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A social-ecological systems perspective on dried fish value chains

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ABSTRACT

Small-scale fisheries (SSF) support over 90% of the 120 million people engaged in fisheries globally. Dried fish is an important sub-sector of SSF, which is characterized by declining social, economic, political conditions of people involved in its production, and the ecosystems they depend on. Dried fish accounts for 12% of the total fish consumption globally but can increase up to 36% in low-income countries. About half of the people involved in dried fish production and marketing are women. The approach taken to analyse dried fish sector has so far followed a narrow subset of commodity chain approaches with a focus on financial value, transmitted in a linear 'vertical' fashion across value chain actors. Existing value chain approach fails to factor the non-capital relationships of dried fish that are contingent upon specific histories, ecologies, peoples, places, and the practices. The narrow neoclassical economic perspective of dried fish value chain (DFVC) also impedes appropriate responses to their unique attributes pertaining to social, ecological, institutional interactions across multiple scales. Failure to consider social-ecological system (SES) attributes, its connections and relationships with dried fish value chain not only undermine social wellbeing of upstream actors but also perpetuates social-environmental inequity and injustice. The paper offers a novel SES-oriented DFVC perspective that focuses on social wellbeing of fishers and dried fish workers. The reconceptualisation of structure, conduct and performance of DFVC is done by conducting an interdisciplinary analysis of peer-reviewed literature from SES, value chain and social wellbeing.

1. Introduction

Dried fish has long been an integral part of south and southeast Asian food systems, social-cultural processes, and the regional and global fish trades (Marcus, 1987; Ruddle and Ishige, 2010). We use the FAO definition of dried fish that includes products that are cured, salted, preserved in-brine and/or smoked (FAO, 2015). Rich in calcium and other micronutrients, dried fish consumption and trade is significantly larger in low-income countries, where it acts as a significant source of food and nutrition in both coastal and arid mountainous regions (Belton and Thilsted, 2014). The Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty eradication also considers fishing and dried fish processing as important drivers of food security and poverty eradication (FAO, 2015).

Dried fish, however, has been largely neglected in global, regional and national analysis despite constituting about 12% of the global fish production (FAO, 2015) and making crucial contributions to the nutritional and social wellbeing of the poor (Thilsted et al., 2014). The trade focus and increasing capitalisation of commercial fishing has posed serious challenges to the dried fish economy and ecology, including the livelihoods of dried fish processors, small traders, and poor fish workers engaged in the sector (Dey and Center, 2008). This raises serious questions about the efficacy of maintaining a conventional value chain approach in policy development in the context of a multidimensional, complex, and highly dynamic dried fish subsector. Value chain analysis has been a preferred approach over other trade theories in explaining why the poor may face barriers to trade and recent work has highlighted significant gaps in its ability to address non-trade (and economics) to include social, cultural and ecological challenges (Altenburg, 2007; Mitchell et al., 2009).

A value chain framework offers an understanding of multi-layered interactions and exchanges between various market nodes with a strong focus on economic returns (Gereffi et al., 2005).Value chains address limitations regarding understanding and analyzing entry level barriers of poor producers and distribution of benefits to all actors across the entire chain. However, the focus is largely on the economic

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multiplier effects of input-output relations between firms and systematic competitiveness across scales (Kaplinsky and Morris, 2000). Interdisciplinary scholars have contested such neoclassical economic perspective that singularly considers natural resources as commodities (Fabinyi et al., 2018b; Johnson, 2018; Nayak and Berkes, 2011). In the case of products like dried fish that are embedded in particular social, ecological, political, cultural and geographic contexts, they cannot be considered in isolation from the multiple ongoing social and ecological processes, dynamics and relationships (Adger, 2006; Jentoft, 2000). For example, a fisheries value chain with a primarily financial orientation fails to factor in the essential characteristics of the product with regard to its non-capital relations that are contingent upon specific histories, ecologies, people, place and the practices therein (Fabinyi et al., 2018a; Failler and Pan, 2007; Ruddle and Ishige, 2010). Further, a lack of consideration of nutrition and food system perspective in dried fish value chain policy and investment (Ahmed and Lorica, 2002) limits appropriate responses that are matched to complex social, ecological and institutional interactions across multiple scales (Ericksen, 2008; Marshall, 2015). This calls for novel approaches that can help develop more inclusive and holistic understanding of value chains, with specific reference to dried fish.

The objective of this paper is to examine if and how a social-ecological systems perspective may offer a comparative advantage to cohesively analyse the horizontal and vertical factors inherent in dried fish value chains in small-scale fisheries (SSF) contexts. As such, our analysis draws attention to the need for a conceptual departure from a neoclassical economic orientation of dried fish value chains to an emphasis on linked social-ecological systems (SES) perspective. A social-ecological systems perspective is defined here as an integrated, coupled, interdependent and co-evolutionary system with mutual vertical and horizontal feedbacks between ecological and social subsystems (Berkes et al., 2003).

1.1. Methods

To characterize and frame an alternative social-ecological perspective on dried fish value chains, we use a scoping review of the literature with direct and indirect relevance to dried fish economy and actors engaged in dried fish value chains and particularly small-scale dried fish producers and workers. The scoping review was undertaken with two objectives: 1) to understand the extant value chain characteristics of dried fish; and 2) to outline the key social-ecological attributes of the dried fish value chain that accommodate contextual reality and dynamic ecosystem-human interactions through an interdisciplinary analysis. Literature databases including Scopus, ProQuest, Science Direct and the Dried Fish Maters (DFM) Global Literature Archive were scanned using specific key words and search criteria. A combination of key words such dried fish and value chain", dried fish and SES", "dried fish, value chain and SES" were used by only considering the peer reviewed journal papers.

Literature on dried fish value chain is somewhat limited and a significant portion of the existing scholarship focuses on technological aspects, including drying techniques and quality enhancing parameters (see https://diredfishmatters.org/). Therefore, strategic investigation of the targeted research questions was made through an explicit approach to identify, select, and examine allied literatures to empirically enhance the scope of our analysis beyond the 'conventional' dried fish literature. Specific inputs and perspectives on our research objectives were thus scoped through a targeted search of literature with high topical relevance to dried fish system that included dried fish value chains, small-scale fisheries (SSF) value chain analysis, social-ecological systems sand SSF, food systems value chain, and pro-poor value chain literatures. A total of 72 peer-reviewed papers were assessed, along with attention to other relevant literature and applied sources of information.

We analyzed the literature in a sequential manner to facilitate organization and identify key insights. First, we outline the main features of conventional value chains and their limitations and highlight in particular the importance of value chain structure, conduct and performance. Second, we synthesize the key features of a social-ecological systems view of value chains in a dried fish context, drawing on the main theoretical and empirical contributions from documented applied research and the relevant literature. Here, our emphasis is on feedbacks across scales, linkages (social-ecological), the role of uncertainty, and emergent properties. Third, we compare and contrast dried fish value chain parameters through the lens of conventional and social-ecological system perspectives and offer a framework that better accounts for complexity in the system.

