Chapter 49
A Stakeholder Delphi Study on the Adaptive Capacity of Local Communities to Climate Change in the Coastal Area: Case Study in An Duong District (Hai Phong, Vietnam)

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Abstract Hai Phong, a coastal city in the Vietnam Red River Delta, is considered to be one of the ten cities most threatened by climate change in the world. This paper presents the impacts of climate change - related to hazards and adaptive capacity of local communities of the An Duong district, Hai Phong city. The study deals with applying the Delphi technique combined with the PSR (Pressure-State-Response) framework. The research established a catalog of 18 questions and 18 statements, indicating the PSR constituents. Delphi questionnaires allow the agreement to be identified among a stakeholder group's respondents. 40 panel members engaged in a two-round Delphi process. The results indicate that the establishment of advanced agricultural production models, the intensification of training courses on farming techniques and response to climate change, and the economical use of energy should be the main responses in An Duong. The value of Kendall's W in the second round is 0.738, gaining "very strong agreement" and "very high confidence" from the panel members. The contribution of Delphi results achieves a significant impact on local socio-economic development, namely in ecosystem-based management, sustainability, and climate change-resilient goals.

Keywords Climate change · Adaptative capacity · Local communities · Delphi technique · PSR framework · An Duong district · Hai Phong city

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A. T. Nguyen, L. Hens (eds.), *Global Changes and Sustainable Development in Asian Emerging Market Economies Vol. 2*, https://doi.org/10.1007/978-3-030-81443-4_49

1 Introduction

Vietnam is among the countries most seriously affected by climate change and sea level rise, especially in coastal regions (Cruz et al., 2007; MONRE, 2012; Thayer, 2007; United Nations [UN], 2009). Hai Phong is a coastal city on the Red River Delta that has undergone the consequences of climate change, especially sea level rise, extreme weather events (tropical storm, flood, drought, etc.), and annual average temperature increases (Hai Phong Government [HPG], 2015; MONRE, 2010). According to the Organization for Economic Co-operation and Development (OECD), Hai Phong is one of the ten cities in the world that has been threatened the most by climate change. The climate change scenario given by the Vietnamese Ministry of Natural Resources and Environment in 2016 shows that the temperature of Hai Phong can increase by 0.6 to 1.4 °C; its heatwaves have increased as well over a period of 20 years (from 2016 to 2035) (MONRE, 2016). According to the meteorological observation of the North East Hydro-meteorological Station, the end of January in 2016, which is the coldest month, has the lowest temperature among months of 4.5 °C at Phu Lien C station. This has been the lowest temperature in Hai Phong for nearly 50 years (since 1968), which caused considerable impacts on the socio-economic situation in the region, especially on the agricultural ecosystem of Hai Phong city, such as damage to plants, animals, and humans (Hai Phong Statistical Office [HSO], 2018).

The Delphi technique contributes ideas aiming for early prediction of the effects of climate change, giving warning situations about the consequences of climate change (Biloslavo & Grebenc, 2012), eliciting adaptive solutions (Biloslavo & Dolinšek, 2010). In addition, this technique supports analyzing the trend and vulnerability of affected populations (Yang & Kim, 2013; Yoon et al., 2013). The study integrated stakeholder Delphi techniques with the PSR framework (Pressure-State-Response) to evaluate how climate change impacts agriculture in An Duong district, Hai Phong city, and adaptive solutions of local communities to climate change. These provide information to managers, policymakers, and local communities to help them to improve their adaptability to climate change in a sustainable way.

2 Methodology

2.1 Study Area

The Red River Delta (Vietnam) has ten provinces including four Gulf of Tonkin-bordered provinces: Hai Phong, Thai Binh, Nam Dinh, and Ninh Binh. An Duong district is located in the northwest of Hai Phong city, with 15 communes and 1 town. The terrain of the district is not smooth, sloping from North to South, with average height compared with sea level ranging from +0.3 to +0.7 m. The total area of natural land in An Duong district is 97.6 km^2, in which agricultural land occupies about

