the same impact pathway), but these would clearly not be generic to other categories of stressors such as earthquakes.

The *Adaptive capacity* dimension captures people's ability to confront or address changes by mitigating, coping with, and recovering from the potential impact (i.e. the combination of exposure and sensitivity) of a stressor. At the community level, adaptive capacity has both generic and specific *facets* (Eakin, Lemos, et al., 2014; Lemos, Lo, Nelson, Eakin, & Bedran-Martins, 2016) that can be reflected in five key domains (Cinner et al., 2013): The *flexibility* domain captures the opportunities that communities have for switching between adaptation strategies, while the *agency* domain reflects their ability to have free choice in responding to change. To adapt, people can also draw upon individually owned and public goods such as financial, technological, and service resources; these are captured in the *assets* domain. The *organization* domain captures the formal and informal ways in which individuals are organized to enable cooperation, collective action, and knowledge sharing, and reflects trust and social cohesion within the community. Finally, the *learning* domain assesses people's capacity to generate, absorb, and process new information about current and future stressors, adaptation options, and ways to live with and manage change.

2.3 | Operationalizing social vulnerability to poaching and markets

In the context of this study, fisher unions' vulnerabilities to poaching and markets entails stressor-specific exposure, generic sensitivity, and generic and specific adaptive capacity (Figure 2).

We operationalized vulnerability (Figure 2) using measurable indicators collected in 2014 as part of a socio-economic survey conducted in 42 Chilean fisher unions engaged with the TURF regime. Overall, our study area covers all 12 coastal regions between Arica (North) and Los Lagos (South), spanning a 2,700 km coastline where most unions concentrate (Gelcich et al., 2017). In each study site, we conducted two different types of semi-structured interviews to capture union-scale (where there exists only one value per fisher union) and individual-scale (where there are different observations for each fisher) information. For the union-scale aspects, we interviewed one leader of each fisher union (n = 42). For the individual-scale aspects, we targeted a random sample of 10 fishermen from these unions. The number was achieved in 39 unions but only seven and three fishers were respectively surveyed in two and one unions as fishers were unwilling to participate in one union and overall number of fishers actively working in the other union constrained sample size. A total of 407 complete individual surveys were obtained. Both questionnaires included multiple choice questions, ranking exercises and Likert-type scale responses, and were conducted in Spanish by four trained interviewers. All interviews were recorded anonymously with free and prior informed consent. Participants were informed of the research objectives and use of data, and were given contact information as well as the option not to answer any question or leave

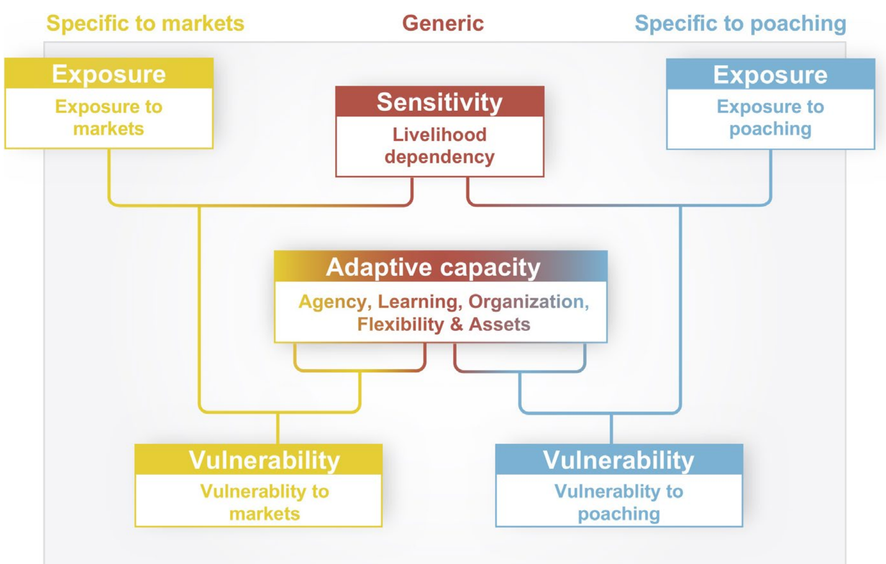

FIGURE 2 IPCC's vulnerability framework adapted for our multi-stressor assessment in the context of natural resource management. Here, exposure refers to the extent to which a fisher union is subject to a stressor and sensitivity refers to the fishers' dependency on the ecosystem services for livelihood. Adaptive capacity refers to their ability to confront changes by mitigating, coping with, and recovering from exposure and sensitivity, and has both generic and specific facets. Note that we narrowly consider sensitivity as generic since, in our context, stressors affect people via the same impact pathway. One might consider sensitivity as specific if exposure involves unique impact pathways. Yellow: market-specific; blue: poaching-specific; red: generic

the survey when they wished. The study and its methodology were approved by the Pontificia Universidad Católica Ethics Committee (reference 150730011). In addition to interviews, we obtained market data from the Chilean Undersecretary of Fisheries (SUBPESCA), which consisted of monthly species prices and landings between January 2005 and January 2015 at the national- and union-level, respectively.

Together, interviews and market data provided quantitative information on 17 theoretically- and empirically grounded indicators that inferred indirectly on various domains of generic and specific facets of vulnerability dimensions (Table 1 and Supporting Information). When possible, several indicators were used to depict particular domains in order to reduce the effect of potential mismeasurement and triangulate more accurate values. For sensitivity, we were only able to capture the economic dependency domain with a single indicator. We were able to include the five domains of generic facets of adaptive capacity with one or two indicators each. We only incorporated domains of specific adaptive capacity for which we had empirical evidence. These include the role of assets such as support for surveillance (Arias, Pressey, Jones, Álvarez-Romero, & Cinner, 2016; Davis, Kragt, Gelcich, Schilizzi, et al., 2015; Oyanedel et al., 2018) and organization through graduated sanctions to adapt to poaching (Cox et al., 2010; Ostrom, 1990), as well as flexibility and organization via increased gear diversity and collective bargaining power, respectively, to respond to market changes (Béné, Macfadyen, & Allison, 2007; Cline et al., 2017; Matsue, Daw, & Garrett, 2014).

Each of the 17 indicators was standardized to a scale ranging from 0 (minimum possible value) to 1 (maximum possible value) following Gustafson et al., (2016). We aggregated indicators using the TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution; Tzeng & Huang, 2011) method. We used a hierarchical weighting scheme designed so that (a) each *dimension* contributes equally to vulnerability and (b) the relative contribution of each indicator to each *dimension* depends on the total number of such indicators analysed under a particular *domain* nested in a particular *facet* (Table 1; see Figure S1 for illustration of the weighting scheme). We analysed unions' vulnerability to poaching and markets at two aggregation levels: at the *facet*-level (i.e. generic adaptive capacity and sensitivity, specific exposure and adaptive capacity to poaching and specific exposure and adaptive capacity to markets) and at the overall vulnerability-level (i.e. vulnerability to poaching and vulnerability to markets). This yielded facet- and overall vulnerability-level scores for each fisher union which we finally standardized between 0 (lowest possible score) and 1 (highest possible score) for ease of interpretation. See Supporting Information for full details on aggregation and weighting methods.

2.4 | Examining interactions among vulnerability facets

Previous studies exploring the interactions between generic and specific *facets* of vulnerability have tended to focus on few study sites using in-depth longitudinal data (Belliveau et al., 2006; Lemos et al., 2016; McDowell & Hess, 2012; Nelson, Lemos, Eakin, & Lo, 2016; Roncoli et al., 2001). Such design enables to compare how *facets* changed following a disaster or an intervention targeting a particular *facet*. In our case, however, it was not feasible to identify a strict "before" period given the long history of many fisher unions (Gelcich et al., 2017), the long-lasting manifestation of poaching and market forces, and the absence of policy interventions specifically designed to tackle these issues. Our study design however includes a range of fisher unions with different local socio-economic arrangements (Gelcich et al., 2017) that may lead to a variety of vulnerability configurations. This heterogeneity may in turn unveil how various configurations of vulnerability *facets* can or cannot co-occur. Drawing on generalized ideas about adaptation and vulnerability to climate change, we identified three concerns that could potentially hinder vulnerability-based management in natural resource management settings (Table 2).

The first concern relates to the interplay between generic and specific adaptive capacities. Indeed, the two facets of adaptive capacity can sometimes be mutually exclusive (Lemos et al., 2013). In our fisheries context, this trade-off situation may for instance occur if, in response to markets exposure (i.e. lower or highly volatile revenue from landings), unions rely too much on generic adaptive capacity (e.g. assets, social safety nets, etc.) and do not develop stressor-specific adaptive capacity that would help them altering exposure more directly (e.g. improving bargaining power and gear diversity to negotiate better selling prices with the middlemen and adapt their catch composition to market demand, respectively). In such a case, specific and generic adaptive capacities would be associated negatively. Conversely, adaptive capacity may also involve a co-dependent, or synergistic association between generic capacity and its specific counterpart (Brooks, Adger, & Kelly, 2005; Lemos et al., 2013; 2016), for instance if generic adaptive capacity is channelled effectively to build specific adaptive capacity. This would be reflected here by a positive relationship between generic and specific capacities.

