Climate Change Impacts and Gender Roles on Value Chain of Philippine Siganid Aquaculture

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Abstract *– Fish is essential to one's meal due to its protein and nutrient contents. Because of the increasing population, its production should grow to meet its high demand. Aquaculture is one of the most helpful ways to produce the fish supply. Among the countries known for such is the Philippines. It is widely engaged in aquaculture of Siganid (Siganus guttatus). The two main regions identified in this commodity are Ilocos and Cagayan Valley, respectively. Said species are the promising commodity for its meat quality and taste. This study answered problems on aquaculture; such as climate change impacts ; activities; distinct features of value chains; gender-roles with their profiles, adaptation strategies, and chain's commodity flow. Primary and secondary sources determined the market distribution of S. guttatus. The framework of the study was the value chain analysis (VCA). Results were presented and validated through focus group discussions (FGDs). The extreme and most recent hazard that brought the high decline in aquaculture siganid production and made the male input providers/growers and female traders was a typhoon. Gender-role showed that input providers (fishers) were males while the females were engaged in trading (wholesaling and retailing). There was a significant interplay between and among chain role players. The product flow showed a limited market distribution since it was just within the identified provinces. Each key gender-role players (men and women) involved in the chain have their adaptation strategies to address climate change impacts.*

Keywords*: Aquaculture, Climate change impacts, Gender-role, Siganid, Value chain*

INTRODUCTION

The Philippines has high dependence on both capture fisheries and aquaculture sub - industries in providing employment, generating income, enabling trade, and achieving food security [1]. In fact, the Asia–Pacific region dominates both fisheries and aquaculture, particularly in terms of number of people working in these sectors: 86 percent of fishers and fish farmers worldwide live in Asia, with 8.1 million fishers and 4.5 million fish farmers in China [2]. Asia is also a major producer of fish, accounting for 52 percent of the world's wild caught fish, while aquaculture in the Asia–Pacific region accounts for 89 percent of world production and 77 percent in terms of value [2]. In 2006, fisheries and aquaculture produced a total of 143.6 million metric tons [2]. Of this, 81.9 million metric tons were from marine capture fisheries, 10.1 million metric tons from inland capture fisheries, 31.6 million metric tons from inland aquaculture and 20.1 million metric tons from marine aquaculture. Hence, the livelihoods of 520 million people depend on fisheries and aquaculture [2], 98 % of whom live in developing countries [3]

Aquaculture is a fast-expanding sector of food production in the world. Currently, it accounts for nearly 50 percent of the total fish production consumed by human beings. In the case of finfish and shellfish, about 220 species are involved in aquaculture [4]. Aquaculture has been growing at a rapid pace and is indeed one of the fastest growing food industries with a growth rate of around 10 percent per annum. According to FAO, it is reported that the total world fisheries production on in 2009 amounted to 145.1 million tons, out of which the total capture fisheries shared 90 million tons and culture fisheries 55.1 million tons [5].

Aquaculture in the Philippines is carried out in three major aquatic environments: brackishwater, freshwater, and marine. Brackishwater aquaculture is limited to intertidal flats, mangrove swamps, and estuarine areas [9]. It is the largest regarding extent and value of production. Average annual production of brackishwater fishponds, pens, and cages from 2003 to 2005 reached 265,000 tons representing 16% of total aquaculture production and more than half of the food-fish output [6]-[7]. Aquaculture is as diverse as agriculture. Table 1 indicates that at least 18 species with only 6 commodity groups or species are farmed contributing substantially either by volume or value terms to total production: seaweeds, milkfish, tilapia, penaeid shrimps (principally the black tiger shrimp, *Penaeus monodon*), mussels and mud crabs (Scylla spp.). However, one of the species that are becoming important in the fisheries sector are siganids (Table 1), which are captured [8] or cultured [9]. They are olive-green in

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color with characteristic small white spots on its sides. Some of the most common species in the Philippines, particularly in Region 1 and Region 2 are *Siganus canaliculatus* and *Siganus guttatus*. Traditionally, *S. guttatus* (Figure 1) and *S. vermiculatus* are cultured in brackishwater ponds. Reports showed that they attain a marketable size of 150g within 5 –7 months. These species are preferred for culture because of their herbivorous food habits, fairly good growth, and economic value [10].