10.67% (104,125.5 ha) (Hai Phong Statistical Office [HSO], 2014). An Duong district, which is located in the economic triangle of Hanoi–Hai Duong–Hai Phong, especially with Highway 5, has favorable conditions for agricultural development. Therefore, An Duong district is one of the major agricultural districts of Hai Phong city today. According to the plan of the city to 2020, An Duong district was planned to be one of the agricultural production belts in the direction of specialized production to provide food and foodstuff for the city and nearby areas (Vietnam Government [VG], 2001). The main crops of the district are rice (39,870.58 tons) and vegetables (41,247.08 tons); common livestock is pigs (37,069) and poultry (572,400) (An Duong People's Committee [ADC], 2018). In agricultural activities, the district has been experimenting an agricultural model that applies new farming methods and advances in science and technology to adjust farming techniques, and the model is replicated throughout the whole city. According to the Department of Agriculture and Rural Development of Hai Phong city, An Duong is one of the three districts that are most affected by climate change (An Duong Department of Agriculture and Rural Development [ADDA], 2018).

2.2 PSR-Based Stakeholder Delphi

The Delphi technique was first developed by the Rand Corporation in the United States in the early 1950s. This technology has been applied flexibly in many areas of research such as medicine (Sinha, Smyth, & Williamson, 2011), social policy (Adler & Ziglio, 1996), tourism (Donohoe & Needham, 2009), sustainable development (Hugé, Le, Pham, Kuilman, & Hens, 2010), and has been comprehensively assessed in many places (Linstone, 1975; Lock, 1987; Parenté & Anderson-Parenté, 1987; Stewart, 1987). Membership of Delphi techniques focused on solving a problem through organized surveys (Hasson, Keeney, & McKenna, 2000). Delphi techniques have at least two rounds of inquiry corresponding to at least two structured questionnaires (Rowe & Wright, 1999). Members respond to questions in the form of anonymous feedback. This technique can be used to predict future problems (Dalkey & Helmer, 1963; Paliwoda, 1983) and to solve the problems (Martin et al., 2012; McBride et al., 2012). The Delphi Group is more efficient than the statistical groups and the standard interactive groups (Rowe & Wright, 1999).

This study integrates the Stakeholder Delphi technique with a PSR model. In this study, the Delphi process established 18 questions for the first round and 18 statements for the second round of the investigation. The list of these questions is presented in the PSR model as follows: five questions on pressure (P; the main cause of local environmental damage, pressure leading to environmental damage and change in agriculture), eight questions on state (S; time, observation and magnitude of climate change occurring in the local area, effects of climate change on local agriculture), and five questions on response (R; agricultural solutions that local communities use to cope with climate change). There have been 40 panel members in total who were randomly picked from four stakeholder groups in this study. They

represent expert groups: local authorities (12), farmers (18), agricultural engineers (5), and agricultural product traders (5). The 12 panel members of the authorities work at the People's Committee of An Duong district (1), the Department of Natural Resources and Environment of An Duong district (6), the Department of Agriculture and Rural Development of An Duong district (3), the Department of Culture and Information of An Duong District (1), the Economic and Infrastructure Department of An Duong District (1). Five agricultural engineers are officials of An Duong District Agricultural and Fisheries Center. The 23 panel members who are agricultural product traders and farmers live in communes severely affected by natural risks, namely Dai Ban (3), Le Thien (3), Tan Tien (3), An Hung (2), Hong Phong (2), An Hoa (2), Quoc Tuan (2), An Dong (2), Dong Thai (1), Hong Thai (1), Nam Son (1), and Dang Cuong (1). Expert groups here are selected as they are knowledgeable and prestigious in the field of research. Approval was obtained from the local ethics committee.

In this study, the Delphi process is conducted through three main steps:

Step 1. Preliminary. Defining objectives and developing a comprehensive set of questions based on the content of climate change impacts on agriculture, feedback ability of the agricultural system, and the responses to climate change by local communities. Establishing sample size and selecting panel members (experts). The preliminary phase took place between 4 February and 2 March 2018.

