Impacts of Anthropogenic Marine Environmental Incidents on Household Livelihood Resilience: A Case Study in Ha Tinh Formosa 2016, Vietnam

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Abstract: The marine environmental incident (Formosa, 2016) has seriously affected the material and spiritual life of different households in Ha Tinh, Quang Binh, Quang Tri, and Thua Thien Hue provinces. The study focuses on assessing impacts of the Formosa incident on physical and mental life and finding out appropriate solutions to the incident, aimed at improving livelihood resilience of the local households. We conducted in-depth interviews and surveyed 520 impacted households by using a semi-structure questionnaire. Obviously, the Formosa incident has impacted on all aspects related to livelihood of households. Our findings show that impacts of anthropogenic marine environmental incidents on the livelihood resilience includes fishing duration, material life, and household income. Besides, the perception of the levels of impacts, the labour capacity, and the capacity to rehabilitate the household economy are also considered important factors for assessment. Local households have applied a number of adaptation measures and received support from the government to overcome the impacts. They are really significant to improve the livelihood resilience of impacted households after the Ha Tinh Formosa incident.

Key words: Impact, Livelihood, Resilience, Formosa incident, Central Vietnam.

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1. Introduction

Social and ecological vulnerability to disasters, particular anthropogenic environmental shocks from extreme events and their outcomes are influenced by resilience thresholds and capacity both before and after these shocks occur within a community (Adger et al., 2005). Coastal regions are significantly influenced by human activities under economic development pressure (Mimura, 2006). Any impacts of coastal ecosystems have influenced communities whose livelihood depended on coastal resources (Coulthard, 2008). The Asia and Pacific region accommodates more than half the world's population. Meanwhile, about 60% of the population in the region are found on or near coasts. During the dramatic economic development in Asia, the anthropogenic pressures have tremendously increased (Chou, 1994; Amer, 2014).

Under challenges of economic development and anthropogenic environmental incidents, the resilience of community is considered as the critical capacity to overcome all impacts (Somers, 2009; Oldekop et al., 2012; Amer, 2014). According to Walker et al. (2002), resilience is understood as maintaining the functionality of a system, when the environmental-social-economic system is disturbed. Resilience is increasingly becoming a key concept in social science-oriented environmental research analysing human-nature interactions in socio–ecological systems and exploring how to deal successfully with climatic, economic or social changes (Speranza et al., 2014). Thus, the resilience strategies are critically considered to mitigate difficulties and to improve the adaptive capacity under any pressures (Somers, 2009). Livelihood resilience strategy decisions of households depend on their perceptions of the levels of impacts of anthropogenic environmental incidents (Kofinas and Chapin, 2009; Bera and Daněk, 2018). To provide suggestion and support for the livelihood resilience of communities, therefore, it is important to understand the impacts of anthropogenic environmental incidents on livelihood of household and communities. In addition, it is crucial to understand the people's perceptions of the levels of impacts so as to strengthen further households' activities to manage the risk and improve their social vulnerability, both at the individual and collective levels (Oldekop et al., 2012; Methorst et al., 2017; Bera and Daněk, 2018). Perceptions of insecurity and risk vis-a-vis ecosystem services affect decisions about governing the well-being (Kofinas and Chapin, 2009). These perceptions are seen as a key driver of the opportunity recognition (Renko et al., 2012) and are thus important in the identification of opportunities in the early phase of the

strategic decision- making process. Moreover, a better understanding of how individuals or communities perceive impacts of shocks or stresses, ongoing adaptation/coping measures, and the motivations influencing the decision to adapt or transfer in practices is needed to make appropriate policies and programmes aimed at promoting successful adaptation of livelihood (Bryan et al., 2009; Bryan et al., 2010; Dey, 2015).

Livelihood in many coastal areas of the world, including fishing communities in Vietnam, are complicated and dynamic due to the day-to-day uncertainty of shocks or extreme events (Marschke and Berkes, 2006). According to Chambers and Conway (1992), livelihood of individuals and households includes their capabilities, tangible assets, and means of living. Livelihood resilience for research and practice is considered as "the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social, and political disturbances" (Tanner et al., 2015), p: 23. Therefore, livelihood resilience draws attention to the factors and processes, which help to maintain the livelihood and enrich the means of livelihood, aimed at increasing people's capacity to cope with incidents and reduce poverty .