Table 1.Volume and Value Terms of Species

Species	Volume Quantity (t)	Share (%)	Value Amount ('000 P)	Share (%)
ALL SPECIES	**1,895,847**	**100**	**49,169,788**	**100**
Seaweeds	1,338,597	70.6	6,040,899	12.28
Milkfish	289, 153	15.25	17,577,207	35.74
Tilapia	163,003	8.59	8,900,613	18.1
Black Tiger Shrimp	37,721	1.98	13, 623,435	27.7
Mussels	20,159	1.06	138,863	0.28
Carps	17,228	0.9	365,705	0.74
Oysters	16,495	0.87	105,974	0.21
Mud Crab	6,861	0.36	1,694,588	3.44
Catfish	2,355	0.12	146,546	0.29
White Shrimp	1,519	0.08	158,357	0.32
Groupers	273	0.01	101,566	0.2
Siganids	151	0.01	22,389	0.04
Other Species	2,334	0.12	293,646	0.59

Fig. 1 Siganus guttatus (Malaga)

The total Philippine production of siganid was not encouraging volume -wise, from 2006 to 2016 (Figure1). However, the reverse can be said when the aquaculture system of production is taken into account as it generally behaved in an increasing fashion with isolated, occasional drops in some years (Figure 2). The tremendous growth in aquaculture, however, underscores the importance of the sector in maintaining the supply of fish [11]. Both figures show a sudden decrease in 2016. Said event was associated to climate change (typhoons, floods, saltwater intrusion, and among others) that might have affected the siganid industry especially the key role players involve in a value chain. Because of its occurrence, production of different commodities including market transactions (shipment and trading) changed and brought low income, destroyed assets and even shift in other source of livelihood just to earn an income.

Climate change is predicted to have a range of serious consequences, like spread of disease and sea level rise, while some have immediately obvious impacts, such as intense rain, flood, extreme temperature and storms [12]. Climate change impacts on aquatic and marine ecosystems and associated livelihoods are growing, and there is a compilation of initial examples by [13] in the FAO Fisheries and Aquaculture Circular. According to her, climate change will affect fisheries and aquaculture via acidification, changes in sea temperatures and circulation patterns, the frequency and severity of extreme events, and sea-level rise and associated ecological changes. Sea-level rise, storm surges and flooding can have negative and positive impacts on fish productivity, while human impacts to these will be negative.

Coastal areas with coral reefs are particularly vulnerable to changes in temperature and acidity, with serious food security concerns for countries that rely on these resources for food and coastal protection. Inland aquaculture may provide an important animal protein source in the future.

However, it will be affected by changing temperatures, water scarcity and salinization of coastal waters. Tropical and subtropical areas will experience more reduced ecosystem productivity than temperate and polar ecosystems, with impacts on fishery catch potential in the exclusive economic zones of those countries [14]. The development of disease in an aquaculture system involves several factors: the farmed fish, pathogens and environment. The stability of the environment especially the physicochemical parameter of the water determines the health of the fish to a great extent. 9 Fluctuations in temperature, pH, salinity or dissolved oxygen beyond the optimum range of the fish may lead to stress and diseases [15].

Environmental diseases caused by adverse environmental conditions are low dissolved oxygen and high salinity in brackish water/freshwater areas. These can result in sudden mass mortality or death, though not contagious. As an example, extreme high salinities are associated with progressive emaciation, scale loss and opaque eye lenses in affected fish. Secondary bacterial, viral, or parasitic infection may easily set in once injuries are introduced to the fish [15-16]. Farmers and fishers are seen to be most severely affected by climate change since their livelihoods are highly dependent on resources that rely on a stable climate.

Additionally, these groups are more prone to greater climate change impacts because they are less equipped to adapt to climate-related disasters and weather variations [17-18].