2. Value chains and their limitations in a dried fish context

A value chain is defined as the range of activities that are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers and final disposal after use (Kaplinsky and Morris, 2000). A fishery value chain is defined as a set of interlinked value-adding activities that convert inputs into outputs, which in turn, add to the bottom line and help to create competitive advantage for the fishery business (De Silva, 2011). Over the last decade or so, value chains have gained importance especially in the food sector as an analytical tool (Reardon et al., 2012; Stoian et al., 2012). The FAO (2005) technical guidelines for responsible fisheries has also placed stronger emphasis on value chain development of fish processing, trade and poor-friendly market systems for enhanced economic efficiency and welfare gains in developing countries. Indeed, the value chain approach has been recognised for its advantageous role in analyzing interlinkages and dynamic interactions across actors, institutions, policy environment in an integrated manner that go beyond a farm and even sectoral boundaries (Kaplinsky and Morris, 2000)

The typical value chain approach for sea food products can be simultaneously considered as narrow as well as broad. The narrow approach provides for a range of actions taken by a farm to produce certain outputs. A broad approach outlines the activities of an enterprise, and the interactions among economic agents involved in the movement of products from raw material to consumer with an understanding of backward and forward linkages (Rosales et al., 2017). In most cases, fisheries value chains follow a financial approach and have limitations of factoring in non-capital relations (Fabinyi et al., 2018a). Fundamentally, dried fish value chain analysis, just like other economic value chains, focuses on three major aspects - structure, conduct and performance (Attaie and Fourcadet, 2003; Belton et al., 2018)

A ***structural*** perspective helps in systematically mapping the size of the chain and its functionality in terms of the positioning of economic agents participating in the production, distribution, marketing, and sale of a particular product (or products). It also explains the distribution of benefits among economic agents in the chain and analyses the potential gain for each economic agent from increased organization support (Attaie and Fourcadet, 2003; Belton et al., 2018; Rosales et al., 2017). While the structure highlights the importance on different nodes, segments and economic agents through profit points, the biophysical resource system is considered only as a part of the enabling environment and, therefore, remains neglected and excluded. The value chain node is understood as a step in the chain that helps in value creation of a product, such as production, processing, wholesaling, exporting and retailing. Similarly, a value chain segment signifies distribution of actors based on their role in the chain. We have considered three segments viz., upper segment (fishers, small processors and dried fish workers), middle segment (larger processors, commission agents, traders) and lower segment (wholesalers, exporters, and retailers). The resource system refers to the ecological resource base that comprises of multiple resource units and multitier users (Ostrom, 2007). For this paper we considered coastal fisheries as the resource system and preferred species used for drying as a resource unit

The value chain structure is primarily guided by the notion of circulation, i.e., exchange relations and the politics of buying and selling determined by cost and revenue flows. Such structural considerations limit the ability of the value chain to consider the ecological and contextual social factors at points of production (see Baglioni and Campling, 2017; Béné et al., 2010). It often leads to misallocation of limited resources and propel choices antagonistic to positive results for the fishers involved in production systems

Value chain ***conduct*** describes the economic behaviour that is often motivated by revenue multiplier through a linear system of exchange among economic agents involved in the value chain (Kaplinsky and Morris, 2000; Rosales et al., 2017). In case of fisheries value chain, the value chain conduct deals with provision of goods and services and the nature of relationships among the actors in the chain (Belton et al., 2018). Value chain analysis has been effective in promoting relationships between particular links in the chain (e.g., between a buyer and supplier). Driven by the logic of profit, the lower end value chain actors, such as traders, retailers and customers are especially interested in price, convenience, and hygiene of the product. Their concerns for environmental sustainability and wellbeing of fishing communities and dried fish producers are either low or absent. In fact, the upper end value chain actors (fishers, small curers, dried fish workers) are often challenged with factors like lack of quality measures, improper market information, and lack of power in the market (De Silva, 2011; Schuurhuizen et al., 2006). The trade investment in both fishing and fish processing is rather accentuating the problem with vertical consolidation of supply chain, overfishing, loss of traditional jobs and shrinking access to resources by small-scale fishers (Béné, 2009; Schuurhuizen et al., 2006). Often value chain analysis of natural resource products, in this case dried fish, lack adequate understanding of actor behaviour and linkages, or the forms of coordination that are inherently relational, dynamic and non-linear (Lowitt et al., 2015). The fishing and fish processing practices are often characterized by strong social norms, kinship and other unique relationship networks with context specificities which are inherently varied (Johnson, 2018). However, dried fish is often an essential part of local food systems, relates to people's positions within these systems, and signifies patterns of interactions between actors, particularly people in low income groups and with limited cashflow (Arthur et al., 2021)

Value chain ***performance*** focuses on the value addition across the value stream and often places management importance on vertical interactions between individual actors and nodes. However, in the case of ecological resources like dried fish, the feedbacks across scales are often non-linear and interaction is dynamic and iterative in nature. In typical fisheries value chains, upgrading function plays a role in value creation (Kaplinsky, 2000) either through transformations in terms of quality and product design or by diversification in the product lines which is generally achieved through skill and technology enhancement (Attaie and Fourcadet, 2003; Rosales et al., 2017). Further efficiency is achieved by bringing management and technological changes in midstream (processing, value chain diversification, supply chain efficiency) and lower stream (forging complementary market networks among market players) with or without considering the upstream issues (fishers and dried fish workers). In recent years there has been greater discussion on value chain performance within the small-scale fishery sector, with specific attention to inclusiveness, efficiency and product quality (Belton et al., 2018). However, in most cases, the transformative processes are led by the commercial actors, who ensure control of all dimensions of fisheries food systems leaving the poor fishers and fish processors in disadvantaged position (Arthur et al., 2021). With clear emphasis on efficiency and quality control, value chains operate in a predictable, mechanistic way and rely on repetitive linkages and interactions between actors and organizations in the chain (Kaplinsky and Morris, 2000). In contrast, the wicked problems associated with fisheries are rarely predictable and often beyond the control of value chain actors (Khan and Neis, 2010). Further, the capacity of fisheries resource systems to remain within desired states have been challenged by increased frequency and magnitude of abrupt changes through external drivers such as climate change and market induced overfishing (Brander, 2007; Crona et al., 2015a). In this context, sectoral economic approaches are less useful as they treat uncertainties as risk and sometimes ignore the limitations of the conventional value chain. Hence, there is a need to understand value chains using approaches that facilitate multiple possibilities, diverse equilibrium states and accommodate multi-level drivers, appreciate socio-cultural specificities and respond to their impacts (Adger, 2000; Finkbeiner, 2015; Nayak and Armitage, 2018a)