Stable livelihood is one of the strongest determinants of safety and security (Kofinas and Chapin, 2009). Lack of food security, in particular, is a critical component of well-being and sustainable livelihood (IFPRI 2002; see Chapter 12). Families that have neither sufficient income to buy food nor appropriate land to grow crops are more vulnerable to environmental hazards that influence food supply, in comparison with those who have greater access to these assets. Although previous research works on risk and vulnerability focused primarily on the exposure to environmental hazards, there is an increasing recognition considering livelihood security to be a stronger determinant of vulnerabilities and risks such as anthropogenic pressures (Adger et al., 2005; Adger, 2006). Clearly, basic material resources (material life), security, and well-being are closely linked to each other. Anthropogenic pressures interacts with other components of livelihood resilience; in this study, therefore, material life is seen as the main aspect in the assessment of the impacts of anthropogenic marine environmental incidents to livelihood. The concept of livelihood resilience is applied as an analytical approach to answer the following research questions: 1) What are the impacts of the Formosa incident on the household livelihood?; 2) How do households perceive impacts of the Formosa incident?; 3) What are current strategies taken by households and the government in response to the Formosa incident?

2. The Context and Methods of the Study

2.1. The study context

The central coastline is two thousands kilometers long, running from Thanh Hoa to Binh Thuan provinces. The fishing community in Vietnam is large with approximately 8 million people, who earn a living mainly by doing fishing, and other 12 million people, whose income partly comes from fisheries. Over the past ten years, the fisheries developed substantially, in terms of the number of workers, fishing boats/vessels, and the landing catch (Ministry of Agriculture and Rural Development, 2015). Yet, poverty of fishing households especially in the coastal communes (called bai ngang - with no harbour to park large boats) is severe and local people strongly depend on fishing and farming income. These communes are classified as "especially difficult communes" for government supports. As estimated by the World Bank (2014), the number of poor people in fishing communities is about 5.1 million, accounting for 30% of the total number of poor people in the whole country. Moreover, the fishing communities not only have to face a decline in natural resources, but are also affected by a wide range of different (extremely) adverse events (shocks and stressors) as the consequences of a combination of various drivers (climate change, human activities, globalisation).

In addition, the Central coastal areas have suffered from severe natural conditions, impacted by various natural calamities and disasters (Duc, 2015). In the process of development, the Central coastal areas generally and the Central sea areas specifically have to encounter many unfavourable impacts from the environment and natural conditions. For the past few years, they have been one of the regions that are most influenced by climate change and anthropogenic environmental incidents (e.g. Formosa or the over exploitation of Titanium), which cause negative impacts on local people's life and socio-economic development as well.

2.2. Methods

The study sites

The study was carried out in 4 provinces in Central Vietnam namely Ha Tinh, Quang Binh, Quang Tri, and Thua Thien Hue, which were impacted by the Formosa Ha Tinh incident. To select the appropriate fishing communities for this study, we conducted an in-depth interview with the head of the Provincial Department of Natural Resources and Environment in each province. As a

result, we selected four communes, each in one of those provinces, for data collection, including Ky Khang commune in Ha Tinh province; Phu Thuan commune in Thua Thien Hue province; Ngu Thuy Bac commune in Quang Binh province, and Hai An commune in Quang Tri province. The main reasons for selecting those communes are: (1) they were directly impacted by the Formosa incident, and (2) most of local residents in those communes have participated in fishery, aquaculture and livelihood-depended sea activities (Ya-chen et al., 2016).