Climate change, indeed, is a serious phenomenon affecting present and future fisheries and aquaculture production. Typhoons, flooding, strong winds, and extreme temperatures are some of the tropical natural disasters impacting off-shore and inland fishing

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and fish farming. The Philippines is one of the developing countries most affected by these phenomena. The fisheries industry is one of the most affected by climate change in the country. Climate change induces rise in temperature which would inundate low-lying wet and dry land areas, increase salinity of estuaries, and threaten freshwater aquifer.

Climate change also causes change in rainfall patterns, frequent typhoons with extreme flooding, change in wind direction that alters the characteristics of near-shore fish habitats, ocean circulation pattern, coral reef production, and fish migration pattern. With these, areas for fishery activities will decrease in size while important fish species may move to other areas making it less available to fishers.

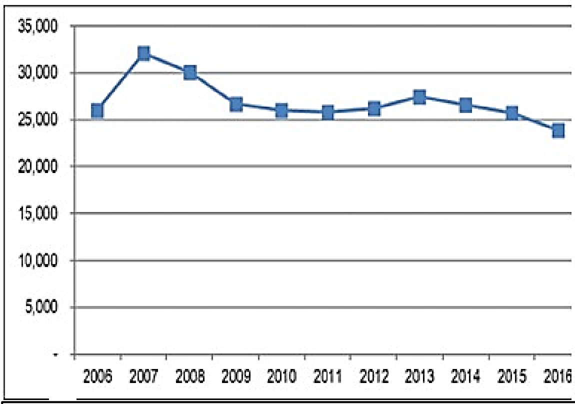

Fig. 2 Total Siganid Production (mt) in the Philippines (1996-2016) Source: PSA

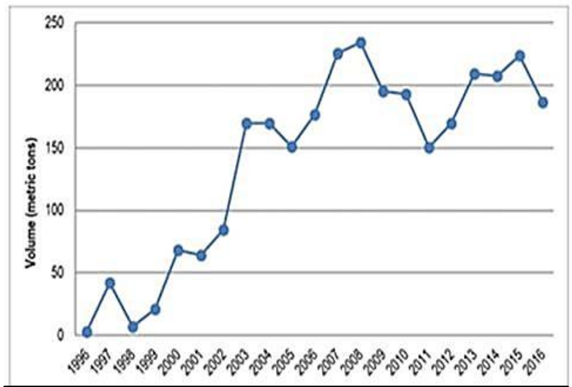

Fig. 3 Total Siganid Aquaculture Production (mt) in the Philippines (1996-2016) Source: PSA