Step 2. Round 1. The steps for this round include: preparation, pre-test and revising the open questions in accordance with the locality; introduction of the initial questionnaire (including open questions) to the panelists; submitting the questionnaire consist of 18 questions to 40 experts; getting feedback from panel members, and analyzing the collected data. The data set up the foundation for a new closed questionnaire, which would be used for the second round. This round took place from 2 to 20 May 2018.

Step 3. Round 2. This step constitutes the second round of the Delphi survey, which was conducted during the field trip between 5 and 27 August 2018. Based on the results of Round 1, the study selects highly valued answers to transfer into statements. Eighteen statements were established. Experts used a Likert scale (10 points, from 1 (total disagreement) to 10 (total agreement) to assess the degree of agreement for 18 statements. For each statement, the average score, standard deviation, and quartile were computed. The reliability of the responses was assessed using Kendall's coefficient of concordance (Schmidt, 1997) (Table 49.1). In this study,

Table 49.1 Interpretation of the agreement and confidence of Kendall's W (Schmidt, 1997)

Kendall's W	Agreement	Confidence in ranks
>0.7–1.0	Very strong	Very high
>0.5–0.7	Strong	High
>0.3–0.5	Average	Average
> 0.1–0.3	Weak	Low
0.0–0.1	Very weak	None

round two has a value of 0.738 ($p < 0.001$), which refers to “very strong" agreement and a “very high” degree of confidence (Schmidt, 1997). Hence, the Delphi process was terminated after round 2. Finally, the recorded results were reported back in favor of providing information for all panel members.

3 Results

3.1 Round 1

3.1.1 Pressure

Table 49.2 presents the main causes of environmental damage in An Duong district. There are two main factors being mentioned in this section: agricultural activity and non-agricultural activities. The results show that the over-use and abuse of plant protection chemicals and fertilizers (chosen by 37/40 respondents) and agricultural waste, which have not been rationalized (36/40 choices), are the two main causes of environmental damage. These elements were integrated and cited in the statement “S_1.1” in round 2. In off-farm activities, the rapid development of local industry (34/40 choices) has damaged the environment. This cause is transferred to round 2 with content code “S_1.2”.

Industrial energy consumption and waste generation are the principal sources of stress from economic activities that change in agriculture. Thirty-eight out of 40 respondents assert that industrial waste was the main contributor to these problems; 32/40 panel members indicated that the changes in agriculture were due to energy consumption by industry. These choices are shown in the statement “S_1.3” in round 2. The reasons for agriculture variation stemmed from climate change (38/40), indicated in the statement “S_1.4”. Land use change (35/40), and market demand and price for agricultural products (37/40) also led to changes in agricultural production at the local level. These two elements are combined and presented in the statement “S_1.5”.

3.1.2 State

This section contains eight questions relating to the occurrence of extreme weather events, their manifestations, the impacts of climate change risks on agricultural production, and affected groups (Table 49.3). About 5–10 years ago, extreme weather events were more regular and more destructive (33/40 choices). Climate change occurs locally through the following manifestations: extreme weather events (storms, prolonged heat) occur more frequently and more severely (37/40 choices) and the increase in annual average temperature (31/40 choices). Twenty-eight out of 40 agreed with the opinion of the agricultural sector that it was heavily influenced

Table 49.2 Questions about Pressure (P) and response by the respondents in round 1

Code	Questions	Answers	Number of responses/ total responses	Most frequently chosen alternative	Symbols presented in round 2 statement (S code)
Q_1.1	What are the principal dynamics of agriculture adversely affecting the environment?	Abuse of plant protection chemicals and fertilizers	37/40	- Abuse of plant protection chemicals and fertilizers - Agricultural waste not properly treated	S_1.1
		Over-farming	17/40		
		Agricultural waste not properly treated	36/40		
Q_1.2	What are the principal dynamics of non-agricultural activities adversely affecting the environment?	Industry	34/40	Industry	S_1.2
		Transport	20/40		
		Tourism	13/40		
		Activities of dwellers (cooking, littering, etc.)	13/40		
Q_1.3	What are the principal pressures from economic activities that lead to changes in agricultural production?	Energy consumption by industry	32/40	- Energy consumption by industry - Waste generation (industry, agriculture, etc.)	S_1.3
		Energy consumption by transport	19/40		
		Waste generation (industry, agriculture, etc.)	38/40		
		Other sources (economic development of the surrounding areas, etc.)	5/40		
Q_1.4	What are the main biophysical pressures that lead to changes in agricultural production?	Climate change	38/40	Climate change	S_1.4
		Land degradation	22/40		
		Natural disease outbreaks (insect epidemics, animal epidemics, etc.)	20/40		