The second concern relates to the case where specific adaptive capacity does not lead to direct adaptive action. Fisher unions with high specific adaptive capacity have the means to directly alter their exposure, because they are both operators and receptors of their adaptive actions (Eisenack & Stecker, 2012). Just like in the example of markets above where gear diversity and bargaining power may enable fishers to reduce the effect of markets on their livelihood, fishers can potentially mobilize poaching-specific adaptive capacity (e.g. increase surveillance effort and use graduated sanctions) to reduce their exposure to poaching (e.g. reduced illegal fishing from outsiders and insiders, respectively). In this case, specific adaptive capacity to a stressor would be negatively associated with exposure to that same stressor. However, adaptation barriers and missing 'mobilizing factors' may prevent adaptive capacity to translate into actual adaptive action (Adger & Barnett, 2009; Eisenack & Stecker, 2012). For instance, even with the best adaptive capacity available, fisher unions may fail to perceive the need to adapt, or may not employ it effectively enough to markedly alter their exposure. This would create a positive or neutral relationship between specific adaptive capacity and exposure to the stressor.

TABLE 1 Rationale and source of the indictors used to operationalize vulnerability dimensions, facets and domains of fisher unions in the context of market volatility and poaching

Dimension	Facet (stressor)	Domain	Indicator	Rationale	Source	Weight Increases (+) or decreases (−) vulnerability
Exposure	Specific (poaching)	Exposure to poaching	Internal poaching	Poaching by union members may occur in various forms: resource extraction under the minimum size; exceeding quota limits or fishing during closures (Oyanedel et al., 2018).	Union leaders	0.5 (+)
Exposure	Specific (poaching)	Exposure to poaching	External poaching	Fishers who are not part of the union may engage in illegal fishing within a union's TURF (Davis, Kragt, Gelcich, Burton, et al., 2015; Davis, Kragt, Gelcich, Schilizzi, et al., 2015).	Union leaders	0.5 (+)
Exposure	Specific (markets)	Exposure to market forces	Landed value trend	Progressive reduction of market prices affects the catch's long-term value of the species targeted, and thus undermines fishers' livelihood through reduced income (Castilla et al., 2016).	National Fishery Service	0.5 (+)
Exposure	Specific (markets)	Exposure to market forces	Landed value volatility	Shorter-term market price changes can be a boon for income generation, but predominately coincide with exposition to unmanageable price fluctuations (Crona et al., 2016), ultimately impacting the livelihood of resource users (Béné & Doyen, 2000).	National Fishery Service	0.5 (+)
Sensitivity	Generic	Livelihood dependency	Dependency on fishing	For communities directly reliant on ecosystem services for livelihood, resource dependency is a critical determinant of communities' sensitivity to environmental change (Marshall, Marshall, & Abdulla, 2009; 2017; Daw et al., 2016). People whose livelihood depends on the ecosystem are more likely to be harmed if the chain linking ecosystem to their livelihood (e.g. ecosystem condition, good, value) is undermined by a stressor.	Fishers	1 (+)
Adaptive capacity	Generic	Learning	Education	Universal primary and secondary education is key to adapt to various stressors, including droughts, tsunami, storms and climate change (Lutz, Muttarak, & Striessnig, 2014; Muttarak & Lutz, 2014).	Fishers	0.1 (−)
Adaptive capacity	Generic	Flexibility	Occupational multiplicity	People with multiple livelihood activities can minimize losses by shifting into different occupational sectors, either temporarily or permanently, in response to exposure (Allison & Ellis, 2001; Cinner & Bodin, 2010; Torell et al., 2017).	Fishers	0.1 (−)
Adaptive capacity	Generic	Assets	Infrastructure	Can inform on the community-scale socio-economic development and thus reflects the unions' ability to access particular goods and services necessary to adapt (Aguilera et al., 2015; Cinner et al., 2009).	Union leaders	0.05 (−)
Adaptive capacity	Generic	Assets	Material style of life	Reflects the fishers' relative wealth or social status within the community (Pollnac & Crawford, 2000), and thus their ability to access particular goods and services to adapt.	Fishers	0.05 (−)
Adaptive capacity	Generic	Organization	Trust	Agreeing on coordinated action to respond to numerous stressors requires trust between the community members (Matera, 2016).	Fishers	0.05 (−)
Adaptive capacity	Generic	Organization	Social capital	Social cohesion through sustained interaction among groups can play a key role in whether or not people will support each other in times of need (Gutiérrez, Hilborn, & Defeo, 2011; Marin et al., 2012; Rosas, Dresdner, Chávez, & Quiroga, 2014).	Fishers	0.05 (-)

(Continues)

TABLE 1 (Continued)

Dimension	Facet (stressor)	Domain	Indicator	Rationale	Source	Weight Increases (+) or decreases (−) vulnerability
Adaptive capacity	Generic	Agency	Involvement in decision-making	Implication in decision-making empowers union members to trigger adaptive responses to change through collective action and self-organization (Coulthard, 2012; Nenadovic, Basurto, & Weaver, 2016). Plays a central role in mobilizing other domains of generic adaptive capacity.	Fishers	0.1 (−)
Adaptive capacity	Specific (poaching)	Organization	Graduated sanctions	Maintaining proportionality between the severity or the repetition of violations of community rules (i.e. poaching) deters participants from excessive violations while helping to maintain community cohesion (Agrawal, 2001; Cox et al., 2010; Ostrom, 1990).	Union leaders	0.25 (−)
Adaptive capacity	Specific (poaching)	Assets	Surveillance intensity	Effective monitoring within managed areas increases the chances to identify and catch offenders (Arias et al., 2016).	Union leaders	0.125 (−)
Adaptive capacity	Specific (poaching)	Assets	Support for surveillance	Responsive and frequent action from government agencies in regards to monitoring and apprehension and penalization of fishers from outside the fisher union increase the expected cost of illegal fishing and may encourage more enforcement by union members (Davis, Kragt, Gelcich, Schilizzi, et al., 2015; Gelcich et al., 2017; Oyanedel et al., 2018).	Union leaders	0.125 (−)
Adaptive capacity	Specific (markets)	Organization	Bargaining power	Collective bargaining power enable fishers to negotiate selling prices of their catch with the middleman, which can help fishers minimize losses or even take advantage of prices changes (Pomeroy & Andrew, 2011; Ponte et al., 2007).	Fishers	0.25 (−)
Adaptive capacity	Specific (markets)	Flexibility	Gear diversity	High gear diversity reflects a union's ability to shift target species on both short- and long-terms, which is key to adapt to market price volatility and drops (Aguilera et al., 2015; Béné et al., 2007; Cline et al., 2017; Matsue et al., 2014).	Fishers	0.25 (−)

Indicators obtained from the fishers' survey were averaged at the organization level. Weight refers to the weight given to each indicator when used to calculate each dimension, which have a cumulative weight score of one. Indicators and weights are described in detail in the Supporting Information.

The third potential concern we examined relates to maladaptation, and describes the case where building adaptive capacity to one stressor increases vulnerability to another stressor (Adger & Barnett, 2009; Barnett & O'Neill, 2010). This may occur if capacity building targeting one specific stressor crowds out capacity building targeting another (Barnett et al., 2015; Barnett & O'Neill, 2010) or increases exposure to that other stressor (Eakin, 2005). In our case, fisher unions may for instance choose to invest in specific capacity to address poaching, but this may be at the expense of the development of specific adaptive capacity and/or exposure reduction to markets due to limited time, resources or competing concerns. Such maladaptation scenario would be reflected here by a negative association between specific adaptive capacities and/or a positive association between specific adaptive capacity to one stressor and exposure to the other. The direction of associations would be reversed if synergies were involved instead of trade-offs. Note that although capacity building to one stressor may also increase sensitivity to other stressors (Bacon et al., 2017; Belliveau et al., 2006; Roncoli et al., 2001), we did not consider this scenario because sensitivity is here generic and does not vary between stressors (Figure 2).