According to the reports issued in May 2018 by the Provincial People's Committee of Ha Tinh, Quang Binh, Quang Tri, and Thua Thien Hue provinces, there were 222,500 impacted people and 56,000 impacted households. Although the Formosa incident occurred in Ha Tinh province, the number of affected households in Quang Binh was the highest (85% of households). According to the reports of the communes, the total number of households in the 4 studied communes is 7,455 households, and up to 48.5% (n=3,614) of households are affected by the Formosa incident. The proportion of impacted household varies by group. The fishing group has the highest proportion of impacted households (48%, n=1725), followed by the aquaculture group (32%, n=1179) and finally the service group (20%, n=710). Most of impacted people in the service group were female. The data at both provincial and commune levels showed that the proportion of the households impacted by the Formosa was high. These data was calculated, based on the households who received the compensation and support from the government. However, the real data may be higher

Data collection

Both qualitative and quantitative methods were used to collect data during the period from August to December 2018. The data collection started with reviewing secondary data such as social-economic reports of the four provinces and the studied communes, impact reports from the four provinces, the studied communes, and the government, the news in newspapers and websites of the local governments. Then, a rapid rural appraisal to gain an overview of the significant social and physical features of the selected communes (Chambers, 1994) was applied to collect the primary data. A mixture of participatory methods including in-depth key informant interviews at villages and communes (n=40) and a survey using semi-structure interviews (n=520) were used, allowing households to share their perceptions, experiences and knowledge in various ways.

Households to be selected are those who rely on near-shore fishing and have direct impact from the incidence.

The main topics for a semi-structure interview included (1) livelihood characteristics such as livelihood capital and activities by fishing household groups; household wellbeing focusing on "material life" and "relational life" by household groups; (2) impacts of the marine environment incidence 2016 on livelihoods, which included: (i) the occurrence of the marine environment incidence; (ii) loss caused by the incident in terms of social, economic and environments; (3) response, adaptation and transformation adopted by the impacted households in handling the incidence.

Data analysis

The research uses Excel and SPSS programmes for data management and analysis. This include both quantitative and qualitative approaches. Data from interviews were collected and synthesized with descriptive statistics, which help to analyze the collected data. Descriptive statistics were used to present people's perceptions of various impacts of Formosa incident, and the impacts of Formosa incident on the material life. In addition, the qualitative data from in-depth interviews and secondary data were coded and condensed with reduction methods and thematic analysis (Morse et al., 2001). The main topics for qualitative analysis included the impacted process and the way people managed to rehabilitate the household and communities economy. The most frequently reported impacts of the Formosa incident were discussed and cross checked with the secondary data. The results of this analysis are described as follows:

3. Results

3.1. Characteristics of sampled respondents

Among 520 impacted households in four representative areas of four provinces, around 28.5% (n=150) of the household heads are female. The impacted households were divided into three groups, including fishing group (n=200), aquaculture group (n=150), and services-dependent sea resources group (n=170)[1]. The average household size was 4.6 member per one household and the average number of labourers was 2.9 labor per one household. Their income activities have depended on the marine resources. For

[1] Fishing household group: The main income of this group is the catching fish
Aquaculture household group: The main income of this group is the aquaculture activities
Services-dependent sea resources household group: The main income of this group is service activities in the beach, tourism, or seafood business

each household group, the average household member and labourers in the fishing, aquaculture, and service group were 4.7; 4.5; 4.6 member/household and 3.0; 2.7; 2.9 labourers/household respectively. Thus, resource-based activities (income sources from fishing, aquaculture, and services-dependent sea resources) are important means for subsistence and economic purposes of interviewed households.

3.2. Impacts of the Formosa incident on the study communities

The impact duration of households after the Formosa incident

The impact duration after any shocks or incidents are considered to be crucial for understanding the resilience capacity of a household or a community (Mirhosseini et al., 2013). The impact duration was assessed based on number of months that households have to completed standstill or partial standstill of livelihood activities. Besides that, this study also assessed the impact duration of households after the Formosa incident at four levels. These levels include: level I = under 6 months, level II = from 6 months to 12 months, level III = from thirteen months to twenty-four months, and level IV = more than twenty-four months, (fig. 1). These levels based on the results from the household survey with key informants in impacted communities and local authorities. In addition, we also based on the duration of assessment and test of water quality made by the government agencies after the Formosa incident.