(continued)

Table 49.2 (continued)

Code	Questions	Answers	Number of responses/ total responses	Most frequently chosen alternative	Symbols presented in round 2 statement (S code)
Q_1.5	What are the main social pressures that lead to changes in agricultural production?	Market demand and price for agricultural products	37/40	- Market demand and price for agricultural products - Land use change	S_1.5
		Change in state agricultural policy	21/40		
		Land use change	35/40		

by climate change. The above three answers are transferred to round 2 corresponding to the statements "S_2.1," "S_2.2," and "S_2.3."

The impact of climate change on the productivity of crops and livestock (33/40 choices), increasing epidemics, and emerging new diseases (31/40 choices). These two elements are transferred into the content of the statement "S_2.4." Climate change has altered the cultivated area (narrow area; 34/40 choices), changed the crop's seasons (34/40 choices), changed the structure of crops and livestock (32/40 choices), and changed agricultural techniques (31/40 choices). These are the contents of the statement "S_2.5." Food crops (33/40 choices) and poultries (29/40 choices) were affected by the increase in extreme weather and natural disasters, appearing in "S_2.6" and "S_2.7." Climate change also affects the community. Most panel members agree that the group of people affected by climate change are farmers (32/40 choices) and local people (29/40 choices) who are present in the statement "S_2.8" of the second round.

3.1.3 Response

The second round's statement "S_3.1" contains the contents of establishing advanced agricultural production models (36/40 choices), intensifying training courses on farming techniques and responding to climate change (35/40 choices), and mainstreaming climate change responses into agricultural development policy (30/40 choices). These factors are selected from question "Q_3.1" of round 1. Thirty-five out of 40 members presented that adaptation measures locally were inadequate ("S_3.2"). In an effort to adapt to the detrimental effects of climate change, panel members indicated that governments locally provide financial support to farmers to overcome the consequences of climate change (35/40 choices), support of seed sources and livestock (32/40 choices), and seasonal changes in agricultural production and farming practices (31/40 choices) are the appropriate solutions. The three solutions are presented in the "S_3.3" statement of round 2. In other areas, the use of energy saving in socio-economic activities (38/40 choices) and

Table 49.3 Questions about States (S) and responses by the respondents in round 1

Code	Questions	Answers	Number of responses/ total responses	Most frequently chosen alternative	Symbols presented in round 2 statement (S code)
Q_2.1	Since when have the extreme weather events been occurring more regularly and more destructively until now?	5–10 years	33/40	5–10 years	S_2.1
		10–20 years	4/40		
		20–30 years	3/40		
		Unknown	1/40		
Q_2.2	How has climate change manifested during past years?	Extreme weather events (storms, floods, droughts, prolonged heat, etc.) occur more frequently and more severely	37/40	- Extreme weather events (storms, prolonged heat) occur more frequently and more severely - Annual average temperatures follow upward trend	S_2.2
		Annual average temperatures follow upward trend	31/40		
		Seasons of the year change the time period of appearance	19/40		
		The change in rainfall	19/40		
Q_2.3	How is the magnitude of change in agricultural production due to climate change impacts?	Relatively considerable change	28/40	Relatively considerable change	S_2.3
		Negligible change	10/40		
		Stay unchanged	2/40		
Q_2.4	What are the major impacts of climate change on local plants and animals?	Impact on growth and development	23/40	- Impact on productivity - Rise of diseases and breeding of new types of diseases	S_2.4
		Impact on productivity	33/40		
		Rise of diseases and breeding of new types of diseases	31/40		
		Impact on the quality of agricultural products	22/40		

(continued)

Table 49.3 (continued)