We examined these three challenges by quantifying the direction and strength of their relationships between the relevant facets. We used pairwise Spearman rank correlations with p-values adjusted for multiple comparisons using Bonferroni correction. This correlative approach works under the assumption that other broad factors shaping social vulnerability are held constant across the study area (Smit & Wandel, 2006). This assumption is reasonable considering that fisher unions are ruled under the same governance framework (Gelcich et al., 2010) and that the effects of other socio-economic (e.g. global trade) or environmental stressors (e.g. ENSO) remain evenly distributed along the Chilean coast (Sielfeld, Laudien, Vargas, & Villegas,

TABLE 2 Summary of potential interactions that may occur in natural resource management, and expected associations between generic and specific facets of vulnerability

Concerns	Expected associations
Building generic adaptive capacity prevents (or does not translate into) specific capacity building	• Generic adaptive capacity related negatively to specific adaptive capacity
Building specific adaptive capacity does not translate into direct adaptive action	• Specific adaptive capacity to stressor A not or positively associated with exposure to stressor A
Specific adaptive capacity to one stressor increases vulnerability to another stressor	• Specific adaptive capacity to stressor A negatively related to specific adaptive capacity to stressor B • Specific adaptive capacity to stressor A negatively associated with exposure to stressor B

2010; Thiel et al., 2007), and thus have negligible impact on exposure, sensitivity, and adaptive capacity variation across unions.

2.5 | Robustness analysis

To test the robustness of our analyses and account for uncertainty in our weighting scheme, we recalculated *facet*-level scores and pairwise correlations between facets 1,000 times with combinations of weight values randomly drawn from a uniform distribution bound by the original weight values (Table 1) ± 20%, and then recorded the number of times a significant correlation at $\alpha = 0.05$ was observed.

All analyses were performed using the R statistical software (R Core Team, 2017).

3 | RESULTS

Exposure, sensitivity and adaptive capacities varied substantially across study sites and from one stressor to the other. Exposure to poaching ranged from total compliance to total non-compliance with rules (Figures 3 and 4). Exposure to markets was also heterogeneous across unions, with some experiencing stable (low monthly variability) and sometimes increasing market prices and others—especially those located in the North—volatile and decreasing prices (Figures 3 and 4). About 85% ($n = 36$) and 45% ($n = 19$) of fisher unions scored lower than 0.5 in specific adaptive capacity to markets and poaching, respectively. Curanipe, Los Molles and Maitencillo had the highest level of generic adaptive capacity because they scored high in all of the five domains, while San Marcos, Carrizal Bajo and Puertecillo scored low in most domains, particularly in *Learning* and *Organization* (Figure 3 and Figure S2).

The *facet*-level analysis highlighted strong positive associations between generic and specific adaptive capacity ($\rho = 0.77$; p-value <.001 for markets, and $\rho = 0.74$; p-value <.001 for poaching), although they have been estimated with different indicators (Table 1). Additionally, fisher unions that scored high in specific adaptive capacity to markets tended to also have high exposure to markets ($\rho = 0.43$; p-value = .024) and high adaptive capacity to poaching ($\rho = .49$; p-value = .006). We found no significant association between exposure and specific adaptive capacity to poaching ($\rho = -0.002$; p-value = 1). We examined how different indicator weightings affected the relationships between the different facets of vulnerability, and found they had little impact on the direction and significance of the correlations (Figure 4), providing high confidence in the results derived from the original weighting scheme (Table 1).

Despite the positive relationships among various facets of vulnerability, the overall vulnerability of fisher unions to one stressor was not necessarily related to the vulnerability to the other stressor ($\rho = 0.31$; p-value = .05; Figure 5). Social vulnerability was unevenly distributed with no evident spatial pattern and a high range of variation across fisher unions, regardless of the stressor considered.

4 | DISCUSSION

When applied to natural resource management, vulnerability assessments can help practitioners target where particular policy and management interventions are best fitted to maximize outcomes. Vulnerability assessments that incorporate a generic/specific framing are particularly useful because they enable practitioners to explicitly evaluate trade-offs or synergies between diverse intervention options (Eakin, Lemos, et al., 2014; Lemos et al., 2013; Nelson et al., 2016). Here, we work towards integration of this key notion into the context of non-climatic stressors associated to natural resource management.

Insights from the climate adaptation literature suggest that vulnerability should be reduced by jointly addressing structural (i.e. generic) and stressor-specific facets. However, addressing one could potentially undermine the other (Eakin, Lemos, et al., 2014; Lemos et al., 2013; Nelson et al., 2016). Here, we found a positive relationship between generic and stressor-specific adaptive capacities. This suggests that far from being mutually exclusive, these two facets can be closely and positively interdependent. Some generic elements of adaptive capacity may contribute to the development of stressor-specific adaptive capacity. This may also explain the absence of trade-offs between specific adaptive capacities to markets and poaching, respectively. Livelihoods diversification programs (Torell, McNally, Crawford, & Majubwa, 2017), approaches to poverty alleviation (Allison & Ellis, 2001), investments in infrastructure and material assets (McClanahan et al., 2008), or social capital building (Cinner et al., 2018; Marin, Gelcich, Castilla, & Berkes, 2012) are among the options available to policymakers to directly lower people's sensitivity and enhance certain domains of generic adaptive capacity.

Despite the presence of shared (i.e. generic) facets and their positive associations with their specific counterpart, we found no association between vulnerability to poaching and vulnerability to markets. Hence, lowering vulnerability to multiple stressors requires developing portfolios of interventions that not only target generic facets, but also focus on specific ones. Doing so, however,

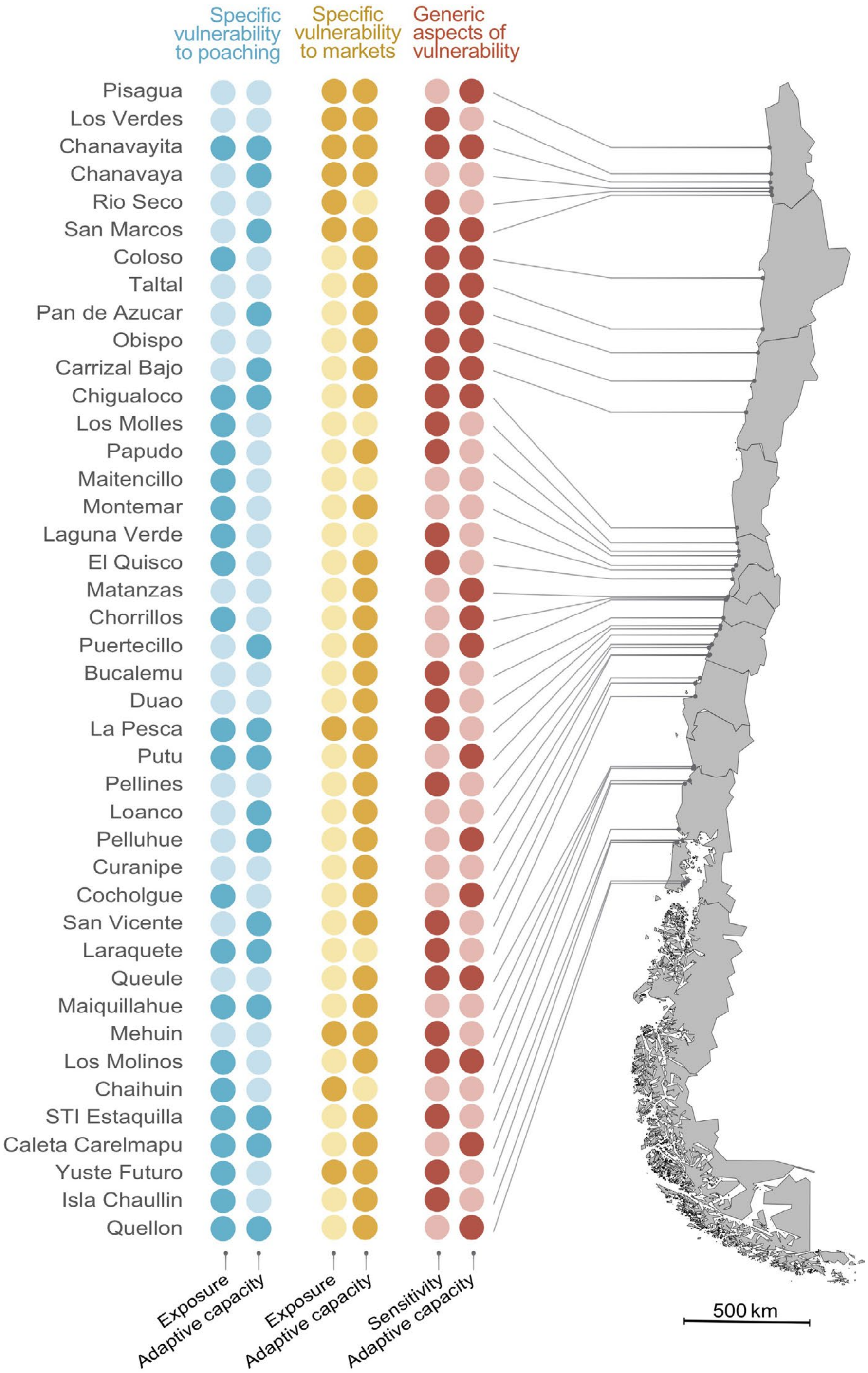

FIGURE 3 Variation in specific and generic facets of vulnerability to markets and poaching across the 42 fisher unions sampled along the Chilean coast. Saturated colours indicate major sources of vulnerability and may include specific facets of vulnerability to poaching (blue), specific vulnerability to markets (yellow), generic facets of vulnerability (red), or a combination of these. Cutoff value = 0.5 on each rescaled facet value (0–1)