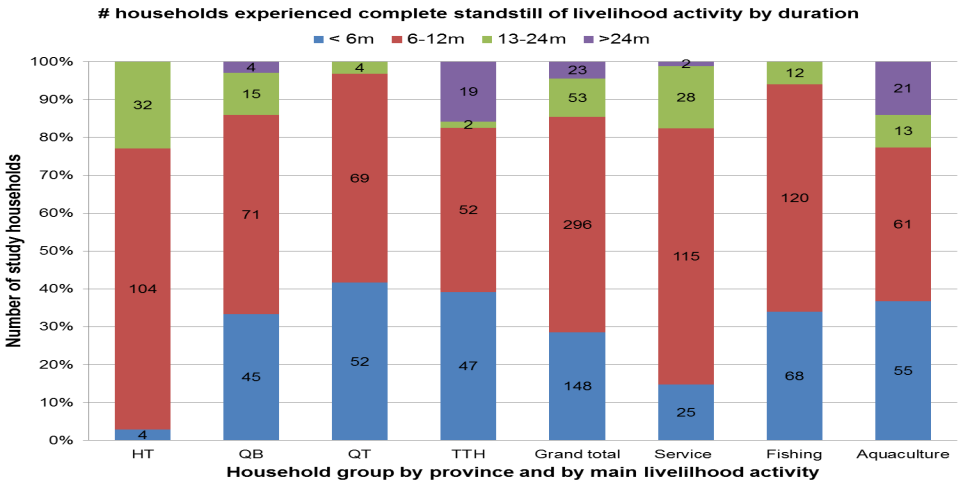
According to the survey results, the total impact months of three groups were 21.5 months for service households, 23 months for fishing households, and 21.8 months for aquaculture households. Particularly, the households with a female head had a longer impact duration than other households. On average, household groups had to stop their livelihood activities completely for around 9.4 months and partially for around 13 months. Specifically, the aquaculture household group completely stopped all their livelihood activities for the longest period (11 months), followed by the service household group (10.3 months) and finally the fishing household group (7.5 months). However, the fishing household group had to stop partially their livelihood activities for the longest duration (15.8 months), followed by the aquaculture and service household groups (11.3 months). The reason explained by the respondents of the in-depth interviews indicates that after the quality of the water environment was informed by the government to be safe for fishing, households in all the three groups started doing fishing again. However, the livelihood was still impacted negatively longer due to the market demand and the regulations of the government on the types of fish and the fishing distance..

Our results demonstrated that under the impacts of Formosa incidents, 58% of the respondents had to stop their main income-generating activities for 6 to 12 months and 28% suffered this loss for less than six months. Seemingly, only 10% stopped their main income activities for 13 months to 24 months (level III). For all the livelihood groups, it is common that they all had to delay income-generating activities for 6 to 12 months. 60% of households in the fishing group, 67% of those in the service group and 40% of those in the aquaculture group share this pattern. Probably, after 6 months, they were allowed to do only offshore fishing, but not near-shore fishing or demersal fishing. As a result, they caught just a relatively small volume of fish. In addition, the market demand was decreased, because consumers still did not really believe in quality of the sea fish at that time. The impact, consequently. lasted longer. For aquaculture households, they had to wait for one year, until MONRE announced that the water quality was safe to meet the conditions for aquaculture activities in four provinces. Households in the service group had to wait for not only the results of the government's announcement of water quality but also the customers' assumption of the sea-food market quality. Therefore, the impact duration for households in this group was longer than those in others groups.

While very few respondents from the service and fishing groups said they had to stop working for more than 12 months, 14% of respondents in the aquaculture group suffered loss for such a long duration. This might be attributed to water pollution and government restriction as explained above, but also due to differences in the business cycles of each type of livelihood. Fishermen go fishing up to 20 days, depending on the distance of catching, offshore or near shore. Meanwhile, aquaculture households have a production cycle ranging from 6 months to 1 year. Thus, if they stop one cycle, they will have no income for a year or more.