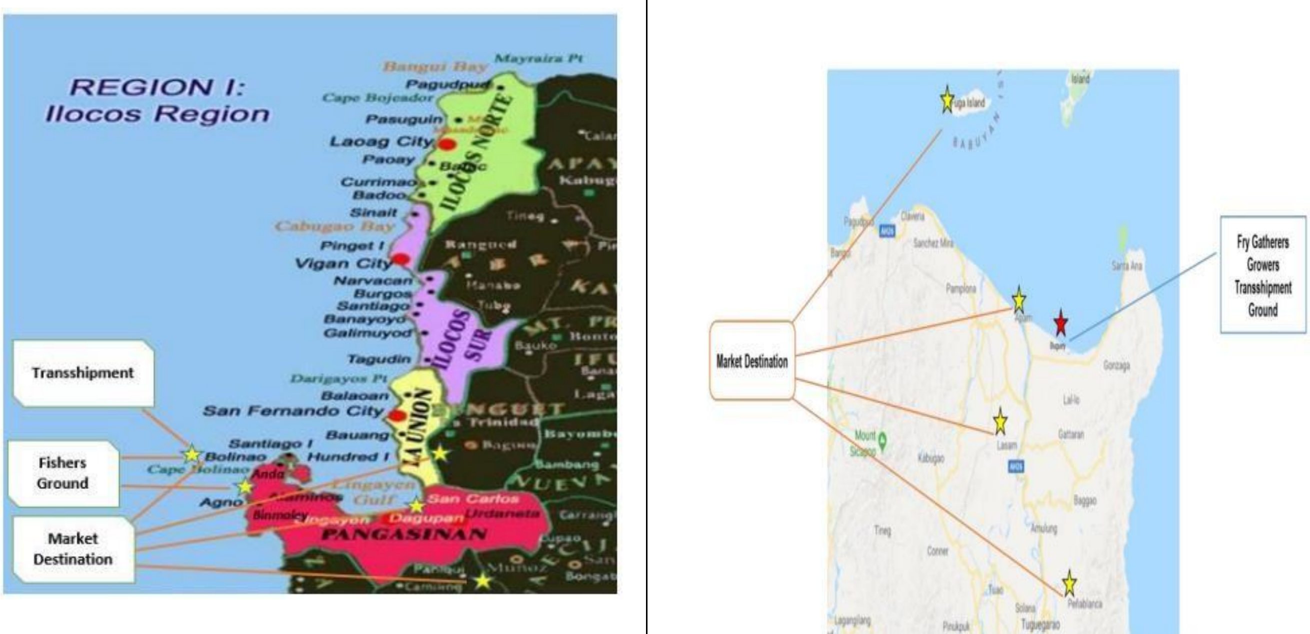

Figure 4. Locale of the Study (Region 1-left and Region 2-Right)

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Objectives Of The Study

The general objective of this study was to determine the impact of various climate change hazards on key players along the value chain of siganid or rabbitfish (aquaculture) in regions 1 (ILocos Region) and 2 (Cagayan Valley). Specifically, the study aimed to: (1) describe the major players in the siganid aquaculture value chain and their roles in siganid aquaculture value chain; (2) assess and validate the most recent and extreme climate change hazard experienced by the siganid aquaculture value chains; (3) determine the characteristics of the siganid value chains and climate change hazards; (4) identify existing adaptation strategies practiced by key players along the two fish value

Materials and Methods

The conceptual framework of the study was anchored on the notion of value chain. Value chain allows the identification of the different players and how they are connected in bringing the product or in providing a service from the source to the end-users. The value chain mapping enables the selected case studies to trace and identify the players, describe the operations, and assess the value added in each segment of the chain under the "with and without" climate change scenarios.

Industry assessment, focus group discussions (FGDs) and surveys were conducted to determine the market distribution of *S. guttatus*, thus; public officials' assistance and rural folks were tapped to trace the major producing areas. From the identified regions, a value chain map wherein traders (wholesalers) served as the link between chain players was established. Value chain analysis (VCA) framework (Figure 5) was used in data analysis.

The first step involved a rapid assessment of the existing aquaculture scenario in both regions wherein some support key institution officials were coordinated and interviewed personally to address the related objectives. An assessment was carried out by organizing the available literature and secondary data related to the said industry to gain an overall picture of the industry and to place the value chain analysis in proper context/perspective. The next step was value chain mapping which was done by locating the key players at the most downstream end (i.e., exporter, processor, institutional buyer, big wholesaler or retailer) then trace the chain backward to the most upstream end (i.e., fishers, hatchery operators, feed suppliers). From the traders initially interviewed in the market, the harvesters or growers and other key players in the value chain were identified, located and interviewed.