may run the risk that interventions to reduce vulnerability to one stressor inadvertently increase the exposure to other stressors (Bacon et al., 2017; Belliveau et al., 2006; Finkbeiner et al., 2017; McDowell & Hess, 2012; Roncoli et al., 2001). Support for this narrative is not confined to discussions on climate change. The resource management literature highlights that, in some cases, interventions may generate unintended new exposure to a variety of demographic (e.g. in-migration, gentrification), health (e.g. acute diseases, injuries, or emotional distress) and cultural drivers (e.g. shifts in traditional practices and organization) (Aswani et al., 2018; Bennett, Blythe, Tyler, & Ban, 2016; Christie, 2004; Gelcich, Edwards-Jones, Kaiser, & Castilla, 2006). Our finding that high specific adaptive capacity to one stressor was not associated with high exposure to the other suggests that trade-offs across stressor-specific interventions may not be involved, or may be present but not exert substantial effects. However, our analysis solely focuses on two stressors and therefore neglects other potential maladaptation pathways. Indeed, interventions tailored to address problems in one context may not only increase exposure to other stressors, but could also trigger unforeseen negative consequences in other systems (e.g. marine resource), sectors (e.g. tourism) or social groups (e.g. non-unionized fishers) (Finkbeiner et al., 2017). A more

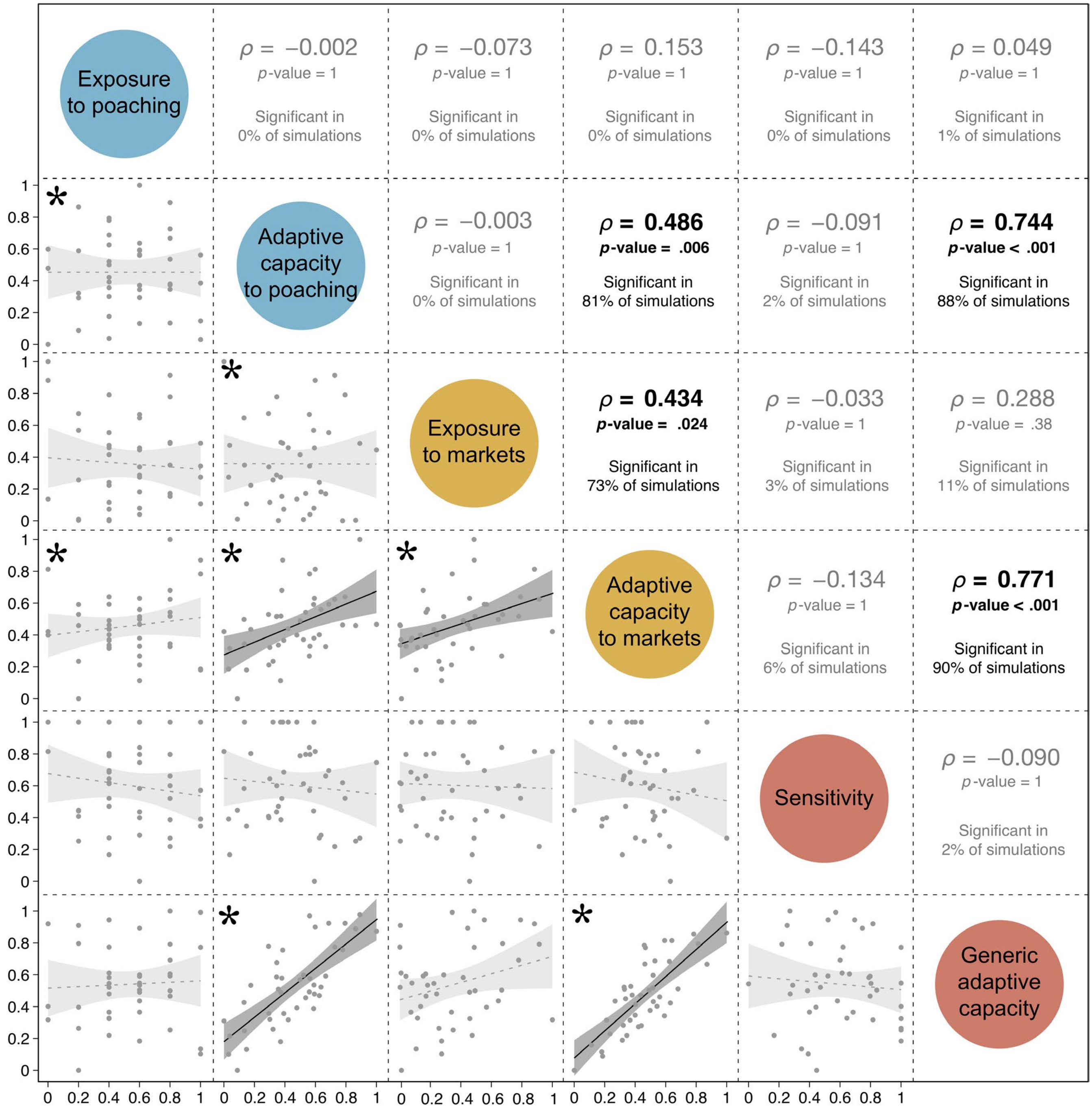

FIGURE 4 Associations between the generic and specific facets of vulnerability to poaching and markets in Chilean fisher unions (n=42). Spearman correlation coefficients (ρ) show the strength of the relation between two *facets*. Where a statistically significant association exists (p-value <.05), the numbers and relationships are shown in dark grey; where an association is not statistically significant, the relationships are shown as a lighter shade of grey. The percentage of time correlations were significant using alternative weighting schemes are also reported, with high values indicating strong cases for significant correlations. Asterisks (*) indicate where associations were expected (Table 2)

integrative understanding of trade-offs will enable vulnerability assessments to more fully inform management and avoid maladaptive strategies (Barnett & O'Neill, 2010).

By design, the vulnerability framework as used in the natural resource management focuses on the interactions between resource users and stressors that can be altered by users themselves, at least to some extent (Thiault et al., 2018b; Tilley & López-Angarita, 2016). Users are thus simultaneously considered as the 'exposure unit' (i.e. they are the ones exposed to the stressor), the operators (i.e. they are the ones that can exercise the response by mobilizing adaptive capacity) and the receptors of their adaptive action (i.e. their actions can improve their own situation by reducing their exposure) (Eisenack & Stecker, 2012). This straightforward case, where adaptations are manifestations of adaptive capacity and represent direct

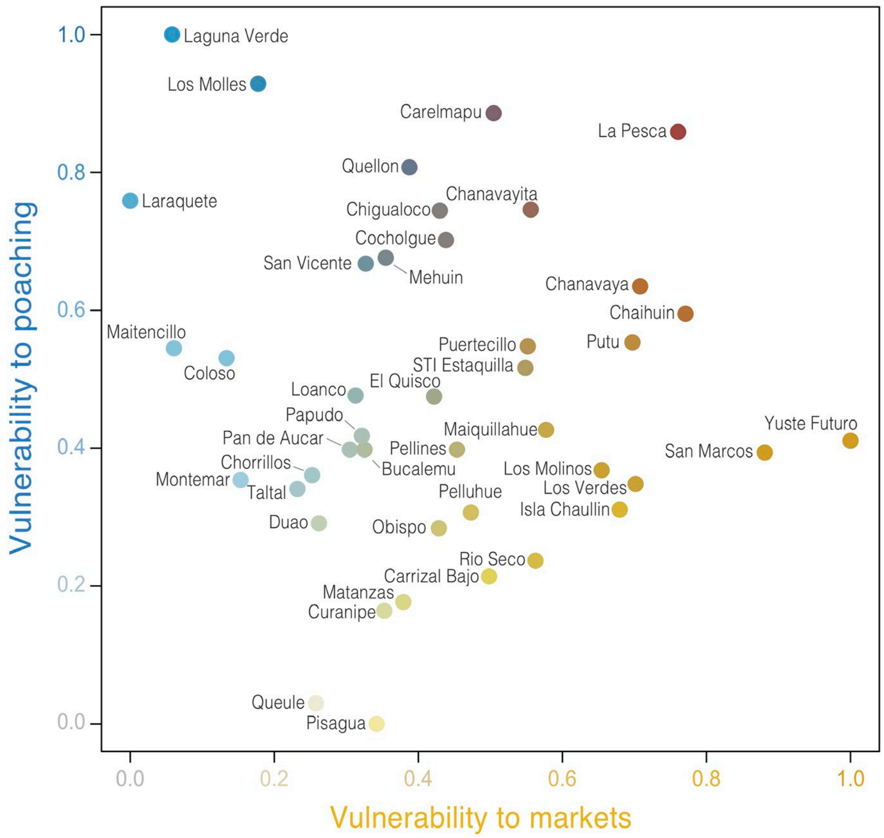

FIGURE 5 Biplot of Chilean fisher unions' social vulnerability to poaching (*y*-axis) and markets (*x*-axis) stressors. Colour gradient represents unions vulnerable to either poaching (blue; top-left), markets (yellow; bottom-right), or both stressors (maroon; top-right)

ways of reducing exposure, means that examining their interactions can provide insights into the theoretical assumption that capacity translates to action (Mortreux & Barnett, 2017).