The production space (fisheries) is not exogenous to dried fish value chain structure as ecological processes such as competition, environmental surprises, vulnerabilities, and habitat characteristics have stronger bearing on bio-economic dynamics of a product. According to Baglioni and Campling (2017),"just as humans determine natural resources through new use and exchange value, natural resources shape and determine the limits and potential of production processes". There has been more emphasis recently on resource issues within sustainable business discourse, but it has mostly focused on market tools such as environmental labels and certification from systematic competitive trade advantage perspectives (Bolwig et al., 2010; Donald, 2004; Ponte, 2008). In this case also, insignificant attention is paid to the integration of horizontal and vertical interactions in the entire chain that is strongly influenced by contextual factors relating to social relations, environmental dynamics and local history (Bolwig et al., 2010). This narrow perspective of value chain analysis and a lack of appreciation of the interplay between vertical and horizontal factors pose multiple challenges to the effective participation of upper value chain segment actors that include poor fishers, dried fish producers and fish workers. Dried fish is a typical subsector where producers are mostly household and other small-scale operators, end users are poor and most of the actors have multiple identities as fishers, processors and even aggregators. These actors encounter several adversaries and competing use of inputs such as small fish for fish meal and animal feed, extractive fishing (with use of gill net and bag nets), reducing fish stock of preferred species for dried fish, non-tariff barriers (ecolabels, quality standards and certification), low capacity of fishers and small-scale processors to comply with hygiene, sanitary and phytosanitary standards associated with food products (Béné, 2009; WTO, 2017)

On the contrary, within the fish and fish product value chain context, positive outcomes from the chain rest on fair distribution of benefits and the connections with the broader historical, social, ecological and institutional context in which value chain is embedded (Belton et al., 2018; Béné et al., 2010). Such relationships are manifested through traditional ecological knowledge of informally managed small-scale fisheries (Chacraverti and Basu, 2014). For example, In West Bengal, India, fishers decision to sequence fishing intensity based on the tidal patterns influenced by lunar cycles, judging catch dynamics from the sound of water, predicting change in weather from wind direction in the sea speak volumes about their ingenuity and meanings they associate with their livelihoods and resources (Chacraverti and Basu, 2014). However, inadequate emphasis on these crucial human-environment factors by fishing enterprises and market forces have turned fishers into passive contributors instead of active collaborators in value chain processes (see Lam and Pitcher, 2012). Management options may be better analyzed with a systems perspective that involves a technology-actor-institution and resource nexus at various scales (Burch et al., 2014; Westley et al., 2011). In this regard, a ssocial-ecological system analysis has the potential to expand this discussion by involving place-based social, cultural, and ecological transactions, knowledge, norms, and behaviour to inform the conduct of the value chain at different scales of operation

3. A social-ecological perspective on dried fish value chains

Berkes et al. (2003) describe social-ecological systems (SES) as integrated, coupled, interdependent and co-evolutionary, and characterized by non-linear vertical and horizontal feedbacks between ecological and social subsystems (Berkes and Folke, 2002; Nayak and Armitage, 2018a; Walker et al., 2004). A SES perspective also accommodates multiple realities and multiple ways of understanding complex human-environment problems (Nayak and Berkes, 2011), and counters the idea of discrete management models that operate without a holistic view of both the social and ecological subsystems (see Berkes and Folke, 2002; Fabinyi et al., 2014). This social-ecological systems perspective can help reimagine value chains as dynamic, non-linear, co-evolutionary, and ultimately, constitutive of linked social and ecological processes that are 'co-productive' (Marshall, 2015). Recent literature has emphasized the value of an SES perspective in understanding the importance of relationships, interactions and connections (Kates et al., 2005; M.E.A., 2005), and the manner in which social-ecological systems (and sub-systems) have both physical and normative boundaries (Marshall, 2015; Nayak and Armitage, 2018a)

Further, key attributes of SES can also provide an analytical framework through which to analyse value chains, and place more emphasis on resource system, resource communities and various internal and external drivers of the dried fish system (Berkes et al., 2003; Bolwig et al., 2010; Cash et al., 2006; Nayak and Armitage, 2018b; Nayak and Berkes, 2019b; Walker et al., 2004). Table 1 summarizes selected SES attributes which provide a more comprehensive and integrated perspective of dried fish value chains, including the importance of feedback, linkages, uncertainty, and emergence (Biggs et al., 2015; Cilliers et al., 2013; Gunderson and Holling, 2002; Walker et al., 2004). These attributes are commonly used to explain the complex nature and associated patten of SES witnessed with multiple-trajectories possible, periods of fast and slow change. (Preiser et al., 2018). We synthesize below the theoretical and empirical contributions of these attributes to the analysis of dried fish value chains

Table 1
SES attributes and key variables for understanding dried fish value chains.

SES attributes	Variables of interest	Rationale for choice of attributes and variables	Key references
Feedback	Intensification, diversification, social relations	Contribute to understand and study the economy as being an "adaptive nonlinear network" of human action vis-à-vis natural system response	Berkes and Ross, 2016; Binder et al., 2013; Cash et al., 2006; Cinner and Bodin, 2010; Fabinyi, 2010; Fabinyi et al., 2018b; Grunert et al., 2005; Jayasinghe and Thomas, 2008; Johnson, 2018; Nayak and Berkes, 2011; Sundkvist et al., 2005; Van Tuyen et al., 2010
Linkages	Rules, resources, relationships, roles	Critical to understand the ecological importance of ecosystem services, as well as how humans value and experience those services, which in turn conditions their actions and responses to the social-ecological system. Collins et al., 2010	(Adger, 2000; Andrew et al., 2007a; Berkes, 2003; Berkes et al., 2003; Birner and Wittmer, 2004; Cash et al., 2006; Collins et al., 2011; B. I. Crona et al., 2015a, 2015b; Grunert et al., 2005; Kleih et al., 2003; Nayak, 2014; Stoian et al., 2012)
Uncertainties	Supply vulnerability, demand vulnerability, process uncertainty, policy, and control	Uncertainties is critical attribute in both SES and value chain literature as it explains the system complexities and help in anlysing the system beyond a predictive risk management framework	Biggs et al., 2015; Charles, 1998b; Larson, 2004; Levin et al., 2013a; Ortiz et al., 2019; Sai Global, 2020; Sethi, 2010
Emergent properties	Spatial features, place-based values, socio-legal arrangements, practice, and skills	To argue that the behaviour of a complex adaptive system of value chain as a whole is a relational and emergent property	(Cilliers et al., 2013; Jayasinghe and Thomas, 2008; Moore et al., 2018; Nayak and Armitage, 2018a; Nayak and Berkes, 2019a; Schlüter et al., 2019)