Code	Questions	Answers	Number of responses/ total responses	Most frequently chosen alternative	Symbols presented in round 2 statement (S code)
Q_2.5	What is the change in agricultural production owing to the climate change impacts in the locality?	Change in the area (narrowing or expanding) or shift of agricultural production location	34/40	- Change in the area (narrowing) of agricultural production location - Change in a crop's seasons - Change in the structure of crops and livestock - Change in agricultural techniques	S_2.5
		Change in a crop's seasons	34/40		
		Change in the organization of crops and livestock	32/40		
		Change in agricultural techniques	31/40		
		Improving and building an irrigation system	12/40		
Q_2.6	How does the increase in extreme weather events and natural disasters impact mostly on crops?	Food crops	32/40	- Food crops	S_2.6
		Vegetables	4/40		
		Fruits	3/40		
		Others	1/40		
Q_2.7	How does the increase in extreme weather events and natural disasters impact mostly on livestock?	Cattles	8/40	- Poultries	S_2.7
		Poultry	29/40		
		Seafood	3/40		
Q_2.8	Which groups of people in society were most susceptible to climate change catastrophes?	Farmers	32/40	- Farmers - Local people	S_2.8
		Local people	29/40		
		Agricultural merchants	14/40		

Table 49.4 Questions about Responses (R) and responses by the respondents in round 1

Code	Questions	Answers	Number of responses/ total responses	Most frequently chosen alternative	Symbols presented in round 2 statement (S code)
Q_3.1	What are local government solutions that support farmers and minimize the impact of extreme weather events and natural disasters on agriculture?	Establishing advanced agricultural production models	36/40	- Establishment of advanced agricultural production models - Intensifying training courses on farming techniques and responding to climate change - Mainstreaming climate change response policies into agricultural development policy	S_3.1
		Intensifying training courses on farming techniques and responding to climate change	35/40		
		Mainstreaming climate change response policies into agricultural development policy	30/40		
		Strengthening the construction of the reservoir system, ensuring water supply during the dry season and water retention during the rainy season	19/40		
Q_3.2	What about the assessment of the current adaptation solutions to handle climate change issues?	Inadequate	35/40	Inadequate	S_3.2
		Sufficient	5/40		
Q_3.3	What are solutions to help farmers acclimatize to climate change?	Financial support	35/40	- Financial support - Support the source of seeds and livestock - Changes in agricultural production and farming practices	S_3.3
		Support the source of seeds and livestock	32/40		
		Changes in agricultural production and farming practices	31/40		
		Use of plants and animals that can adapt to harsh conditions (prolonged heat, salty soil, etc.)	25/40		

(continued)

Table 49.4 (continued)

Code	Questions	Answers	Number of responses/ total responses	Most frequently chosen alternative	Symbols presented in round 2 statement (S code)
Q_3.4	How to reduce greenhouse gas emissions into the atmosphere?	Using energy saving in socio-economic activities	38/40	- Using energy saving in socio-economic activities - Planting trees, growing forests	S_3.4
		Planting trees, growing forests	32/40		
		Redirecting using other forms of energy (solar, wind, etc.)	25/40		
Q_3.5	What kind of renewable energy should be developed in the future in Hai Phong?	Solar energy	34/40	Solar energy	S_3.5
		Wind energy	3/40		
		Tidal energy	3/40		

planting trees and growing forest (32/40 choices) are the two most commonly chosen options. Thus, they were moved to round 2 with the content in the statement "S_3.4". Solar energy development (34/40 choices) is the most recommended solution in the future in Hai Phong ("S_3.5"). The results of this section are shown in Table 49.4.

3.2 Round 2

Table 49.5 presents the results of the second round. Forty experts assessed 18 statements using a Likert scale. Overall, the average values of 18 statements was very high (8.98 to 10). The standard deviation is relatively low (0.00 to 2.43). This proves that the consensus of experts on these 18 statements is very strong.

Figure 49.1 depicts the average scores of 18 statements. Expression S_2.6 has an absolute mean score (mean = 10.0), which is the consensus of 40 members on the Delphi board. There were three statements with the lowest mean scores of S_1.1, S_1.5, and S_2.3 (mean = 8.98).