Our results suggest that policy and management interventions focusing solely on capacity building may be only partly effective at lowering exposure to non-climate stressors. Indeed, the absence of negative association between specific adaptive capacity and exposure—regardless of the stressor considered—suggests that high specific adaptive capacity does not automatically lead to effective exposure reduction. In fact, specific adaptive capacity and exposure were positively related in the context of markets, meaning that unions with the highest gear diversity and bargaining power tended to be more exposed to unfavourable markets conditions. Since fishers recognize the importance of markets variability on their activity (Gelcich et al., 2017), the fact that fisher's unions with high capacity do not lower effectively their exposure might suggest that some mobilizing factors are lacking (Mortreux & Barnett, 2017). The absence of relationship between poaching-specific adaptive capacity and exposure is also likely the result of underlying inhibiting factors related to risk appraisal and self-efficacy (Oyanedel et al., 2018). In has been shown in other contexts that what hinders adaptation actions is not just a lack of adaptive capacity (Adger & Barnett, 2009; Adger et al., 2009; Barnett et al., 2015; Eisenack & Stecker, 2012; IPCC, 2007; Smit & Wandel, 2006).

In order to foster communities' adaptation actions, policy and management should target interventions aimed not only at building adaptive capacity but also at removing adaptation barriers. Although further research is warranted to identify these barriers in the specific context of Chilean artisanal fisheries, possible avenues for market-related management interventions may include environmental certification and eco-labelling to stabilize demand and market prices, and increase catch value (Roheim, Asche, & Insignares, 2011). Improved trade and markets information systems may also help fishers better anticipate price changes. Interventions fostering adaptation to poaching may include refined spatial design and clear boundaries to help avoid accidental poaching (Day et al., 2012), while enforcement subsidies (Sumaila, Lam, Le Manach, Swartz, & Pauly, 2016), training programs (Akella & Cannon, 2004), and communication to union members about the benefits of enforcing and complying with the rules (Davis, Kragt, Gelcich, Schilizzi, et al., 2015) could help change norms and foster voluntary compliance (Bergseth, Gurney, Barnes, Arias, & Cinner, 2018). Oyanedel et al. (2018) also stressed the importance, in Chile, of improving the reporting processes to ensure effective responses from government agencies when illegal activities are reported and improve the sentiment of self-efficacy among fishers.

As we used here a framework initially developed for assessing vulnerability to climate change, we adapted the socio-economic indicators to ensure they capture well the vulnerability domains related to our natural resource management case study. While the *domains* of exposure and adaptive capacity are well represented here, cultural and psychological *domains* of sensitivity are not because they are difficult to capture in an objective and quantitative manner across a large range of fisher's communities. More subjective (Jones, 2018; Tschakert, 2007) or more culturally-grounded indicators (Dacks et al., 2019; Sterling et al., 2017) could yield different results and, in particular, reveal new trade-offs. In addition, since the boundaries between generic and specific aspects of vulnerability may be less clear cut than assumed here (Adger & Vincent, 2005; Eakin & Lemos, 2006; Metcalf et al., 2015; Tol & Yohe, 2007), synergies or trade-offs may occur not only between facets but also among *domains* and across scales and systems (Adger, 2003; Cinner et al., 2018; Engle & Lemos, 2010). More research is needed to: (a) better integrate biocultural and in-depth qualitative approaches into vulnerability assessments; (b) better understand how the interactions among various interventions ultimately affect social vulnerability; (c) reliably identify the barriers and limitations to local adaptive actions.

Our study highlights how distinguishing generic from specific facets of vulnerability provides a useful entry point to evaluate diverse trade-offs and synergies in natural resource management. It illustrates how the vulnerability framework can inform place-based strategies to address important resource management challenges. Thus, this approach may be particularly relevant to inform the ongoing shift towards polycentric management of marine resources. Replication of this approach to other settings and stressors will strengthen our understanding of the mechanisms facilitating or undermining management interventions, which will help practitioners better navigate the many stressors that increasingly threaten resource dependent communities around the world.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

L.T., S.G., J.E.C. and J.C. conceived the ideas and designed methodology; S.G., J.E.C. and S.T.-L. collected the data; L.T. analysed the data; L.T. led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

The market prices database used in this study are owned by the National Fishery Service (SERNAPESCA) and are available upon request at www.sernapesca.cl. Survey data are available from the Dryad Digital Repository https://doi.org/10.5061/dryad.57qv82g (Thiault et al., 2019).

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REFERENCES

Adger, W. N. (2003). Social capital, collective action, and adaptation to climate change. *Economic Geography*, *79*, 387–404. https://doi.org/10.1007/978-3-531-92258-4_19

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*, 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Adger, W. N., & Barnett, J. (2009). Four reasons for concern about adaptation to climate change. *Environment and Planning A: Economy and Space*, *41*, 2800–2805. https://doi.org/10.1068/a42244

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., … Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change*, *93*, 335–354. https://doi.org/10.1007/s10584-008-9520-z

Adger, W. N., & Vincent, K. (2005). Uncertainty in adaptive capacity. *Comptes Rendus Geoscience*, *337*, 399–410. https://doi.org/10.1016/j.crte.2004.11.004

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development*, *29*, 1649–1672. https://doi.org/10.1016/S0305-750X(01)00063-8

Aguilera, S. E., Cole, J., Finkbeiner, E. M., Le Cornu, E., Ban, N. C., Carr, M. H., … Broad, K. (2015). Managing small-scale commercial fisheries for adaptive capacity: Insights from dynamic social-ecological drivers of change in monterey bay. *PLoS ONE*, *10*, 1–22. https://doi.org/10.1371/journal.pone.0118992

Akella, A. S., & Cannon, J. B. (2004). *Strengthening the weakest links: Strategies for improving the enforcement of environmental laws globally*. Washington, DC, USA: Center for Conservation and Government at Conservation International.

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine Policy*, *25*, 377–388. https://doi.org/10.1016/S0308-597X(01)00023-9

Allison, E. H., Perry, A. L., Badjeck, M.-C., Neil Adger, W., Brown, K., Conway, D., … Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries*, *10*, 173–196. https://doi.org/10.1111/j.1467-2979.2008.00310.x

Arias, A., Pressey, R. L., Jones, R. E., Álvarez-Romero, J. G., & Cinner, J. E. (2016). Optimizing enforcement and compliance in offshore marine protected areas: A case study from Cocos Island, Costa Rica. *Oryx*, *50*, 18–26. https://doi.org/10.1017/S0030605314000337

Aswani, S., Basurto, X., Ferse, S., Glaser, M., Campbell, L., Cinner, J. E., … Christie, P. (2018). Marine resource management and conservation in the Anthropocene. *Environmental Conservation*, *45*(2), 192–202. https://doi.org/10.1017/S0376892917000431

Bacon, C. M., Sundstrom, W. A., Stewart, I. T., & Beezer, D. (2017). Vulnerability to cumulative hazards: Coping with the coffee leaf rust outbreak, drought, and food insecurity in Nicaragua. *World Development*, *93*, 136–152.

Barnett, J., Evans, L. S., Gross, C., Kiem, A. S., Kingsford, R. T., Palutikof, J. P., … Smithers, S. G. (2015). From barriers to limits to climate change adaptation: path dependency and the speed of change. *Ecology and Society*, *20*.

Barnett, J., & O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, *20*, 211–213. https://doi.org/10.1016/j.gloenvcha.2009.11.004

Belliveau, S., Smit, B., & Bradshaw, B. (2006). Multiple exposures and dynamic vulnerability: Evidence from the grape industry in the Okanagan Valley, Canada. *Global Environmental Change*, *16*, 364–378. https://doi.org/10.1016/j.gloenvcha.2006.03.003

Béné, C., & Doyen, L. (2000). Storage and viability of a fishery with resource and market dephased seasonalities. *Environmental and Resource Economics*, *15*, 1–26.