> *As said by a women in Ha Tinh province in an in-depth interview of fish seller, "…at that time, after the government announced that fishers could catch fish again, most of the people did not buy sea-fish and even lagoon-fish. For a long time after that, until mid-2017, the activities of buying and selling sea-fish were carried out, but the purchase quantity was also moderate. Most people did not really believe in the quality of sea-fish, although the fish sold on the market were off-shore fish and had quality accredited by the competent authorities. In fact, we faced difficulties and consumers feel very nervous about the fish quality".*

Figure 1. The Impact Duration of Households after the Formosa Incident



The impacts of the Formosa incident on households' livelihood

The results from in-depth interviews in the study communities and the social-economic reports show that one household can have different income sources from various activities such as near-shore fishing, offshore fishing, aquaculture, cultivation, livestock raising, fishery service, sea tourist service, seasonal migration, labour export and hired jobs as well as regular wages/pensions and other. The Formosa incident posed impacts on more than one income generating activity in local communities. More than a half of respondents (64.2%, n=334) indicated that two to three income sources of them were affected. 7.3% (n=38) lost only one income source, while 9.8% (n=51) had got five livelihood activities impacted.

As the result of stopping working, households suffered the loss in annual income compared to the total income before the Formosa incident and their production cost increased when they changed to offshore fishing. On average, annual income of one household was reduced by 116.5 million VND. Table 1 shows that among three groups, aquaculture households suffered the highest reduction in income at 164 million VND per a household, followed by fishing households (130.1 million VND) and services group (58.4 million VND). This loss was partly due to the increase in production cost. For instance, aquaculture group had to invest in machinery and pond maintenance over a long period of stopping working without any revenue to cover the cost. Consequently, the increase in the production cost of those households ranked the highest at 339.1 million VND/a household. Fishermen also had to pay 101 million VND/a

household to cover the increase in production cost. The impact was less severe for service households, as apart from fishing products, they had other income sources such as crop or livestock production, hired jobs or seasonal migration, etc. In particular, the responses of service household group indicated that when the Formosa incident occurred, they quickly changed to other income generating activities. This led to the fact that their level of income reduction was the lowest (reduced 58.4 million VND /a household).

Table 1. Impacts of the Formosa Incident on Material Life of Household (HH)

Indicator	Loss production cost and products after Formosa incident (million/hh)	Reduce income (million/h)	Lost value per yearly income (%)	Lost value per total asset value (%)
Grand Average	151.0	116.5	78.4	33.9
Service HH	43.6	58.4	37.8	21.6
Fishing HH	101.1	130.1	97.8	36.6
Aquaculture HH	339.1	164.1	98.7	44.1

Another important factor leading to the decrease in people's income was the low consumption of seafood products after the incident. Although the government promulgated several policies to support fishing and aquaculture activities, according to several respondents, those policies created very limited changes to their lives.

> *A female household head (Ms. Ho Thi Huyen, Ky Khang, Ha Tinh) said: "My family is poor. We rely on fish trade for living. Every day, I buy fish when fishers come back from sea, in order to sell it in the local market. It is difficult for many days, when the weather is bad and the fishing is not carried out. At that time, I have to work as a hired labourer to earn a living. The incident occurred. It was even more difficult. There was not fish to be bought for selling; and, there was nothing to do to earn income. People got panic; the fishers stopped going fishing. No one needs to hire a labourer. Therefore, my family income reduced".*

Impacts on individuals' income

The government had policies to provide support for individuals and the labourers, who were living in the affected areas. When assessing impacts on individuals, the authors also see the same patterns of impacts as those on households. Among a total of 520 surveyed households, there were 1,247 labourers divided into 3 groups of labourers according to household groups,

including service labourers (n=415), fishing labourers (n=470) and aquaculture labourers (n=362). In terms of the impact duration, three impact levels were identified, including (1) non-affected, (2) affected for less than 12 months, and (3) affected for 12 months and more. These levels were set up, based on the assessment of the government' support/compensation levels after the Formosa incident[2]. Most of labourers in the impacted households revealed that they were impacted for less than 12 months (41%, n=516) and non-affected (23%, n=289). A small proportion of labourers reported that they were impacted for 12 months and more (36%, n=442).