3.2.1 Pressure

The abuse of pesticides and chemical fertilizers and the agricultural waste that has not been properly treated are agricultural activities that cause environmental damage. Statement S_1.1 was rated high, with an average score of 8.98, standard

Table 49.5 Statistical analysis data for perceived statements on climate change in round 2

Statements	Mean	Minimum	Maximum	Standard deviation	Quartiles		
					25%	50%	75%
S_1.1	8.98	7	10	0.85	8.00	9.00	10.00
S_1.2	9.08	7	10	0.74	9.00	9.00	10.00
S_1.3	9.00	7	10	0.87	8.00	9.00	10.00
S_1.4	9.45	5	10	1.89	10.00	10.00	10.00
S_1.5	8.98	6	10	2.23	7.25	10.00	10.00
S_2.1	9.20	7	10	0.78	9.00	9.00	10.00
S_2.2	9.45	7	10	0.51	9.00	10.00	10.00
S_2.3	8.98	7	10	1.15	8.00	9.00	10.00
S_2.4	9.28	7	10	0.77	9.00	10.00	10.00
S_2.5	9.25	6	10	1.06	9.00	10.00	10.00
S_2.6	10.00	10	10	0.00	10.00	10.00	10.00
S_2.7	9.33	8	10	0.48	9.00	9.00	10.00
S_2.8	9.33	4	10	2.43	10.00	10.00	10.00
S_3.1	9.35	7	10	0.90	9.00	10.00	10.00
S_3.2	9.68	8	10	0.48	10.00	10.00	10.00
S_3.3	9.40	7	10	0.76	9.00	10.00	10.00
S_3.4	9.60	8	10	1.53	10.00	10.00	10.00
S_3.5	9.78	9	10	0.28	10.00	10.00	10.00

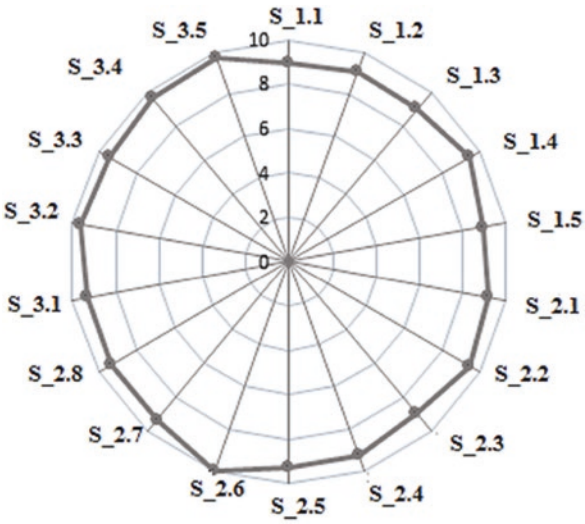

Fig. 49.1 Mean results of the Delphi survey statements in the second round

deviation 0.85. Industrial activity is thought to be the cause of the environmental damage. This is in the statement S_1.2, with an average score of 9.08 and a standard deviation of 0.74.

In the opinion of experts, the energy consumption in industry and the generation of waste in industry and agriculture have changed the agricultural activity (S_1.3;

mean = 9.00). Climate change is the natural pressure to change agriculture (S_1.4) with an average of 9.45. Social activity also exerts pressure on agriculture through changing market demands for agricultural products and changes in land use. This is S_1.5 with an average score of 8.98.

3.2.2 State

Climate change has been occurring locally. According to experts, extreme weather events are more frequent and more devastating than 5–10 years ago (S_2.1; mean = 9.20). Its local manifestations include extreme weather events (storms, floods, droughts, prolonged heat, etc.) occurring more often and more severely, annual temperatures increasing considerably (S_2.2; mean = 9.45). These phenomena have a great influence on agricultural production. This content is in S_2.3 with an average score of 8.98.

Experts show that climate change affects agriculture. They argue that climate change affects plant productivity, growth, and development, and increases disease (S_2.4, mean = 9.28). Climate change also changes the area of agricultural land, production seasons, crop structure, and farming practices (mean = 9.25). In statements S_2.6 and S_2.7, experts agree that food crops and poultry are most severely affected by climate change, with mean scores of 10.00 and 9.33 respectively. Statement S_2.8 shows that farmers and people living and working in the locality are also affected by climate change, with an average score of 9.33.