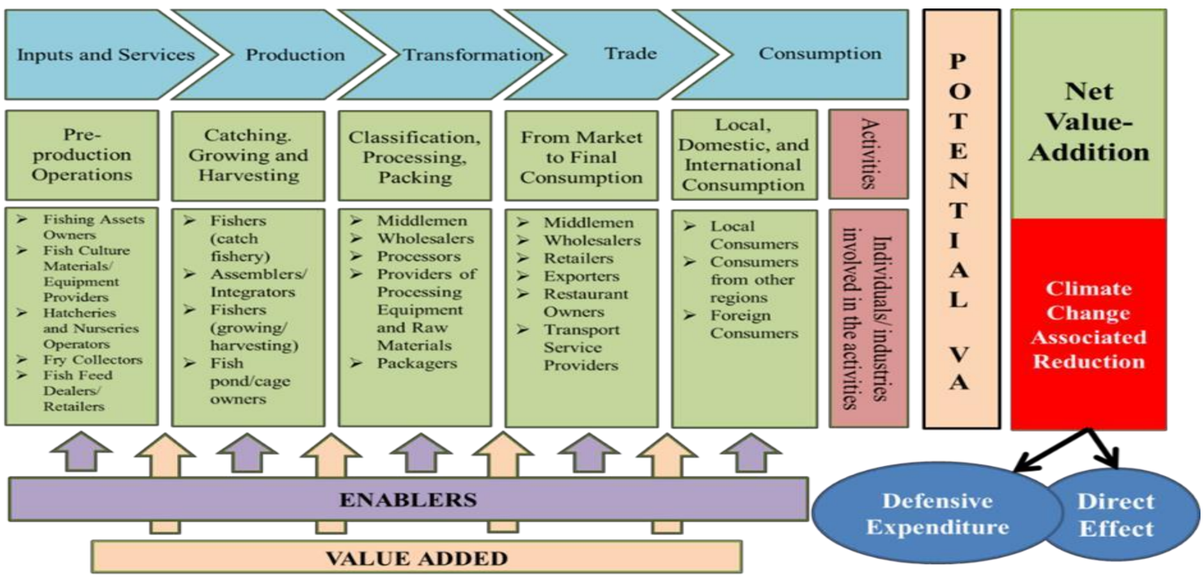

Fig. 5 *Major Players in the Siganid Aquaculture Value Chain and their Roles*

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RESULTS AND DISCUSSION

The organization of presentation of results and discussion in this section follows the proper sequence of stated objectives in the study.

Input providers:

Input providers are suppliers of intermediate inputs needed for fishing, fish farming, processing, logistics and other value adding activity along the value chain. In this study, the focus is on those directly related to fish i.e. fry collectors and hatchery/nursery operators. Fry collectors capture *S. guttatus* fry from the wild, transport, and sell either to nursery operators or directly to growers. Nursery operators: They buy, catch, feed, and grow *S. guttatus* fry for about 30 days to reach its desired size, which also serves to lower or avoid mortality once moved to growers. Respondents were all males. The nursery grower, on the other hand, relies on the fish farmer for price and volume information and decides on the production schedule. They were all males.

For information on fry fishing, siganid fry collectors rely on is from their own experience. For siganid-related activities, they were not able to receive any form of assistance from the government or the private sector nor were they aware of credit institutions or arrangements in their area. For information on price, volume, and production schedule, fry collectors rely on local traders who are their regular customers.

Growers:

Growers can either be pond or cage fish farmer. Cage farmers usually grow siganids in
about 5–8 months (mainly S. guttatus) and will reach the marketable size of 200- 300 g per piece if the initial stock had an average total length of about 5 -6 cm. Siganids are stocked at a density of 30-40 fingerlings per square meter (m2) with average survival rates of 70-80 percent. Pond growers interviewed in the study use technical information in growing or producing S. guttatus in ponds as an adaptation measure. Interviewed respondents were all males.

Siganid cage and pond growers rely on their own experience in their operations. They did not receive any form of assistance from the government or the private sector in relation to their fish-growing activities. However; the pond grower was able to avail of a loan payable within 6 months from a credit institution. The pond grower suggested that with the typhoon, his pond gave a higher net income over his cage farming operation. In terms of information source, pond and cage growers rely on local traders who were their regular customers about price and volume. However, for production schedule , pond growers rely on local traders while cage growers decide when they will harvest.

Wholesalers:

Wholesalers take the retailers in the municipality as their ready buyers. Hence, during typhoons when fishers have lesser catch of siganid, wholesalers resort to sourcing siganid supply out of the province or region. The average volume and price per unit of S. canaliculatus in the wholesale market usually declines when there is typhoon. This has been associated to the size and quality of the fish sold. Wholesaling was performed by both males and females.

Most of the wholesalers were not aware of any program on siganids nor were they able to receive any form of assistance from the government or the private sector. They were also not familiar with credit institutions in their area that may assist them in fish-related activities. The wholesalers and retailers decided about price, volume, and production schedule.