Table 2. Impacts of the Formosa Incident Labor Income

Labour income at 30 months after incident	Service household	Fishing household	Aquaculture household	Grand
Below 50% (*)	9	31	34	74
Between 50 and below 100% (*)	133	63	79	275
Equal 100% (*)	167	222	144	533
Above 100% (*)	27	36	13	76
Total N observed	336	352	270	958

(*):Percentage as compared with income level just before incident

When the study was conducted, it had been 30 months since the incidents. Thus, the government's supporting policies had come into effect for a certain period. Our respondents were asked to rank the changes in their individuals' income between the two periods: 30 months after the Formosa incident and the time before the Formosa incident, based on four levels: (1) less than 50%, (2) between 50% and 100%, (3) 100%, and (4) more than 100%. These levels were set up, based on the assessment of the government's support/compensation levels after the Formosa incident. Most of the labourers (56%, n=533) in impacted households indicated that their income at 30 months after the Formosa incident did changed (i.e. 100%), compared with their income before the incident. A small proportion of labourers reported that their income were less than 50% and those who chose the level of more than 100% also made up a small proportion.

[2] In order to determine the exact level of support and compensation for households with labor affected after the Formosa incident, the government set a duration to affect the income of labors in the affected household, and the percentage income is reduced during the time when the incident occurred compared to the income of the previous labor.

3.3. Households' perception about the impacts of the incident

Beside the quantitative assessment, respondents were asked to assess the level of the Formosa incident impacts (little, serious, very serious) on the household livelihood, household income, household life, and the community,; they were also asked to predict the response from on their household and community, if they encountered similar incidents in future. The variables and indicators used in this study are presented in table 3.

Table 3. Perceptions of Impacts Levels of Impacted Households (HH)

Indicators and variables	Household group (n)		
Impact of Formosa to HH main livelihood	Service	Fishing	Aquaculture
Little (n=10)	4	3	3
Serious (n=222)	55	94	73
Very serious (n=288)	111	103	74
Impact of Formosa to HH income	Service	Fishing	Aquaculture
Little (n=8)	2	3	3
Serious (n=251)	62	104	85
Very serious (n=261)	106	93	62
Impact of Formosa to HH life	Service	Fishing	Aquaculture
Little (n=10)	3	4	3
Serious (n=295)	79	122	94
Very serious (n=215)	88	74	53
Impact of Formosa to community	Service	Fishing	Aquaculture
Little (n=5)	1	1	3
Serious (n=355)	84	149	122
Very serious (n=160)	85	50	25
Impact of similar event in future to your HH	Service	Fishing	Aquaculture
Little (n=18)	12	3	3
Serious (n=293)	87	120	86
Very serious (n=209)	71	77	61
Impact of similar event in future to community	Service	Fishing	Aquaculture
Little (n=16)	10	3	3
Serious (n=337)	91	133	113
Very serious (n=167)	69	64	34

A majority of the respondents assumed that the incidents posed serious or very serious impacts on all aspects. Noticeably, 55% perceived that their income was significantly changed due to the incidents. 99% said that Formosa, the

company itself had a great influence on the local community (68% assessed serious and 31% perceived very serious impacts). Serious and very serious impacts on households' lives were agreed by 98% of interviewees. Around 96% foresaw that similar events in the future will also create dramatic changes to their own household and the whole community.

Such perception can be explained by the fact that almost all interviewed households have one or two main income sources that come from fishing, aquaculture or service-dependent marine. When the Formosa incident occurred, they had to stop all their income activities. Reduced, even stopped access to resources and a declining resource base are ongoing the Formosa incident for resource-dependent fishing households and communities. In addition, these households have less agricultural land and income sources from other livelihoods, even they do not have agricultural land so it was very difficult to change to new livelihood.

During the in-depth survey, a farmer from Ky Khang commune explained that "*…my family income only depends on catching fish by small boat, but now all catching activities have to stop because of the water pollution. We also do not have any land for agricultural cultivation or livestock production, so our income is so serious…*".

3.4. The types of adaptation measures at household level after the Formosa incident

The results from in-depth interview and surveyed households showed that at least 14 different adaptation measures are most commonly used in or advocated (table 4). These adaptation measures have been conducted at household level. The question that interviewers asked respondents: *which measures you already used after the Formosa incident to overcome the reducing income and lost other cost*.

More than half of respondents (53.1%, n=233) indicated that they adopted reducing expenditure in their production, particularly near-shore fishing household group (n=111). Borrowing money from the banks and other financial institutions was also a common strategy as reported by 52.6% of respondents.