3.1. Feedbacks in dried fish value chain

Small-scale fisheries and related trade dynamics result in multiple patterns of interactions with varied outcomes, such as changes in fish stocks, extraction/harvesting patterns, environmental conditions, competition among agencies and actors and economic return to various chain actors (see Crona et al., 2016). The feedbacks are often nonlinear. They drive the dynamic interaction between the social and ecological subsystems, including their components and processes (Binder et al., 2013) that impacts the structure, conduct and performance of value chains. We consider variables such as intensification, diversification, specialization, social interactions that are used to analyse nonlinear feedbacks in social-ecological systems and discuss them in the context of primary and secondary feedback loops as experienced in value chain operations (see Berkes, 2015;Berkes and Ross, 2016; Binder et al., 2013; Cash et al., 2006; Kooiman et al., 2005.; Nayak and Berkes, 2011; Sundkvist et al., 2005)

Fig. 1 outlines variables of nonlinear feedback and their understanding in the context of dried fish value chain. First, intensification is seen as a common strategy adopted by different actors involved in fisheries operations (McCay, 1978; Nayak, 2017; Van Tuyen et al., 2010). Intensification refers to change in practice of fishing, fish processing and trade with certain technological, geographical, species, labour arrangements, market competition and collaboration (Fabinyi, 2010). All these parameters are expressed differently, but they have strong bearing on each other across value chain segments. For example, in the case of the upper end value chain actors including fishers and small-scale dried fish processors, technology intensification signifies change in fishing gear, geographic intensification suggests spaces within which catch is obtained and species intensification is related to catch size and composition. Similarly, labour dynamics in upper end value chains mostly involve the terms of contract and gender dynamics associated with both on the sea and off the sea operations. The middle and lower end value chain actors are mostly concerned about technological changes in market and trade systems. For them, the geographic consideration is mostly about market scoping and value chain integration. These actors look at species intensification from the perspective of demand and price relationships at a system level, all these aspects contribute to the positive and negative feedback loops among the value chain actors at different nodes and segments. For example, Hilsa shad (*Tenualosa ilisha*) is one of the most preferred dried fish species in Indian Bengal Delta historically. However, it currently stands largely extirpated from the list of dried fish species due to its overfishing in response to increased market demands and technological advancements (e.g., intensive fishing through use of advanced gears by trawlers and power boats) (Lauria et al., 2018).

Second, diversification is related to the ability of the actors to switch

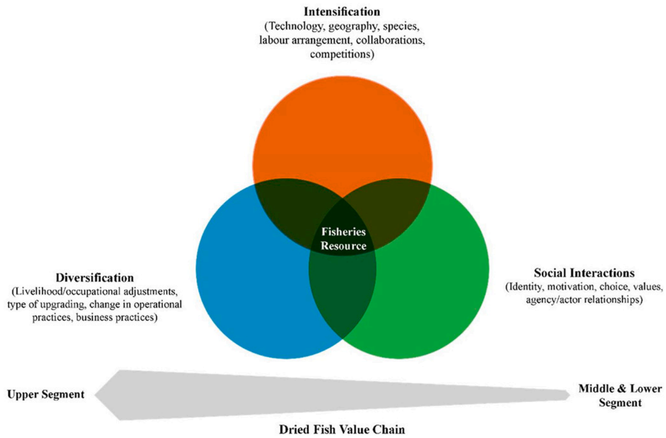

Fig. 1. Variables and indicators of Feedbacks in SES oriented dried fish value chain

across livelihoods options and operating mechanisms that can help to maintain income as environmental or market changes occur (Finkbeiner, 2015). Diversification can be understood by mapping changes in livelihoods, or in occupational systems that are often influenced by a generalist strategy where the fishers and value chain actors seek multiple options and participate in many activities within the dried fish value chains (see Nayak, 2014, 2017; Ellis, 2000. P.15; Smith and Mckelvey, 1986). The heterogeneous and end-user demands create opportunities for lower end value chain actors to diversify investment opportunities within the sector (Grunert et al., 2005). For example, engagement in dried, fermented or pickled and frozen fish, fish meal, or poultry feed preparation that uses the same fishing operations could provide various investment opportunities for lower end value chain actors to minimise the risk of investment and enhance profitability. In many parts of India, the growing aquaculture and livestock industry has triggered growing demand for trash fish (e.g. silverbellies, flatfish, ribbon fish, sciaenids, carangids and catfish) as animal feed (Funge-Smith et al., 2005). These demands have intensified commercial extraction of trash and low value fish to cater to the needs of feed industries. In normal circumstances, these low value fish were available for dried fish processing and for human consumption. In some cases, these changes have pushed the upstream actors to the margins and compels them to think for alternative livelihoods options with reduction of fish production, greater consolidation of catch and reconfiguration of value chain actors. (Aswathy et al., 2011; Staples and Funge-Smith, 2005). Further, people increasingly opt for coping options, such as temporary migration to nearby cities for wage labour work during the *padia* (low harvest) time of the month based on lunar calendar

Third, such diversifications in a market system invite specific transaction costs. In most cases, value chain actors prefer a higher degree of specialization in catering to the needs of a specific consumer segment (Grunert et al., 2005). While specialization and transaction specific investments offer greater stability to lower end market actors (Grunert et al., 2005), increased specialization of economic activities can increase risks from major system disturbances for fishers and cause higher inequality in distribution of income (Adger, 2000; Finkbeiner, 2015). With increasing power imbalances in fisheries value chains (Adger, 2000; Béné, 2009; Grunert et al., 2005), fishers and dried fish workers are always at a disadvantaged position. For example, the booming shrimp market has brought in larger investments and revenue to shrimp value chain in the east coast of India and at the same time, it has caused serious disenfranchisement of traditional fishers and women engaged in fish processing activities in the coastal region of Odisha (Nayak, 2014)

Fourth, social interactions and relations are critical determinants of wellbeing and hold higher importance in the value proposition from the perspective of fishers and fish workers (Fabinyi et al., 2014; Johnson, 2018). At the upper segment of the value chains, identity, community values, intergenerational knowledge, skills, social interactions, customary norms and practices, and community agency influence the value chain behaviour significantly (Fabinyi et al., 2014; Jayasinghe and Thomas, 2008; Johnson, 2018). Similarly, trust, response to consumer choice, community embeddedness of rural entrepreneurs have stronger bearing on dried fish value chains which has dependency on supply side variability (Grunert et al., 2005; Jayasinghe and Thomas, 2008). Understanding the interplay of these social factors with the ecological foundations of the value chain is crucial

A social-ecological systems view offers nuanced perspectives on subsystems and cross-scale linkages within and across systems (Berkes et al., 2003; Berkes, 2002; Cash et al., 2006). The managers of small-scale fisheries cannot ignore environmental flows, biodiversity and conservation issues, international trade negotiations, eco labelling and international codes of conduct that have strong implications for value chain performance (Adger, 2006; FAO, 2015). Linkages between organizations and agencies develop across levels, in part, because of self-interest (Cash et al., 2006). Dried fish value chains are characterized by different segments and nodes that are positioned across multiple boundaries, and each of these segments and nodes comprise a diversity of structures and functions. Such a layered arrangement of the entire value chain risks becoming dysfunctional if strong cross-scale linkages are not properly facilitated (USAID, 2021)