Retailers:

There are two ways retailers sell the siganid. While a number do the ho use-to-house selling, others sell in the poblacion market on rather limited scale. The average volume

sold converges only to about 100 kg per month. This meager volume is further reduced by typhoons. Despite of the desire to expand business, retailers are constrained by capital and limited access to supply of siganid. Eighty percent (80%) of the siganid retailers were females.

Most of the retailers were not aware of any program on siganids nor were they able to receive any form of assistance from the government or the private sector. They were also not familiar with credit institutions in their area that may assist them in fish-related activities. The wholesalers and retailers decided about price, volume, and production schedule

Most Recent and Extreme Climate Change Hazard that Affected the Siganid Aquaculture Value Chains

The most recent and extreme climate change hazard that was considered for analysis in Region II was typhoon Haima, known in the Philippines as Super Typhoon Lawin, with peak intensity of signal number 5. It was the third most intense tropical cyclone in the world in 2016 (Hong Kong Observatory 2016). According to the Department of Social Welfare and Development (DSWD), 18,277 families from Region I, Region II, the Cordillera Administrative Region (CAR), and Region 5 were affected by the storm. In Cagayan where Buguey (the main aquaculture ground in Region 2) is located, the typhoon's strong winds blew the roofs off houses, felled trees, and rendered roads impassable. According to CNN Philippines (2016) the storm damaged around 80% of the city's households and businesses. As to cost estimates of damage on siganid from the wild, no data was gathered from the municipality. However, based on interviews with

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fishers, the scale of fishing operations was very much affected because the usual daily fishing activities without climate change-related hazard (CCH) were no longer observed. In this scenario, fishing frequency changed due to low volume catch, which forced fishers to look for an alternative job to sustain their daily needs. Wholesalers and traders sold other fish species. For value chain players in Region I, Typhoon Lando that hit the area in October 2015 was the most recent and extreme climate change hazard and was considered for the analysis.

Characteristics of the Siganid Value Chains and Climate Change Hazards Impacts

Chain 1 represents a value chain case for siganid (S. guttatus) used for aquaculture in Region I and sold as fresh malaga to final consumers. Almost all culture operations in this chain are based on fry collected from the wild. Juveniles are available from February to May and again early pond aquaculture production (in metric tons) in Region I is contributed by Pangasinan, particularly Binmaley (178.15), Lingayen (66), Dagupan (41.2), Bolinao (32.6), San Fabian (7.84), Bugallon (4.7), Dasol (3.61), Infanta (2.5), and Labrador (0.68) (Pangasinan Fisheries Profile 2016). The main fishing ground in Region I is Binmaley, Pangasinan and the biggest market outlet is Dagupan City. Wholesalers are from Pangasinan, La Union, and Ilocos Norte. The customers' standard size requirement is 8 cm in length and retailers sell an approximate volume of 10 kg per day.

Figure 6 shows that during typhoon, the average catch of fry collectors from Alaminos City reduced (8,000 pieces or 41.03%), which caused a decrease in its price (PhP0.09 or 19%). Nursery operators from Labrador, Pangasinan had a decrease in their average volume of production from 16,800 pieces to 8,500 pieces, which is a reduction of 49.41 percent. However, an increase (45%) in average price was indicated due to production cost incurred by the nursery operators. Between fry collectors and nursery operators were fry traders from Dasol and Labrador, Pangasinan who incurred a reduction in production of 7,083 pieces (14.53 percent) but an increase in price (46.16%) because of additional input expenses to meet the required size of the product. Due to the typhoon, the average volume of production of pond farmers in Binmaley reduced to 200 kg (47.06%) but had a price increase of PhP15. Although wholesalers from Consignacion, Dagupan City also had a reduced volume of siganid being traded as an effect of the low production yield by the growers (12,250 kg or 53.85 percent), the price of the commodity increased (PhP23.06 or 9.74%). In the same way, retailers from Ilocos Norte were affected by the typhoon in terms of the decrease in the volume being traded (2,328.75 kg or 74.93%), which resulted in an increase in price from PhP265.56 to PhP287.29.