Other adaptation practices by each household groups was markedly different. For fishing households, moving to offshore catching fish activities was the main transformation by more than 50% households in this group because the fish quality has saved and appropriate to market demand. In addition, they have also moved to other livelihood activities such as livestock raising (n=68), wage labor

(n=56), collective activities (n=55) and business (n=51). For service group, livestock raising, asking for relatives' support and rural services are top three common practices. Less than 30% of aquaculture household groups adapted by collective activities, asking for relatives' support and business linkage.

9.5% of interviewees had to sell their assets to compensate the loss in income and 5% had to move to other locations for jobs.

Table 4. Adaptation Measures after the Formosa Incident

#	Response/activity during affected (n)	%	Service household (n)	Fishing household (n)	Aquaculture household (n)
1	Reduce expenditure (n=233)	53.1	58	111	64
2	Access loan (n=221)	52.6	79	70	72
3	Livestock raising (n=135)	32.1	39	68	28
4	Collective activity (n=128)	30.5	28	55	45
5	Offshore fishing (n=123)	29.3	8	105	10
6	Business linkage (n=102)	24.3	20	51	31
7	Trading (n=98)	23.3	49	28	21
8	Relative support (n=96)	22.9	35	29	32
9	Aquaculture (n=92)	21.9	10	17	65
10	Wage labor (n=84)	20.0	25	56	3
11	Rural service (n=62)	14.8	32	16	14
12	Crop production (n=50)	11.9	11	33	6
13	Sell assets (n=40)	9.5	6	24	10
14	Migratory labor (n=21)	5.0	3	12	6

3.5. Government responses to the Formosa incident

The Formosa incident starting on 6th April 2016 caused the massive deaths in the seas of four provinces in Central Vietnam. Besides the strategies of

household level to cope, adapt, or transfer their livelihood after the incident happened, there have been several responses and supports from the government and local authorities. (Phuoc et al, 2019).

- First, providing urgent human support including foods (rice) and money for the people and fishery-based business owners who experienced income lost as parts of the incident impacts during 6 months.

- Second, the government combined with the international stakeholders to assess and monitor safety marine environment and seafood to provide base for making a responding plan. The result was that the Formosa Company was forced to commit a fund of 500 million USD as parts of compensation for the responding plan implementation.

- Third, the government assessed the environmental damage and human impact from the incident to provide bases for compensation and other responding plan implementation for household impacted in 4 provinces. The total of budget for compensation to household impacted was 6,516 VND billion.

- Fourth, besides the compensation related to money and food, the government also implemented the socially supportive policies such as health insurance, tuition fee reduction for children, pupils and students during two years 2016-2018, and vocational training for the people who want to change livelihood.

- Fifth, the government has continued supports such as developing fishery-based production, aquaculture, and business including providing low-interest loans, building fishery infrastructure, and developing marine tourist.

- The last strategy was rehabilitating and protecting marine environment and fishery resources through several formal documents from the MONRE and Vietnam government to manage the activities of the Formosa Company.

> *A female household head (Ms. Nguyen Thi Quyen, Ngu Thuy Bac, Quang Binh) said: "My family life mostly relies on my son. He works as a hired labor on a fishing boat. It is always difficult because of low income and of more expense for the children going to school. I do raising pigs and chickens at home for subsistence. After the incident occurred we have no income for over 6 months. Life became very hard. Getting a new job is not easy because many people are looking for jobs. With little support from government, we increased raising animals and tried to do crop production. This was not much help because this is seasonal. My son had to join a bigger fishing boat in other commune to do off-shore fishing as this was still allowed. The cash compensation provided better help but it came very late after 1.5 years".*

3.6. The status of recovery after 30 months of the Formosa incident by local households

To understand the status of recovery after 30 months of the Formosa incident by different household groups, the respondents were asked to assess the progress of their recovery at three levels (completely recovered, on-going and impossible to recover) in terms of four aspects: main livelihood activity, household income, household living and community. The variables and indicators used in this study are presented in table 5. The results from households interviewed showed that, 53% households of three groups and community completely recovered and 44% are under recovery after 30 months of the Formosa incident.