3.2.3 Response

The mean values of response measures have been rated very high (9.35–9.78). Almost all of panel members agreed with the five statements of this section because they realized the feasibility of the measures. Options to mitigate the impacts of climate change on agriculture can be applied locally, including the establishment of advanced production models, the intensification of training courses on farming techniques, adaptation to climate change, and insertion policies to cope with climate change in agricultural development policy. This statement has an average score of 9.35. With an average score of 9.68, the S_3.2 statement shows that most of the members have found that the government taking measures to adapt to climate change is not enough. Experts have come up with a high degree of consensus on the solutions to help farmers acclimatize to climate change (S_3.3; mean = 9.4). Efficient and energy-saving use in socio-economic activities, tree planting, the forest growth and the development of solar energy are the most valued solutions to reduce greenhouse gas emissions that are the cause of climate change (S_3.4; mean = 9.6; S_3.5; mean = 9.78).

Table 49.6 Kendall's W and the level of consensus assigned in round 2

n	Kendall's W	*P*	Agreement	Confidence in ranks
40	0.738	< 0.001	Very strong	Very high

3.3 Kendall's W Test

The feedback of the panel members collected in the second Delphi round allows a Kendall's W of 0.738 to be calculated. It could be seen from Table 49.6 that the panel members reached consensus with a "very strong agreement" and obtained "very high confidence" in ranks. Therefore, the Delphi process stops round 2.

4 Conclusions and Discussion

Climate change has had a significant impact on the coastal communities of Vietnam (Cruz et al., 2007; Thayer, 2007; United Nations [UN], 2009). Adapting and mitigating these impacts is becoming a matter of concern to the public. Adaptation to climate change, however, depends on many other social factors, such as injustice, environmental pollution, or famine (Colagiuri, Boylan, & Morrice, 2015; Eriksen et al., 2011).

Hai Phong is the largest port city in the North of Vietnam. In addition to industrial and transportation development, the city's agriculture is also important. An Duong is an example of agricultural production in Hai Phong. However, climate change and a number of other factors are threatening the district's agriculture. In order to identify the main factors affecting agriculture and to propose appropriate solutions, an integrated approach would allow the complexities surrounding this relationship to be removed (Doria, Boyd, Tompkins, & Adger, 2009; EEA, 1995; Newton & Weichselgartner, 2014). The combination of the Delphi technique between the stakeholder and the PSR model in this study demonstrates the effectiveness of the integrated approach in determining the causes, effects of climate change, and appropriate solutions to respond to climate change in An Duong district, Hai Phong. The results of the study are as follows:

- Pressure: industrial and agricultural waste, industrial energy consumption, climate change, land-use alteration, and the variation of market demand and price for agricultural products are the key dynamics that lead to changes in agriculture.
- State: extreme weather events are more regular and more detrimental compared with 5–10 years ago. The manifestations of climate change in the locality include extreme weather events (storms, prolonged heat) that appear at an increasingly serious level, the annual average temperature has increased considerably, and affects agriculture. Climate change impacts on the productivity of crops and livestock with increased disease and changes in the area of agricultural land. The two agricultural factors that are most heavily affected by climate change are food

crops and poultry. Farmers and people living and working in the area are also affected by climate change.

– Response: in agriculture, people should adopt advanced agricultural models and improve their knowledge of climate change issues and acclimatize to climate change. Agricultural development policies should integrate climate change and local governments should support agricultural materials (seeds, livestock, fertilizers, etc) and financial aid for farmers to overcome the consequences of climate change. Residents should carry out environmental protection and energy conservation activities in socio-economic activities.