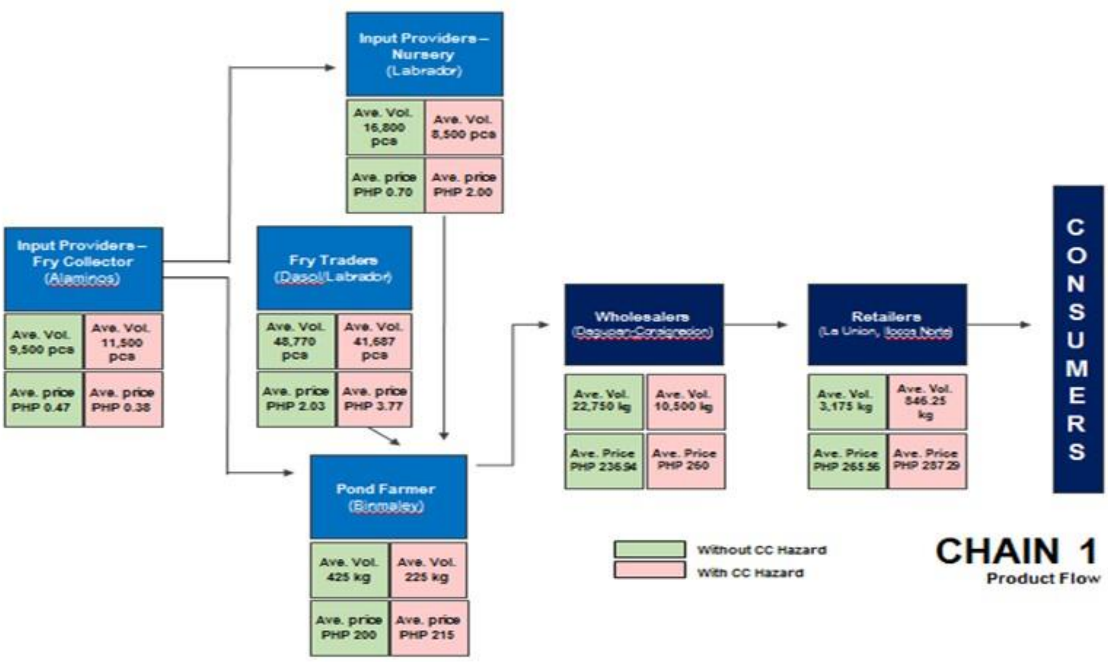

Fig. 6 S. guttatus value chain (without and with CC) Ilocos Region

Chain 2 represents a value chain case for siganid (*S. guttatus*) used for aquaculture in Region II and sold as fresh *malaga* to final consumers. Of the siganid species found in the Philippines, *S. guttatus* and *S. vermiculatus* are considered good candidates for aquaculture because of their faster growth rate compared to other species. Siganids are cultured in either brackish water ponds or cages as both methods were found to be economically feasible. *S. guttatus* is more commonly cultured because of the availability of its fingerlings. Cagayan Valley is the site where the bulk of siganid culture production is located (Figure 7).

Three significant towns contribute to production, namely, Buguey, Sta. Teresita, and Gonzaga. Buguey is the main producer of fresh adult *S. guttatus* (*malaga*) produced using the cage 76 system. As mentioned earlier, this chain

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was affected by Typhoon Lawin in October 2016. The typhoon was considered the main reason for the decrease in production performance of Cagayan Valley.

The product flow in Chain 2 shows that the fry collectors were greatly affected during the climate change hazard because they cannot collect any fry during typhoons (Figure

46). The nursery operator ensures that the volume of fry grown meets the requirement of customers. Wholesalers and retailers sell the product by schedule to customers within Buguey and nearby towns. Cash on delivery was the payment form for siganid products from input providers to fish farmers, with or wi thout CCH. Wholesalers are paid in cash after retailers sell the fish.