Table 5. Perception of Household Respondents on Recovery after 30 Months from Incident

Aspects	Recovery level	Service	Fishing	Aquaculture	Grand
Main livelihood activity	Recovered	112	98	67	277
	Being recovering	56	100	74	230
	Impossible recovered	2	2	9	13
Household income level	Recovered	103	103	61	267
	Being recovering	66	94	88	248
	Impossible recovered	1	3	1	5
Household living	Recovered	113	109	86	308
	Being recovering	55	89	63	207
	Impossible recovered	2	2	1	5

Only a few households responded that they were impossible to recover their original livelihoods. These households are poor ones whose livelihoods have been converted. Therefore, it is difficult for them to return their previous livelihoods. However, the households who are able and will recover their livelihoods after 30 months explained that thanks to the government's support policies and the efforts of local governments to help people overcome the most difficult period then step by step recover the livelihood. In addition, the interviewed households also pointed out that their main and traditional livelihoods are fishing and aquaculture, so transformation to other livelihoods is challenging.

4. Discussion and Conclusion

The findings of this research highlight impacts that Formosa incidents posed on local livelihoods after 30 months in terms of duration and income loss. It is shown that more than half of local community had to stop their main income generating activities from 6 to 12 months but the impacts still last much longer even though the government allowed the fishers to resume their jobs after six months. This was because marine water quality was not perceived as safe for seafood consumption by local customers and seafood market. Aquaculture households even had to wait for one year until the government announced the water is absolutely safe for this activity. Consequently, this group was the one suffering the greatest loss in income. On average, the annual household income in four provinces was reduced by 116.5 million VND/household but this loss for aquaculture group was much more significant at 164.1 million VND/household. People also had to pay for higher production cost under the impacts of the incidents and pauses in all activities. Aquaculture group had to pay 339.1 million VND/households on average to maintain machines and ponds at least half of the year without any revenue to cover the cost. Fishermen also had to pay 101 million VND/households to cover the cost of transforming to offshore fishing. The service group has more households with delay in income from 13 to 24 months after the incidents as their income depends on the recovery of other two groups. However, apart from fishing products, this group has other income sources such as crop or livestock production, hired jobs or seasonal migration, etc. so their actual income loss became less than the other two groups, at around 58.4 million VND/household. Despite these differences in impact duration and income loss, the vast majority of the respondents perceived that the incidents posed serious to very serious impacts on their income, their jobs, and their lives and stated that the company created negative changes to their community.

To response to these changes, people adopted different strategies but mainly reducing daily expenditure, borrowing money from the banks or relatives and living on livestock raising. Particularly, for fishing group, moving to offshore fishing is the main trend as encouraged by local government. A small proportion of around 9.5% of interviewees had to sell their assets to cover the loss in income and 5% had to move to other locations for jobs.

There are several government policies to help people overcome difficulties in short term including providing rice, subsidizing health insurance, reducing

tuition fee for children, pupils and students during two years 2016-2018, and vocational training for recovering people life. Especially, the government played a critical role in pushing Formosa to compensate 500 million USD for impacted people and communities.

After two and a half years after the Formosa incident, 53% households of three groups and community completely recovered, 44% are under recovery and 2.5%, mainly poor households said that they could not recover at all.

Extreme events are nothing new to the Central people in Vietnam, particularly related to climate variations. However, the anthropogenic marine environmental incidents were indeed new extreme event in this area. Perception of impacted households and community to impact levels and understanding impacts of the anthropogenic marine environmental incidents have positively influenced the capacity as well as duration to recovery. We found that most of three of household groups are very aware of impacts of the Formosa and therefore they already have and are most willing to invest in coping strategies as well as consensus with support and guideline to recovery livelihood and life from the central and local government.

Besides that, the household's ability to the recovery also depends on the availability of other sources of income including remittances from family members living outside the area, informal loans from money lenders or from the government and systems of mutual support at the government and community level (Pomeroy *et al.*, 2006). Therefore, the livelihood resilience process of coastal livelihoods is not only about giving people jobs, it also requires addressing fundamental social, economic, and environmental reforms that affect coastal communities and livelihoods.

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