Eighteen statements of the three PSR components are subject to evaluation by 40 experts on the review panel. Planning is determined by a number of factors, in which the consensus of stakeholders on the research issue is an important factor (Linstone, 1975). Most experts believe that the statements content of this study is consistent with the real situation in An Duong district, Hai Phong. Therefore, they rated a very strong degree of agreement with these statements (mean = 8.98–10.00). According to the plan of Hai Phong city up to 2020, An Duong district's agriculture was to develop in the direction of specialization (Vietnam Government [VG], 2001). However, at present, agricultural production has not effectively applied the advanced production models and technology. Agriculture in the district still faces many difficulties in investing capital for production, implementation of advanced farming techniques, and especially in responding to climate change. The misuse of both pesticides and chemical fertilizers still continues in the district. This is a major threat to the environment of An Duong district. During the implementation of the Delphi survey rounds, the study looked at farmers' perceptions of the use of chemicals in agriculture. About 75% of farmers use more than just drugs and fertilizers. In the period 2010–2018, the weather in An Duong district as well as Hai Phong has complex occurrences. Average annual temperatures increased significantly (Hai Phong People's Committee [HPC], 2018; Haiphong's Department of Natural Resources and Environment [HPE], 2012). The number of typhoons affecting Hai Phong is also increasing and the average annual rainfall is decreasing (Haiphong's Department of Natural Resources and Environment [HPE], 2012). In addition, diseases in plants and animals also occur abnormally and are quite serious. In 2005 and 2013, bird-flu epidemics occurred and spread throughout Hai Phong city in general and An Duong in particular. In the period of 2006–2012, the outbreaks were controlled to only small ones, but they also severely affected poultry farming in An Duong district, which resulted in the destruction of 100,000 poultry per year (An Duong Department of Agriculture and Rural Development [ADDA], 2018). The cause was determined to be abnormal weather changes, which facilitated the outbreaks.

In addition to the effects of climate change, the agricultural sector of An Duong district is also affected by many factors such as economic restructuring, land-use change, urbanization, industrialization, etc. According to the statistics of An Duong district, in the period 2010–2015, the area of agricultural land decreased significantly (from 10,246.1 ha to 8374.14 ha) (An Duong People's Committee [ADC],

2015). This decline in agricultural land is mainly due to the conversion of agricultural land to land for industry and livelihoods. The orientation of economic development of Hai Phong city to the year 2025 is to become a large and competitive industrial service center and the key to the development of the national economy (Vietnam Government [VG], 2018). Following the general trend of the city, An Duong district gradually shifted its economic structure to the development of industry and services to replace the agricultural sector, for example, industrial parks such as An Duong Industrial Park (812.62 ha), Nomura Industrial Park (153 ha), Trang Due Industrial Park (600 ha) (Hai Phong People's Committee [HPC], 2018). Demand for land use in the area of An Duong and Hai Phong city increased owing to the population increase. Along with that, the speed of urbanization in Hai Phong also increased sharply. According to the Government's plan, in 2020, Haiphong's population should have reached about 2.1 million people with an urbanization rate of 50–55%; by 2025, this would be about 2.25 million people with an urbanization rate of 60–65%; by 2030, about 2.4 million people with an urbanization rate of 65–70% (Vietnam Government [VG], 2018). Increased industrialization and urbanization combined with climate change have reduced the area of agricultural land in the district. This has greatly affected the local agricultural output.

Local authorities have implemented a number of measures to mitigate the consequences of climate change such as: building modern agricultural models and programmes, training people with the knowledge on how to respond to climate change, etc. (An Duong Department of Agriculture and Rural Development [ADDA], 2016). However, the actions taken were not synchronous and persistent; thus, the efficiency was not high. In addition, experts have expressed that the solutions proposed are not enough; more solutions are needed such as planting trees, adjusting crop seasons according to weather conditions, encouraging the development of clean energy sources, as shown in the results. A study on the effects of climate change on the coastal areas of Ha Tinh, Vietnam also pointed out similarities in local adaptation capacity (Nguyen, Vu, Dang, Hoang, and Hens, 2017).

The contents of this study may become a reference for policymakers in setting up measures for responding to the impacts of climate change on agriculture and contributing to solving the problems that the authorities and people in An Duong district are encountering.

Acknowledgments The author would like to thank the households, and the district and commune authorities, as well as the local people, for their assistance and cooperation in completing the questionnaires and providing a discussion of the survey findings.

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