Conclusion and Recommendation

There is very limited set of adaptation strategies documented with many players interviewed. For nursery operators, typhoon Lawin indirectly affected them thru the low volume of S. guttatus fry collected from the wild. Without an established hatchery network at the moment, their production operation is restricted to what is available although some resort to moving to other/farther fishing ground for potential fry supply. Based on nursery operators interviewed, they did not receive any form of assistance from the government or the private sector and were not aware of any credit assistance. According to some respondent operators, important factors influencing the success of fry production include access to low interest loans to purchase equipment/facilities (e.g. water pumps), creating high awareness about climate change, and improving technical knowledge on production (e.g. stocking salt to maintain water salinity). At present, key players in the chain relied more on their past experiences for technical information in fishing, harvesting, and marketing management. Like the upstream players in the chain, the traders interviewed were not aware of any program on siganids. They reported that they did not meet problems in dealing with government extension workers but had not received any assistance from the private sector nor availed of loans from credit institutions for their siganid-related activities. According to retailers, important factors influencing the success of the siganid trading industry is the continuous daily supply of siganid to sustain their income. Similar to other players in the siganid chain, retailers did not engage in any adaptation strategy nor were aware of any siganid industry p rogram or government assistance in their locality.

The existing features of the value chain and the environments on which they operate are critical in enhancing the sector's capacity to adapt to climate change. These characteristics include: relationships between key players in the value chain and support organizations and institutions; relationships within support organizations; the capacity of value chain players to use their resources to build resilience into busine ss continuity; and players' perceptions of climate risks.

Research development for alternative pond/cage designs that are more durable may lessen the direct impacts of typhoons. LGUs in coordination with BFAR and other concerned agencies may address productivity impacts caused by using appropriate technologies. The extreme damage of strong typhoons may be lessened through mapping of vulnerable areas. The challenge remains on facilitating and searching for more effective measures to come up with appropriate and safer fishing operations, management methods and climate change adaptation.

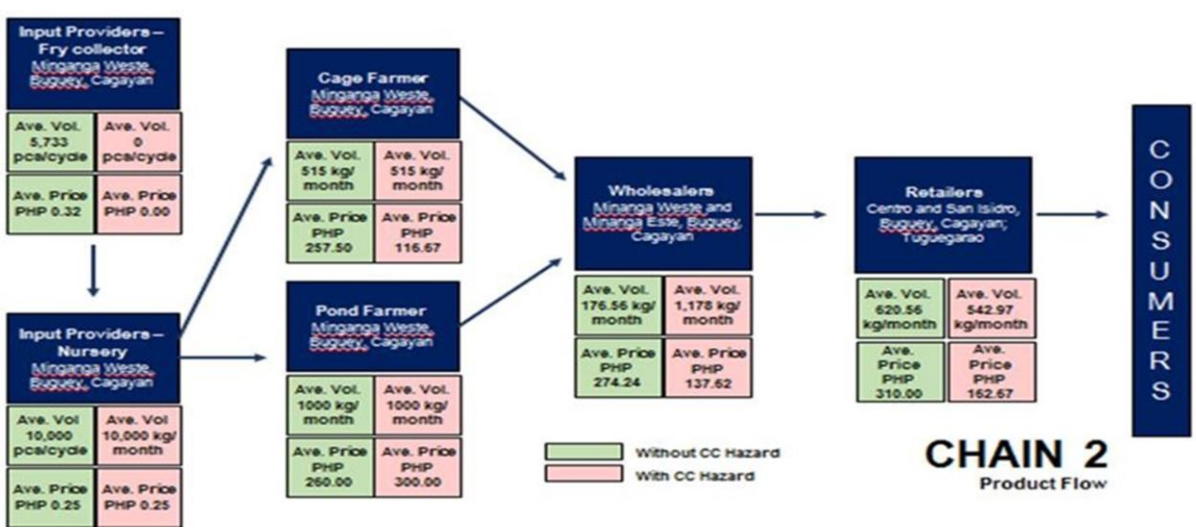

Fig. 7 S. guttatus value chain (without and with CC) Cagayan Valley

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