Critical linkages regarding resources, roles, relationships, rules, and results determine the process of actor collaboration, competition for production, distribution and consumptions of goods and services. On the other hand, the neoclassical framework of value chains subscribes to a command-and-control system with a stronger power asymmetry among the value chain actors. More powerful actors with higher political, economic and financial power often exploit the value chain benefits in their favour (Adger, 2006; Grunert et al., 2005). In the context of a dried fish value chain, upper segment actors are in highly disadvantageous position. As such, it is important to identify those linkages that promote a fair distribution of benefits and avoid those that have the potential to undermine trust between stakeholder groups (Adger, 2006). Pro-poor value chains typically involve significant transaction costs that involve negotiations over shared values, objectives, and social interactions. Such costs are often considered a burden on efficiency under neoclassical economic models (see Adger, 2006; Birner and Wittmer, 2004)

Fig. 2 outlines different variables to explain the role of stronger linkages in SES-oriented dried fish value chains across nodes and segments. First, rules and provisions regarding resource access and trade determine the position of the actors operating in different segments of the value chain and it reflects relationships among fishers, small fish processors within the wider social system (Ommer et al., 2012) Inadequate policy processes often criminalise poor fishers and the business people involved in input and market supply chains. While poor occasionally adopt non-recommended practices of fishing for basic survival needs, actors operating in lower end of value chain use the desperation of the poor for selfish profiteering. In this process both resource systems and poor fishers face double marginalisation due to limited access to security, justice and political capital (Kleih et al., 2003). For example, in the Bay of Bengal region of eastern India, the prawn / shrimp aquaculture industry has used the poverty of fishers as an opportunity to incentivise and influence their engagement in catching shrimp juveniles and destroying the swamps and mangroves (Jana and Jana, 2003). It has adversely affected the dried fish sector due to its primary reliance on artisanal and inshore fishing

Second, the access to resources in terms of catch, credit (Kleih et al., 2003), technology, infrastructure, knowledge (Andrew et al., 2007b; Crona et al., 2015b; Stoian et al., 2012) determines the negotiation power of trade actors and influences benefit distribution across chain actors. Therefore, it is critical to understand the resource related linkages among actors in upper, middle, and lower segments of the dried fish

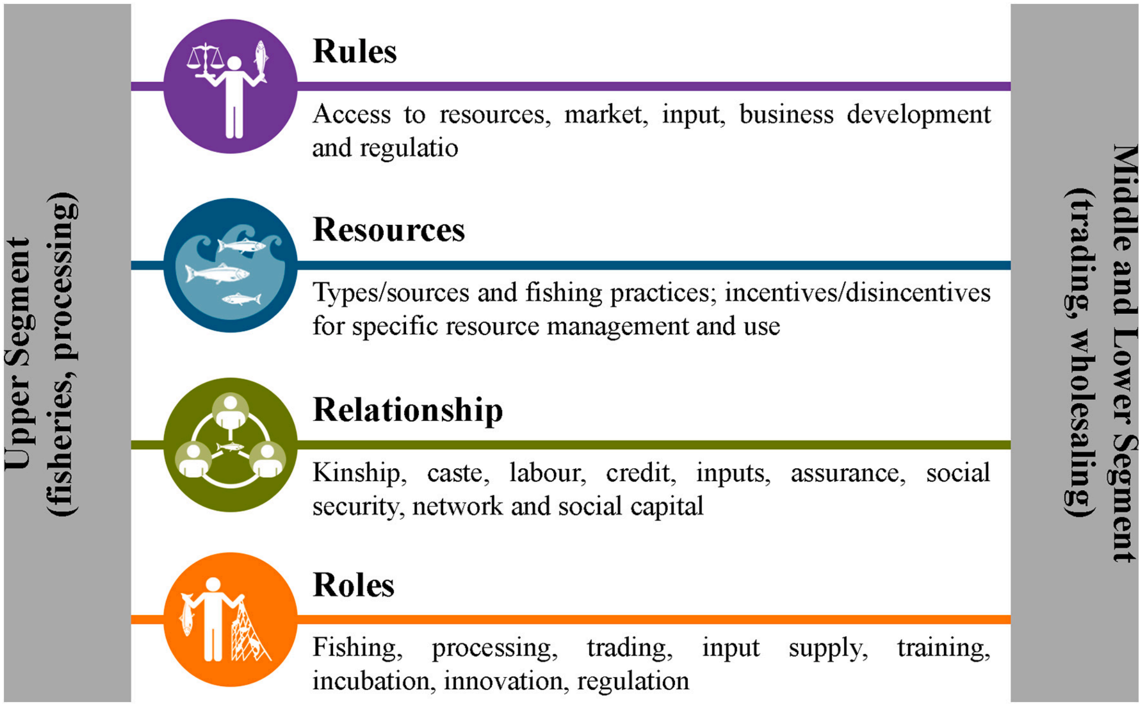

Fig. 2. Variables and indicators of linkages in SES oriented dried fish value chain

value chain. Third, actors' relationships both in terms of material and non-material associations with resources in terms of identity and inter-generational skills determine the wellbeing outcomes for people engaged in upper segments of the value chain (Nayak, 2014). The actor relationships across scales and levels influence value chain behaviours and shape cooperation and competition among actors (Crona et al., 2010). For instance, in Naziratek Bangladesh it is found that there is a strong distinction between locals (fishing communities of southeast Bangladesh) and outsiders (floating population of Chittagong city). Exploitation of labour was legitimated through a variety of discursive practices, often involving identity, access, local knowledge and connection with local social-ecological systems (Belton et al., 2018)

Fourth, actor roles are a key variable of horizontal and vertical linkages as they determine incentives and disincentives for different actors in the value chain. The specialised nature and knowledge intensive systems of dried fish operations help build linkages with resources and actors though the lower segment actors manipulate the systems using the poverty situation of upper segment actors. In fact, a successful pro-poor value chain relies on linkages among the chain actors and ensures greater social benefits having linkages with associated sub-systems like health, education, social protection (USAID, 2021). Minimisation of entry barriers though appropriate capacity development, incubation support and greater science-practice dialogue are also emphasized (Stoian et al., 2012). For example, a study from Digha coast of West Bengal suggests that in a typical dried fish value chain that involve more than six actors in the chain, the fishers share is about 7.78% of the consumer rupee and the processors margin is about 6.39%. In the same where the chain is short and dried fish processors have greater access to wholesaler without involvement of intermediaries the fisher's share is about 15.8%. The fishers and dried fish producers who have access to market infrastructure, storage and proper drying facilities have faired better in terms of their share in consumer price (Payra et al., 2018)