Béné, C., Macfadyen, G., & Allison, E. H. (2007). Increasing the contribution of small scale fisheries to poverty alleviation and food security (FAO, Ed). Rome, Italy: FAO. FAO Fisheries Technical Paper. No. 481, 125 pp.

Bennett, N. J., Blythe, J., Tyler, S., & Ban, N. C. (2016). Communities and change in the anthropocene: Understanding social-ecological vulnerability and planning adaptations to multiple interacting exposures. *Regional Environmental Change*, *16*, 907–926. https://doi.org/10.1007/s10113-015-0839-5

Bergseth, B. J., Gurney, G. G., Barnes, M. L., Arias, A., & Cinner, J. E. (2018). Addressing poaching in marine protected areas through voluntary surveillance and enforcement. *Nature Sustainability*, *1*, 421–426. https://doi.org/10.1038/s41893-018-0117-x

Bousquet, F., Anderies, M., Antona, M., Bassett, T., Benjaminsen, T., Bonato, O., … Vassal, J. M. (2015). Socio-ecological theories and empirical research. Comparing social-ecological schools of thoughts in action. [Research Report], CIRAD-GREEN.

Brooks, N., Adger, W. N., & Kelly, P. M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, *15*, 151–163. https://doi.org/10.1016/j.gloenvcha.2004.12.006

Brugère, C., & De Young, C. (2015). *Assessing climate change vulnerability in fisheries and aquaculture: Available methodologies and their relevance for the sector (FAO Fisheries and Aquaculture Technical Paper No. 597, Ed).* Rome, Italy.

Carpenter, S. R., & Brock, W. A. (2004). Spatial complexity, resilience, and policy diversity: Fishing on lake-rich landscapes. *Ecology and Society*, *9*, 8.

Castilla, J. C. (2010). Fisheries in Chile: small pelagics, management, rights, and sea zoning. *Bulletin of Marine Science*, *86*, 221–234.

Castilla, J. C., Espinosa, J., Yamashiro, C., Melo, O., & Gelcich, S. (2016). Telecoupling between catch, farming, and international trade for the gastropods *Concholepas concholepas* (loco) and *Haliotis* spp. (abalone). *Journal of Shellfish Research*, *35*, 499–506. https://doi.org/10.2983/035.035.0223

Chen, C., & Lopez-Carr, D. (2014). The importance of place: Unraveling the vulnerability of fisherman livelihoods to the impact of marine protected areas. *Applied Geography*, *59*, 88–97. https://doi.org/10.1016/j.apgeog.2014.10.015

Chen, C., López-Carr, D., & Walker, B. L. E. (2014). A framework to assess the vulnerability of California commercial sea urchin fishermen to the impact of MPAs under climate change. *GeoJournal*, *79*, 755–773. https://doi.org/10.1007/s10708-014-9543-0

Christie, P. (2004). Marine protected areas as biological successes and social failures in Southeast Asia. *American Fisheries Society Symposium*, *42*, 155–164.

Cinner, J. E., Adger, W. N., Allison, E. H., Barnes, M. L., Brown, K., Cohen, P. J., … Morrison, T. H. (2018). Building adaptive capacity to climate change in tropical coastal communities. *Nature Climate Change*, *8*(2), 117–123. https://doi.org/10.1038/s41558-017-0065-x

Cinner, J. E., & Bodin, Ö. (2010). Livelihood diversification in tropical coastal communities: A network-based approach to analyzing "livelihood landscapes". *PLoS ONE*, *5*, e11999. https://doi.org/10.1371/journal.pone.0011999

Cinner, J. E., Huchery, C., Darling, E. S., Humphries, A. T., Graham, N. A. J., Hicks, C. C., … McClanahan, T. R. (2013). Evaluating social and ecological vulnerability of coral reef Fisheries to Climate Change (S Dupont, Ed). *PLoS ONE*, *8*, e74321.

Cinner, J. E., McClanahan, T. R., Daw, T. M., Graham, N. A. J., Maina, J., Wilson, S. K., & Hughes, T. P. (2009). Linking social and ecological systems to sustain coral reef fisheries. *Current Biology*, *19*, 206–212. https://doi.org/10.1016/j.cub.2008.11.055

Cinner, J. E., McClanahan, T. R., Graham, N., Daw, T. M., Maina, J., Stead, S. M., … Bodin, Ö. (2012). Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries. *Global Environmental Change*, *22*, 12–20. https://doi.org/10.1016/j.gloenvcha.2011.09.018

Cline, T. J., Schindler, D. E., & Hilborn, R. (2017). Fisheries portfolio diversification and turnover buffer Alaskan fishing communities from abrupt resource and market changes. *Nature Communications*, *8*, 14042. https://doi.org/10.1038/ncomms14042

Cottrell, R. S., Nash, K. L., Halpern, B. S., Remenyi, T. A., Corney, S. P., Fleming, A., … Blanchard, J. L. (2019). Food production shocks across land and sea. *Nature Sustainability*. https://doi.org/10.1038/s41893-018-0210-1

Coulthard, S. (2012). Can we be both resilient and well, and what choices do people have? incorporating agency into the resilience debate from a fisheries perspective. *Ecology and Society*, *17*. https://doi.org/10.5751/es-04483-170104

Cox, M., Arnold, G., & Villamayor, S. (2010). A review of design principles for community-based natural resource management. *Ecology and Society*, *15*, 38. https://doi.org/10.5751/ES-03704-150438

Crona, B. I., Basurto, X., Squires, D., Gelcich, S., Daw, T. M., Khan, A., … Allison, E. H. (2016). Towards a typology of interactions between small-scale fisheries and global seafood trade. *Marine Policy*, *65*, 1–10. https://doi.org/10.1016/j.marpol.2015.11.016

Dacks, R., Ticktin, T., Mawyer, A., Caillon, S., Claudet, J., Fabre, P., … Wongbusarakum, S. (2019). Developing biocultural indicators for resource management. *Conservation Science and Practice*, *1*(6), e38. https://doi.org/10.1111/csp2.38

Davis, K. J., Kragt, M. E., Gelcich, S., Burton, M., Schilizzi, S., & Pannell, D. J. (2015). Why are fishers not enforcing their marine user rights? *Environmental and Resource Economics*, *67*, 661–681. https://doi.org/10.1007/s10640-015-9992-z

Davis, K., Kragt, M., Gelcich, S., Schilizzi, S., & Pannell, D. (2015). Accounting for enforcement costs in the spatial allocation of marine zones. *Conservation Biology*, *29*, 226–237. https://doi.org/10.1111/cobi.12358

Daw, T. M., Hicks, C. C., Brown, K., Chaigneau, T., Januchowski-Hartley, F. A., Cheung, W. W. L., … McClanahan, T. R. (2016). Elasticity in ecosystem services: Exploring the variable relationship between ecosystems and human well-being. *Ecology and Society*, *21*, art11. https://doi.org/10.5751/ES-08173-210211

Day, J., Dudley, N., Hockings, M., Holmes, G., Laffoley, D., Stolton, S., & Wells, S.(2012). *Guidelines for applying the IUCN protected area management categories to marine protected areas*. Gland, Switzerland: IUCN, 36 pp.

Defeo, O., Castrejón, M., Pérez-Castañeda, R., Castilla, J. C., Gutiérrez, N. L., Essington, T. E., & Folke, C. (2016). Co-management in Latin American small-scale shellfisheries: Assessment from long-term case studies. *Fish and Fisheries*, *17*, 176–192. https://doi.org/10.1111/faf.12101

Depietri, Y. (2019). The social–ecological dimension of vulnerability and risk to natural hazards. *Sustainability Science*. https://doi.org/10.1007/s11625-019-00710-y

Eakin, H. (2005). Institutional change, climate risk, and rural vulnerability: Cases from Central Mexico. *World Development*, *33*, 1923–1938.