3.2. Uncertainties in dried fish value chains

Uncertainties are inherent in complex systems (Biggs et al., 2015). They pose strong challenges to the governance of social-ecological systems and make it difficult to develop and adopt appropriate economic policies (Levin et al., 2013b). In a value chain context, uncertainties are often treated as a risk. While risk often has negative outcomes, uncertainties can produce positive results through emergence of new possibilities (Charles, 1998b). Markets perceive uncertainties under three broad categories: (1) organizational uncertainty (product characteristics, production process, decision-making, management control, organizational behaviour); (2) internal supply chain uncertainties (consumer demand, supplier-related issues, inventory issues, infrastructure and facilities); and (3) external uncertainties (government regulation, competitive behaviour and macro-economic processes, disasters and natural hazards) (Simangunsong et al., 2012). To manage uncertainties, most of the value chain actors rely on strategies that bring efficiency in procurement systems through a series of measures, including price dependent base stock policy, inventory management, collaborations among the chain agents (Simangunsong et al., 2012). While risk and uncertainty have received strong management attention within a market system that includes value chains, the irreducible and dynamic nature of uncertainties in complex systems have generally not been accounted for in dried fish (or other resource-oriented) value chains

Uncertainties in fisheries systems can be grouped under three major categories: (1) random fluctuations; (2) imprecise estimates and surprise by nature; and (3) structural uncertainties (Charles, 1998b). Random fluctuations are relatively better managed with a clear understanding of demand and supply variability and process uncertainty related issues. The supply variability is assessed by mapping yield parameters, habitat characters, market fluctuations and preferences and other possible factors that influence supply of fish and fish products to market. Demand variability is critical as it shapes the nature of value chain structure to a great extent (Grunert et al., 2005). In dried fish system, resource access, enterprise and commerce policies, phytosanitary standards, sustainability standards hold higher importance. At the same time, consumer preferences are often subject to variability experienced in their income and access to market

Process uncertainty is particularly prevalent due to strong bill of materials (BoM) structure whereby, for example, pelagic fish that earlier had limited use options is now greatly in demand due to their growing value (and demand) in fish mill and poultry feed industries. The fast-changing technology, along with the nature of skills and resource access, cause higher levels of uncertainty for actors particularly in the upper segment of the value chain. Such uncertainties are often dealt with through strategies including scenario planning which, for example, includes survival rates of species and prices in the market, and inventory management (Larson, 2004; Sethi, 2010). However, it is important to acknowledge that there are stronger interactions between subsystems that influence random fluctuations and any change in subsystem characteristics will have strong non-linear feedbacks to whole system (e.g., market, value chain). In a value chain context, actors also need to have greater clarity on planning and control aspects that include policy matters, societal norms and behaviour, market information systems and consumer preferences, all of which are responsible for creating opportunities and stress in the value chain operations. Structural uncertainty is most problematic as it reflects challenges in the fishery system (Charles, 1998a) that can cause unanticipated change (Holling, 1973, 1978). In a dried fish context, for example, the growing emphasis on culture fisheries under MKSSY programme in eastern coast of Bay of Bengal has resulted in exploitative form of fishing as the market demand for trash fish for fish meal industries increased many folds. It has not only triggered to use smaller mess size nets but also marginalized local small, dried fish processors due to dwindling local catch and expansion of trade territories with deep sea fishers able to tap distant markets. At the same time, with longer fishing trips undertaken for shrimp and high value fish, it is also seen the discard is higher as they have limited ability to preserve and drying within the sea. With greater push and policy incentives on domestic and international exports of high value fishes, the low value fishes that were earlier used for drying is also sold as fresh fish. (Salagrama, 1998). All these factors have cumulative impact on the small scale dried fish processors and fishers in easter cost of India

In view of this discussion, a SES perspective becomes increasingly useful as it advocates for practical ways to embrace uncertainties in a complex system, instead of avoiding them, as a way to achieve system resilience and sustainability (Nayak and Armitage, 2018b; Biggs et al., 2015). This has profound implications for how we conceive a SES-oriented value chain for dried fish. A SES perspective allows for knowledge integration from diverse sources including at the node level and interactions within whole social-ecological systems, thus, promoting holistic understanding about the functioning of the entire system. A SES perspective enables collaboration without jeopardizing the interests of fishers and dried fish workers and multilevel partnerships between the segment actors that can lead to creative problem-solving in the face of uncertainties (Berkes, 2007; Ommer et al., 2012)

The dried fish subsector is relatively invisible, while fish value chains face multiple challenges from political, economic, and environmental factors, including climate change. Fig. 3 outlines key variables and indicators derived from fisheries systems and food processing related value chain literatures, and their implications for uncertainty. The supply variability in dried fish value chain setting can be understood by analyzing change in habitat characteristics, yield and market demand. Similarly, indicators such as employment incentive/disincentives, consumer preference, market promotion and product subtitution can explain the demand variability of a product. Dried fish systems are characterized by strong process uncertainties and it can be understood by analyzing its BoM structure, changes in technology in various value chain nodes and associated processes, and change in the skill and competence level of people engaged in the sector. The policy and control uncertainty related to laws, regulation, changing social norms and caste dynamics in fisheries and larger economic development processes influences the conduct and performace of the value chain significantly

3.3. Emergent properties in dried fish value chains

Emergence is defined as the advent of novel properties or functionalities that cannot be anticipated from the knowledge of the parts of the system alone (Centre for Complex Systems Science, 2011; Moore et al., 2018). This novelty is the result of a continuous process in which interactions among and between people and ecosystems generate emergent outcomes that change the context of future human actions and ecosystem dynamics (Schlüter et al., 2019). The Relevant literature outlines four key variables that help further our understanding of emergent properties in the context of a SES-oriented dried fish value chain. The variables include spatial features, place based values and ethos of value chain actors, socio-legal arrangements, and practice and skills (Gereffi et al., 2005; Jayasinghe and Thomas, 2008). Fig. 4 offers an analytical perspective of variables with regard to upstream, middle, and lower stream actors of the value chain

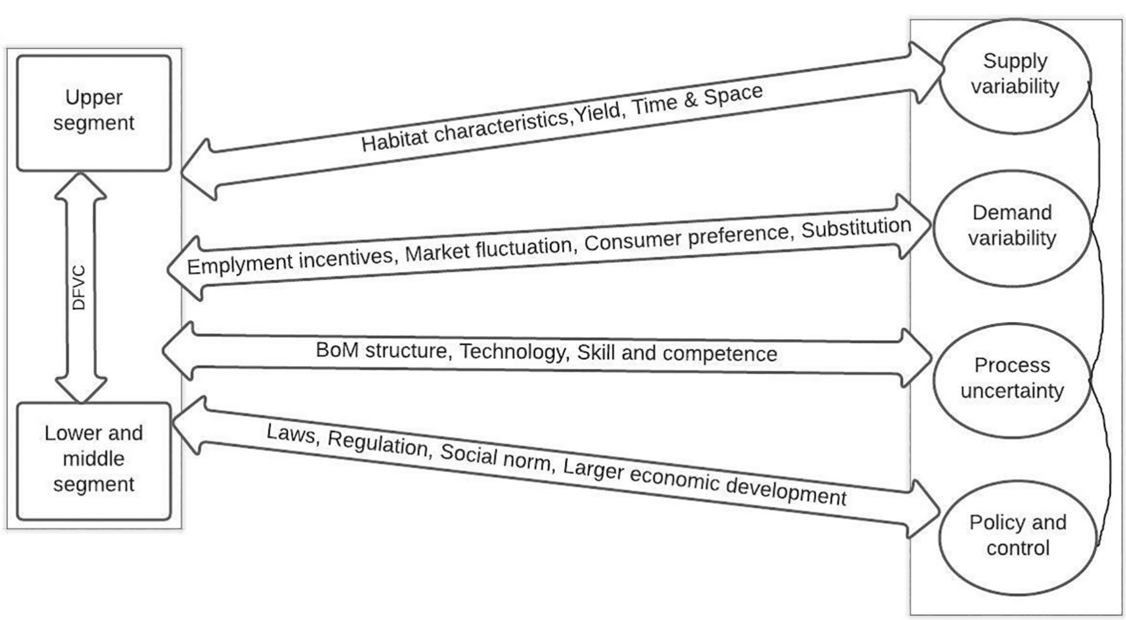

Fig. 3. Variables and indicators of uncertainties in SES oriented dried fish value chain

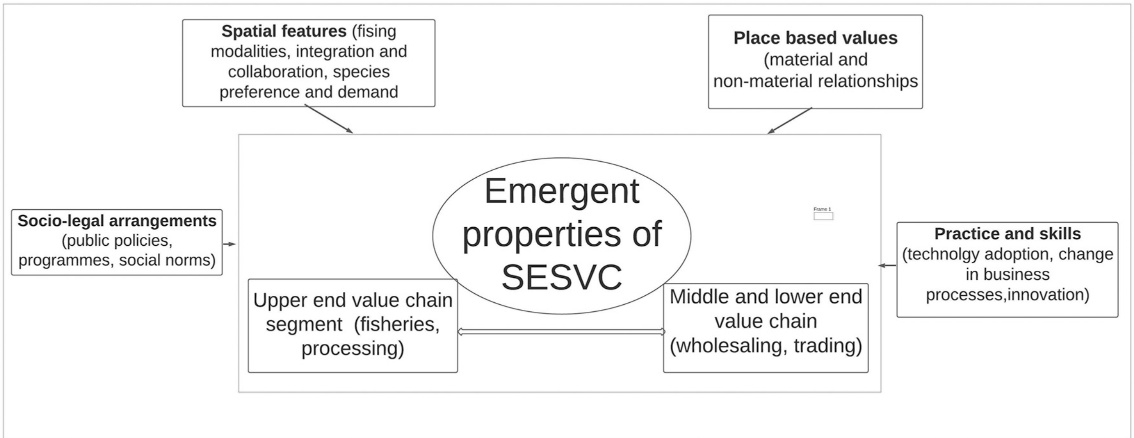

Fig. 4. Variables and indicators of emergent properties of SES oriented dried fish value chain

Spatial features such as trade demands for specific products along with processes and practices shape the behaviour of actors and agencies across the product value chain with respect of resource use and trade practices (Gereffi et al., 2005; Kaplinsky and Morris, 2000). The product specificity in dried fish context can be understood as a specific product type, product source, species preference, and enabling trade environment. This is also true in the case of fishers and dried fish workers. For example, the market preference of dried shrimp and unsalted Indian anchovy, golden anchovy, and white mullet from Odisha coast is higher than other parts of the country, and similarly the Bombay duck from the western coast has stronger market preference. There are also strong interdependencies and exchange mechanisms that exist among the dried fish processor of different region who specialise in different species. Such preferences have stronger influence on value chain operations with respect to catch preference, actor dynamics in fishing and supply chain interactions

Studies in small scale fisheries reveal that market drivers often cause rapid change and at times modify the characteristics of social-ecological systems, and the actors engaged in different levels of the value chain manifest new pathways of engaging with resource and market systems (Nayak and Berkes, 2019a). However, the entrenched place-based values and ethos of local fisher communities also influence the interactions with resources and transactions with other value chain actors (Jayasinghe and Thomas, 2008)

At the same time, socio-legal arrangements such as rules, norms and trade terms offer new opportunities for the actors to continuously adapt and innovate in the face of novel and somewhat unexpected outcomes, i.e., emergent properties of the dried fish. For example, due to the increasing emphasis on aquaculture with about 200% enhancement in production during the period 2001 to 2019 in Odisha alone (Ngasotter et al., 2020), the eastern coast of Bay of Bengal has experienced significant changes in the working profile of small-scale fishers. As a result, some fishers who have adequate human resources at home are now buying 'c-class fishes (i.e., pelagic fishes whose shelf life is almost nil and not good for other processing including freezing) from deep sea trawlers and processing those as feed mill. These fishers are also acting as small aggregators at the community level and providing marketing support to other small processors who operates with low volume and can not access the market agents due to higher transportation cost considering the volume of production. They tend to have comparative advantage over other small-scale fishing families as they can operate at a minimum scale with consistent levels of production in the face of dwindling in-shore fish catch owing to competition and extractive fishing practices

4. Towards a social-ecological systems perspective for dried fish value chains

A social-ecological systems perspective with a set of reimagined variables for analyzing value chain structure, conduct and performance offers a novel outlook on principles and conditions for understanding dried fish value chains. Such a co-evolutionary perspective promotes collaboration and participation of various stakeholders in value chain decision-making and places more emphasis on interactions with upper segment actors as they are directly linked to the resource systems. A social-ecological perspective also places more emphasis on diverse realities and options rather than focusing on linear transactions among actors operating across various nodes of the value chain

Fig. 5 provides an initial hybrid and interdisciplinary conceptual framing of a SES-oriented dried fish value chain. The framework includes several novel ideas in terms of its main components and cross-scale interactions. **First,** the framework introduces the resource base or the fisheries ecosystem as a central and/or novel node in the dried fish value chain. We have discussed above that the absence of resource and ecosystem considerations tends to create a lopsided value chain with