Eakin, H., & Bojórquez-Tapia, L. A. (2008). Insights into the composition of household vulnerability from multicriteria decision analysis. *Global Environmental Change*, *18*, 112–127. https://doi.org/10.1016/j.gloenvcha.2007.09.001

Eakin, H., & Lemos, M. C. (2006). Adaptation and the state: Latin America and the challenge of capacity-building under globalization. *Global Environmental Change*, *16*, 7–18. https://doi.org/10.1016/j.gloenvcha.2005.10.004

Eakin, H. C., Lemos, M. C., & Nelson, D. R. (2014). Differentiating capacities as a means to sustainable climate change adaptation. *Global Environmental Change*, *27*, 1–8. https://doi.org/10.1016/j.gloenvcha.2014.04.013

Eakin, H., & Luers, A. L. (2006). Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources*, *31*, 365–394. https://doi.org/10.1146/annurev.energy.30.050504.144352

Eakin, H., Perales, H., Appendini, K., & Sweeney, S. (2014). Selling maize in Mexico: The persistence of peasant farming in an era of global markets. *Development and Change*, *45*, 133–155. https://doi.org/10.1111/dech.12074

Eisenack, K., & Stecker, R. (2012). A framework for analyzing climate change adaptations as actions. *Mitigation and Adaptation Strategies for Global Change*, *17*, 243–260. https://doi.org/10.1007/s11027-011-9323-9

Engle, N. L., & Lemos, M. C. (2010). Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil. *Global Environmental Change*, *20*, 4–13. https://doi.org/10.1016/j.gloenvcha.2009.07.001

Eriksen, S., & Brown, K. (2011). Sustainable adaptation to climate change. *Climate and Development*, *3*, 3–6. https://doi.org/10.3763/cdev.2010.0064

Finkbeiner, E. M., Micheli, F., J. Bennett, N., L. Ayers, A., Le Cornu, E., & N. Doerr, A. (2017). Exploring trade-offs in climate change response in the context of Pacific Island fisheries. *Marine Policy*, *88*, 359–364. https://doi.org/10.1016/j.marpol.2017.09.032

Gelcich, S., Cinner, J., Donlan, C. J., Tapia-Lewin, S., Godoy, N., & Castilla, J. C. (2017). Fishers' perceptions on the Chilean coastal TURF system after two decades: Problems, benefits, and emerging needs. *Bulletin of Marine Science*, *93*, 53–67. https://doi.org/10.5343/bms.2015.1082

Gelcich, S., Edwards-Jones, G., & Kaiser, M. J. (2005). Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. *Conservation Biology*, *19*, 865–875. https://doi.org/10.1111/j.1523-1739.2005.00534.x

Gelcich, S., Edwards-Jones, G., Kaiser, M. J., & Castilla, J. C. (2006). Co-management policy can reduce resilience in traditionally managed marine ecosystems. *Ecosystems*, *9*, 951–966. https://doi.org/10.1007/s10021-005-0007-8

Gelcich, S., Fernández, M., Godoy, N., Canepa, A., Prado, L., & Castilla, J. C. (2012). Territorial user rights for fisheries as ancillary instruments for marine coastal conservation in Chile. *Conservation Biology*, *26*, 1005–1015. https://doi.org/10.1111/j.1523-1739.2012.01928.x

Gelcich, S., Godoy, N., & Castilla, J. C. (2009). Artisanal fishers' perceptions regarding coastal co-management policies in Chile and their potentials to scale-up marine biodiversity conservation. *Ocean and Coastal Management*, *52*, 424–432. https://doi.org/10.1016/j.ocecoaman.2009.07.005

Gelcich, S., Godoy, N., Prado, L., & Castilla, J. C. (2008). Add-on conservation benefits of marine territorial user rights fishery policies in central Chile. *Ecological Applications*, *18*, 273–281. https://doi.org/10.1890/06-1896.1

Gelcich, S., Hughes, T. P., Olsson, P., Folke, C., Defeo, O., Fernandez, M., … Castilla, J. C. (2010). Navigating transformations in governance of Chilean marine coastal resources. *Proceedings of the National Academy of Sciences of the United States of America*, *107*, 16794–16799. https://doi.org/10.1073/pnas.1012021107

Gelcich, S., Martínez-Harms, M. J., Tapia-Lewin, S., Vasquez-Lavin, F., & Ruano-Chamorro, C. (2019). Comanagement of small-scale fisheries and ecosystem services. *Conservation Letters*, *12*, 1–13. https://doi.org/10.1111/conl.12637

Gustafson, D., Gutman, A., Leet, W., Drewnowski, A., Fanzo, J., & Ingram, J. (2016). Seven food system metrics of sustainable nutrition security. *Sustainability*, *8*, 196. https://doi.org/10.3390/su8030196

Gutiérrez, N. L., Hilborn, R., & Defeo, O. (2011). Leadership, social capital and incentives promote successful fisheries. *Nature*, *470*, 386–389.

Hughes, S., Yau, A., Max, L., Petrovic, N., Davenport, F., Marshall, M., … Cinner, J. E. (2012). A framework to assess national level vulnerability from the perspective of food security: The case of coral reef fisheries. *Environmental Science & Policy*, *23*, 95–108. https://doi.org/10.1016/j.envsci.2012.07.012

IPCC. (2001). Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. In R. T. Watson, & the Core Writing Team (Eds.) . Cambridge, UK: Cambridge University Press, 398 pp.

IPCC. (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Core Writing Team, R. K. Pachauri, & A. Reisinger (Eds.). Geneva, Switzerland: IPCC, 104 pp.

Islam, M. M., Sallu, S., Hubacek, K., & Paavola, J. (2014). Vulnerability of fishery-based livelihoods to the impacts of climate variability and change: Insights from coastal Bangladesh. *Regional Environmental Change*, *14*, 281–294. https://doi.org/10.1007/s10113-013-0487-6

Jacinto, E. R., & Pomeroy, R. S. (2011). Developing markets for small-scale fisheries: utilizing the value chain approach. In R. S. Pomeroy, & N. L. Andrew (Eds.), *Small-scale fisheries management: frameworks and approaches for the developing world* (pp. 160–177). Wallingford, UK: CABI.

Jones, L. (2018). Resilience isn't the same for all: Comparing subjective and objective approaches to resilience measurement. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(1), e552. https://doi.org/10.1002/wcc.552

Kasperson, J. X., Kasperson, R. E., Turner, B. L., et al. (2005). Vulnerability to global environmental change. In R. E. Kasperson, & J. Kasperson (Eds.), *Social contours of risk: Volume II: Risk analysis, corporations and the globalization of risk*. London: Routledge.

Leichenko, R. M., & O'Brien, K. L. (2002). The dynamics of rural vulnerability to global change: The case of Southern Africa. *Mitigation and Adaptation Strategies for Global Change*, *7*, 1–18.

Lemos, M. C., Agrawal, A., Eakin, H., Nelson, D. R., Engle, N. L., & Johns, O. (2013). Building adaptive capacity to climate change in less developed countries. In A. Ghassem, & J. Hurrell (Eds.), *Climate science for serving society* (pp. 437–457). Dordrecht, the Netherlands: Springer.

Lemos, M. C., Lo, Y.-J., Nelson, D. R., Eakin, H., & Bedran-Martins, A. M. (2016). Linking development to climate adaptation: Leveraging generic and specific capacities to reduce vulnerability to drought in NE Brazil. *Global Environmental Change*, *39*, 170–179. https://doi.org/10.1016/j.gloenvcha.2016.05.001

Lutz, W., Muttarak, R., & Striessnig, E. (2014). Universal education is key to enhanced climate adaptation. *Science*, *346*(6213), 1061–1062. https://doi.org/10.1126/science.1257975

Marin, A., Gelcich, S., Castilla, J. C., & Berkes, F. (2012). Exploring social capital in Chile's coastal benthic comanagement. *Ecology and Society*, *17*.

Marshall, N. A., Curnock, M. I., Goldberg, J., Gooch, M., Marshall, P. A., Pert, P. L., & Tobin, R. C. (2017). The dependency of people on the great barrier reef, Australia. *Coastal Management*, *45*, 505–518. https://doi.org/10.1080/08920753.2017.1373454

Marshall, N. A., Fenton, D. M., Marshall, P. A., & Sutton, S. G. (2007). How resource dependency can influence social resilience within a primary resource industry. *Rural Sociology*, *72*, 359–390. https://doi.org/10.1526/003601107781799254

Marshall, N. A., & Marshall, P. A. (2007). Conceptualizing and operationalizing social resilience within commercial fisheries in northern Australia. *Ecology and Society*, *12*, art1. https://doi.org/10.5751/ES-01940-120101

Marshall, N., Marshall, P., & Abdulla, A. (2009). Using social resilience and resource dependency to increase the effectiveness of marine conservation initiatives in Salum, Egypt. *Journal of Environmental Planning and Management*, *52*, 901–918. https://doi.org/10.1080/09640560903180982

Matera, J. (2016). Livelihood diversification and institutional (dis-)trust: Artisanal fishing communities under resource management programs in Providencia and Santa Catalina, Colombia. *Marine Policy*, *67*, 22–29. https://doi.org/10.1016/j.marpol.2016.01.021

Matsue, N., Daw, T., & Garrett, L. (2014). Women fish traders on the Kenyan Coast: Livelihoods, bargaining power, and participation in management. *Coastal Management*, *42*, 531–554. https://doi.org/10.1080/08920753.2014.964819

McClanahan, T. R., Cinner, J. E., Maina, J., Graham, N., Daw, T. M., Stead, S. M., … Polunin, N. (2008). Conservation action in a changing climate. *Conservation Letters*, *1*, 53–59. https://doi.org/10.1111/j.1755-263X.2008.00008_1.x