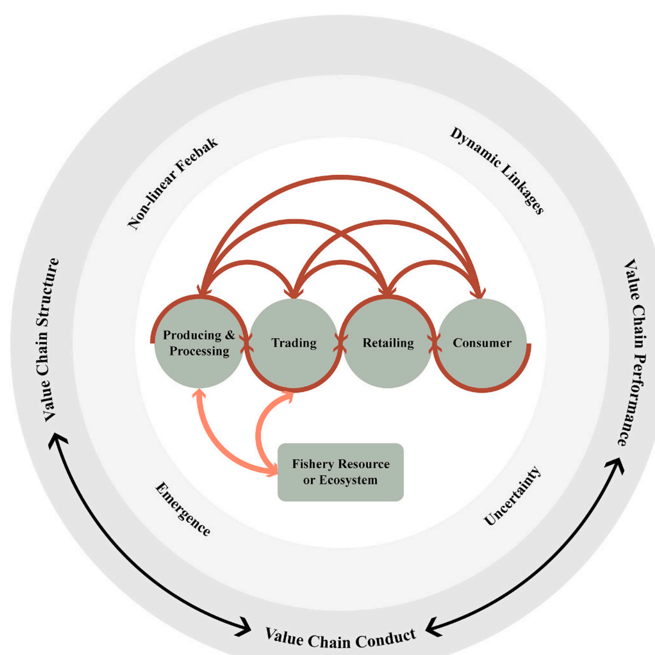

Fig. 5. Conceptual framework of SES oriented dried fish value chain

significant bias towards economic and market mechanisms. This positioning comes at the cost of excluding the fish and the fishers. The principle that 'if there is no fish (and its habitat) there is no dried fish' will become a reality if we continue to exclude the resource and ecosystem node from the value chain (Jentoft, 2000; Nayak and Berkes, 2011, 2019b). The resource node is fundamentally dynamic and that determines the price, product, livelihoods of resource dependent communities and the regulating framework which are critical to the functioning of the value chain. **Second,** the SES value chain perspective places the producing and processing, trading, retailing, and consumer nodes from the conventional value chain along with the new resource and ecosystem node in a two-way feedback relationship. Doing so clarifies that these nodes are bound by multiple interactions across several scales and levels of the entire value chain – that they are in fact 'co-produced'. In tandem with the new resource and ecosystem node, the four conventional nodes help to generate a comprehensive view of the dried fish value chain and a logical sequence in which value chains tend to function effectively. **Third,** the framework reflects a social-ecological system view of the dried fish value chain by organizing nonlinear feedback, dynamic linkages, uncertainties, and emergence as key attributes that guide the node level interactions. **Fourth,** the three segments - structure, conduct and performance - of the value chain remain integral to its core and an active part of the interactive process involving the SES attributes and the five nodes

As reflected in Fig. 5, several configurations of value chain structure exist based on social-ecological system interactions throughout the dried fish value chains. The dynamic interplay of SES attributes, variables, and their expressions vis-a-vis the structure, conduct and performance indicators in the dried fish value chain offer a strong departure from the conventional value chain perspective. Table 2 outlines the shifts in key considerations and principles between the conventional economic value chain and social-ecological system-oriented value chain. Notably, a conventional value chain is heavily reliant on technological innovation in relation to time and distance, and the chain is averse to surprises. In contrast, a SES-oriented dried fish value chain places greater importance on the wellbeing of the resource base and the actors, particularly in the upper segment of the value chain. It considers upstream actors as active collaborators, values the dynamic resource context, and provides new insights for dried fish value chain management

Table 2
Key shifts in SES oriented dried fish value chain dynamics from conventional value chain.

Value chain aspects	Conventional dried fish value chain (VC)	Novel SES-oriented dried fish value chain
Structure	• Biophysical resource base is exogenous to value stream and the problem in the resource is treated as externality.	• Biophysical resource is critical and internal to value stream in the value chain and considered as an important node in the value chain structure
	• Focuses on linear feedback among value chain nodes and actors across value stream in a vertical manner	• Places importance on non-linear feedbacks and inter-action across the level and scale is dynamic. Horizontal issues are given equal importance.
	• Fisher and dried fish workers as passive contributor of input and labour and the weakest economic agent with regard to value chain decision making	• Fishers and dried fish workers as active collaborators with contextual knowledge and cultural bound norms. Participatory and gender aspects are critical for VC decision making
Conduct	• Market logic (profit)	• System logic (social, economic, and ecological)
	• Weak connections and interactions between social justice, social wellbeing, and environmental justice	• Greater consideration of resource and human connections and subsystem interactions. Equal importance on upstream issues (resource system, fisher, and dried fish workers), identity, food security alongside profit and revenue gain.
	• Value Chain efficiency is seen as the aggregate value creation across node. Techno-managerial changes are determined through profit points irrespective of value chain segments	• Performance is critical within and among subsystem of value chain (nodes and segments). Upstream (resource and fishers) aspects are critical for SES oriented dried fish value chain.
Performance	• Revenue gain as designed feature determine value chain performance	• Three-dimensional wellbeing could both be a process and outcome determinant of value chain performance
	• Inbound logistics are determined by technological innovation in relation to durability and distance.	• Alive to uncertainties emanating from changes in environment and market processes. Socially and ecologically acceptable criteria holds importance.
	• Averse to surprise and new changes. Diversification and technological innovation for controlled flow of inputs and revenue flow	• Encourage emergence. Competitive advantage is seized by being culturally, ecologically, and socially relevant
	• Lack of importance to CCRF by lower end value chain actors with greater importance on price, convenience, and healthiness of the product.	• CCRF compliance with fair distribution of benefits and provides for welfare, freedom, social justice, and sustainability of fisheries.

5. Conclusions

Conventional value chains do not effectively capture resource dynamics and relationships with the upstream value chain actors. Critical dimensions of equity and wellbeing on poor fishers, small-scale dried fish processors and workers across the value chain are also not always captured, especially as they are directly linked to the ecological foundations of the value chains. In contrast, a social-ecological systems perspective on value chains encourages consideration of multiple realities and linked understandings of the social, cultural, and economic implications over time and space. Further, an SES-oriented value chain treats the bio-physical resource as an important node, and it considers the upper segment actors (fishers and dried fish workers) as active collaborators rather than passive contributors to the dried fish value chain. SES-oriented value chain analysis also offers additional perspectives for the scholarship on pro-poor value chains where the role of the primary producer and fair distribution of benefits in favour of upstream actors is critical

Further, our analysis considers "value" as reflective of material, relational and subjective dimensions of upstream actors instead of a mere economic construct as envisaged in the extant value chain that adheres more closely with neoclassical perspectives. There is a greater scope for analysis of value as human wellbeing in SES-oriented value chains. Interventions to enhance value chain outcomes will be better informed on the resource and market dynamics and uncertainties by having information about social-ecological context and diverse realities. Such information will help to address value chain challenges without losing sight of the interest of poor fishers and inform the core value chain design processes beyond risk analysis

Data availability statement

The data and literature sources used for the analysis of the paper are available from the corresponding author on reasonable request

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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