McDowell, J. Z., & Hess, J. J. (2012). Accessing adaptation: Multiple stressors on livelihoods in the Bolivian highlands under a changing climate. *Global Environmental Change*, *22*, 342–352. https://doi.org/10.1016/j.gloenvcha.2011.11.002

Metcalf, S. J., van Putten, E. I., Frusher, S., Marshall, N. A., Tull, M., Caputi, N., … Shaw, J. (2015). Measuring the vulnerability of marine social-ecological systems: a prerequisite for the identification of climate change adaptations. *Ecology and Society*, *20*(2), https://doi.org/10.5751/ES-07509-200235

Mortreux, C., & Barnett, J. (2017). Adaptive capacity: Exploring the research frontier. *Wiley Interdisciplinary Reviews: Climate Change*, *8*, e467. https://doi.org/10.1002/wcc.467

Muttarak, R., & Lutz, W. (2014). Is education a key to reducing vulnerability to natural disasters and hence unavoidable climate change? *Ecology and Society*, *19*(1), https://doi.org/10.5751/ES-06476-190142

Næss, L. O., Bang, G., Eriksen, S., & Vevatne, J. (2005). Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change*, *15*, 125–138. https://doi.org/10.1016/j.gloenvcha.2004.10.003

Nelson, D. R., Lemos, M. C., Eakin, H., & Lo, Y. (2016). The limits of poverty reduction in support of climate change adaptation. *Environmental Research Letters*, *11*, 094011. https://doi.org/10.1088/1748-9326/11/9/094011

Nenadovic, M., Basurto, X., & Weaver, A. H. (2016). Contribution of subsidies and participatory governance to Fishers' adaptive capacity. *The Journal of Environment & Development*, *25*(4), 426–454. https://doi.org/10.1177/1070496516670448

O'Brien, K. L., & Leichenko, R. M. (2000). Double exposure: Assessing the impacts of climate change within the context of economic globalization. *Global Environmental Change*, *10*, 221–232. https://doi.org/10.1016/s0959-3780(00)00021-2

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., … West, J. (2004). Mapping vulnerability to multiple stressors: Climate change and globalization in India. *Global Environmental Change*, *14*, 303–313. https://doi.org/10.1016/j.gloenvcha.2004.01.001

Ostrom, E. (1990). *Governing the Commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.

Oyanedel, R., Keim, A., Castilla, J. C., & Gelcich, S. (2018). Illegal fishing and territorial user rights in Chile. *Conservation Biology*, *32*, 619–627. https://doi.org/10.1111/cobi.13048

Pollnac, R. B., & Crawford, B. R. (2000). Assessing Behavioral Aspects of Coastal Resource Use. Proyek Pesisir Publications Special Report. Coastal Resources Center Coastal Management Report #2226. Coastal Resources Center, University of Rhode Island, Narragansett, RI, 139 pp.

Pomeroy, R. S., & Andrew, N. L. (Eds.). (2011). *Small-scale fisheries management: Frameworks and approaches for the developing world*. UK: CABI, 247 pp.

Pomeroy, R., Ferrer, A. J., & Pedrajas, J. (2017). An analysis of livelihood projects and programs for fishing communities in the Philippines. *Marine Policy*, *81*, 250–255. https://doi.org/10.1016/j.marpol.2017.04.008

Ponte, S., Raakjaer, J., & Campling, L. (2007). Swimming upstream: Market access for african fish exports in the context of WTO and EU negotiations and regulation. *Development Policy Review*, *25*, 113–138. https://doi.org/10.1111/j.1467-7679.2007.00362.x

R Core Team. (2017). *R: A language and environment for statistical computing*. R Found Stat Comput.

Roheim, C. A., Asche, F., & Insignares, J. (2011). The Elusive price premium for ecolabelled products: Evidence from seafood in the UK Market. *Journal of Agricultural Economics*, *62*, 655–668.

Roncoli, C., Ingram, K., & Kirshen, P. (2001). The costs and risks of coping with drought: Livelihood impacts and farmers' responses in Burkina Faso. *Climate Research*, *19*, 119–132. https://doi.org/10.3354/cr019119

Rosas, J., Dresdner, J., Chávez, C., & Quiroga, M. (2014). Effect of social networks on the economic performance of TURFs: The case of the artisanal fishermen organizations in Southern Chile. *Ocean and Coastal Management*, *88*, 43–52.

Saldaña-Zorrilla, S. O. (2008). Stakeholders ' views in reducing rural vulnerability to natural disasters in Southern Mexico : Hazard exposure and coping and adaptive capacity. *Global Environmental Change*, *18*, 583–597. https://doi.org/10.1016/j.gloenvcha.2008.09.004

Scheffers, B. R., De Meester, L., Bridge, T. C. L., Hoffmann, A. A., Pandolfi, J. M., Corlett, R. T., … Watson, J. E. M. (2016). The broad footprint of climate change from genes to biomes to people. *Science*, *354*(6313), aaf7671. https://doi.org/10.1126/science.aaf7671

Selig, E. R., Hole, D. G., Allison, E. H., Arkema, K. K., McKinnon, M. C., Chu, J., … Zvoleff, A. (2019). Mapping global human dependence on marine ecosystems. *Conservation Letters*, *12*, e12617. https://doi.org/10.1111/conl.12617

Sielfeld, W., Laudien, J., Vargas, M., & Villegas, M. (2010). El Niño induced changes of the coastal fish fauna off northern Chile and implications for ichthyogeography. *Revista De Biología Marina Y Oceanografía*, *45*, 705–722. https://doi.org/10.4067/S0718-19572010000400014

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*, 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Sterling, E., Ticktin, T., Kipa Kepa Morgan, T. ē., Cullman, G., Alvira, D., Andrade, P., … Wali, A. (2017). Culturally grounded indicators of resilience in social-ecological systems. *Environment and Society*, *8*, 63–95. https://doi.org/10.3167/ares.2017.080104

Sumaila, U. R., Lam, V., Le Manach, F., Swartz, W., & Pauly, D. (2016). Global fisheries subsidies: An updated estimate. *Marine Policy*, *69*, 189–193. https://doi.org/10.1016/j.marpol.2015.12.026

Thiault, L., Gelcich, S., Cinner, J. E., Tapia-Lewin, S., Chlous, F., & Claudet, J. (2019). Data from: Generic and specific facets of vulnerability for analysing trade-offs and synergies in natural resource management. *Dryad Digital Repository*, https://doi.org/10.5061/dryad.57qv82g

Thiault, L., Marshall, P., Gelcich, S., Collin, A., Chlous, F., & Claudet, J. (2018a). Space and time matter in social-ecological vulnerability assessments. *Marine Policy*, *88*, 213–221. https://doi.org/10.1016/j.marpol.2017.11.027

Thiault, L., Marshall, P., Gelcich, S., Collin, A., Chlous, F., & Claudet, J. (2018b). Mapping social-ecological vulnerability to inform local decision making. *Conservation Biology*, *32*, 447–456. https://doi.org/10.1111/cobi.12989

Thiel, M., Macaya, E., Acuna, E., Arntz, W. E., Bastias, H., Brokordt, K., … Cortes, M. (2007). The humboldt current system of northern and central Chile: Oceanographic processes, ecological interactions and socioeconomic feedback. *Oceanography and Marine Biology: An Annual Review*, *45*, 195–344.

Tilley, A., & López-Angarita, J. (2016). Predicting vulnerability to management changes in data-limited, small-scale fisheries. *Marine Policy*, *72*, 211–218.

Tol, R. S. J., & Yohe, G. W. (2007). The weakest link hypothesis for adaptive capacity: An empirical test. *Global Environmental Change*, *17*, 218–227. https://doi.org/10.1016/j.gloenvcha.2006.08.001

Tonmoy, F. N., El-Zein, A., & Hinkel, J. (2014). Assessment of vulnerability to climate change using indicators: A meta-analysis of the literature. *Wiley Interdisciplinary Reviews: Climate Change*, *5*, 775–792. https://doi.org/10.1002/wcc.314

Torell, E., McNally, C., Crawford, B., & Majubwa, G. (2017). Coastal livelihood diversification as a pathway out of poverty and vulnerability: Experiences from Tanzania. *Coastal Management*, *45*, 199–218. https://doi.org/10.1080/08920753.2017.1303718

Tschakert, P. (2007). Views from the vulnerable: Understanding climatic and other stressors in the Sahel. *Global Environmental Change*, *17*, 381–396. https://doi.org/10.1016/j.gloenvcha.2006.11.008

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., … Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, *100*, 8074–8079. https://doi.org/10.1073/pnas.1231335100

Tzeng, G., & Huang, J. (2011). *Multiple attribute decision making methods and applications*. Boca Raton, FL: A Chapman & Hall Book, 352 pp.

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