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R E S E A R C H   R E P O R T

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# Assessing the Effects of Information Provision on Policy Decisions Related to Adaptation to Sea-Level Rise in Zhejiang Province, China

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Globally, sea levels are rising as a result of global warming. One country that is being particularly badly affected by this challenge is China, where sea levels are rising at a faster-than-average rate. It is therefore vital that China's coastal communities are able to adapt to these changes. To assess the readiness of such communities to act and to see how they could be helped, a new EEPSEA study looks at how local decision makers in coastal communities perceive and respond to the sea-level rise issue. It also investigates the effects of information provision on decision-makers' opinions and actions.

The study is the work of Jin Jianjun, from the College of Resources Science & Technology at Beijing Normal University. It shows that local decision makers do not place a high priority on the sea-level rise issue. It also shows that providing local decision makers with relevant information raises their awareness of the need to act. However, it also shows that such information does not necessarily lead to action. The study therefore recommends that, alongside increased information provision, local and national government agencies should provide more direct financial and technical assistance and offer more leadership and direction.

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September, 2010

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# **ASSESSING THE EFFECTS OF INFORMATION PROVISION ON POLICY DECISIONS RELATED TO ADAPTATION TO SEA-LEVEL RISE IN ZHEJIANG PROVINCE, CHINA**

Jin Jianjun

## **EXECUTIVE SUMMARY**

Sea levels are rising as a result of global warming. Adaptation is the only option to address the threats caused by sea level rise. Sea levels off the coasts of China have risen at rates higher than the world annual rate and Zhejiang Province has the highest rate in the country. Studies have shown that information provision plays an important role in both individual and institutional decision-making processes. This research aimed to assess how local decision-makers perceived sea-level rise and investigated the effects of information provision on decision-makers' perceptions and actions related to adaptation to sea-level rise in the coastal villages of Zhejiang Province.

The sample group for this study was made up of local village leaders selected from 21 towns on islands in Zhejiang Province. Three kinds of towns (tourism towns, fishery towns and commercial towns) were chosen. In order to study the possible effects of information provision, a controlled experiment was designed. Subjects were randomly assigned to two experimental groups receiving an information brochure on sea-level rise and adaptation to it, or to a control group not receiving any such information. The experiment had three phases.

The hypotheses to be tested were that the village without information and the other two villages with information would produce different outcomes while the two villages with information would produce similar outcomes. The results showed that local village leaders along the Zhejiang coast had little knowledge of global warming and sea-level rise. The study found that while some local village leaders in Zhejiang Province had a positive attitude towards adaptation to sea-level rise, most of them had a negative attitude towards taking specific policy action on this. More than half of them thought that it was the central government's responsibility to take the necessary adaptation measures. The major finding of this study was that providing local decision-makers with information on sea-level rise and related adaptation could significantly improve their knowledge level, and positively change their attitude towards and awareness of sea-level rise adaptation, but would not lead to policy action.

## **1.0 INTRODUCTION**

### **1.1 Background**

Sea-level rise due to climate change is a serious global threat. Latest estimates of sea-level change predict a rise of up to 88 cm within the next hundred years. Related issues are physical changes of coastal regions of the world, ranging from accelerated

storm frequency and intensity, erosion of sand beaches, loss of wetlands, the salination of groundwater and threats of coastal flooding and inundation.

Even if global carbon dioxide (CO<sub>2</sub>) emissions were to cease immediately, global warming impacts would persist until 2050 (Walsh et al. 2004). In other words, the effects of sea-level rise due to global warming cannot be avoided even by global mitigation efforts to reduce CO<sub>2</sub> emissions. For sea-level rise, adaptation is the only option (Lau 2005). Thus, one critical question is how to make better decisions or policies on adaptation to sea-level rise.

China has a coastline of 32,000 km. With 40% of the nation's population, the coastal areas in China contribute to nearly 55% of China's Gross National Product (GNP) and hold 70% of its middle and large-sized cities, which are very susceptible to the impacts of sea-level rise. The news spokesman of the State Oceanic Administration of China announced in 2007 that the coastal sea level in China was rising at 2.5 mm per year on average, higher than 1.8 mm, the world annual rising rate (State Oceanic Administration of China 2007). Moreover, the relative sea level along China's coast has been rising faster than before because of the effects of human activity. Chinese scientists have been paying attention to sea-level rise since the 1980s (Du 1993). However, the literature on sea-level rise is mainly confined to natural science (Cui and Zorita, 1998; Zhang 1997; Li et al. 2000).

There have been several studies on sea-level rise and adaptation including the economic aspects of vulnerability and the impacts on populations at risk. However, only a few of the assessment framework studies on adaptation explicitly mention the importance of non-climatic conditions in successful adaptation (Lau 2005). One objective of this study is to assess how local decision-makers perceive sea-level rise and adaptation to it and act on this perception.

Information provision plays an important role in both individual and institutional decision-making processes. It can affect decision-makers' perceptions about the project task and the related work environment, which may in turn affect their actions and performance in future tasks (Magat et al 1986; Goodhue and Thompson 1995; Wright and Cordery 1999; Segador et al 2005; Bendoly and Swink 2007). Environmental information is a significant contributor to improving decisions on global environment management and sustainable development (Sterner 2003; Tietenberg and Wheeler 1998; Foulon, Lanoie and LaPlante 2002). Ernita et al (2008) argue that there is a gap between information providers and decision-makers in the field of ecosystem management. They illustrate that information and knowledge flows can be ineffective and scientific information, even when requested, cannot be used effectively. Jalan and Somanathan (2008) found that information provision facilitated in getting households in India to purify their water when they were told that their drinking water was possibly contaminated. Thus, another goal of this study was to investigate the possible effects of information provision on local decision-makers' perceptions and actions in regard to adaptation to sea-level rise in the coastal villages on the islands of Zhejiang Province, China.

Zhejiang Province is a maritime province with a sea area of 260,000 square kilometers. The province has the largest number of islands and isles in China; it has 3,061 islands and islets with area of more than 500 square meters. From 1960 to 2000, the average rate of sea-level rise in Zhejiang was 2.75 mm, higher than the national average. According to the 2006 Sea Level Report in China, the sea level in Zhejiang coastal areas rose by 3.3 mm/year from 2004-2006, which is the highest rate in China (State Oceanic Administration of China 2007). The relative sea level along the Zhejiang coast is projected to rise by 20-40 cm by the year 2050 (Dong and Zhou 2005). Thus, human well-being and wealth in Zhejiang's coastal areas, especially on the islands, are at stake if the sea level continues to rise. This is why these areas were chosen as the study sites.

## **1.2 Research Objectives**

This study aimed to assess how local decision-makers perceived sea-level rise and investigated the effects of information on decision-makers' perceptions and policy actions with respect to adaptation to sea-level rise in coastal villages on the islands of Zhejiang Province, China. The specific objectives were as listed below.

- To investigate the perceptions of decision-makers in local government units on sea-level rise and adaptation to it
- To investigate the associations between socio-economic factors and decision-makers' perceptions of sea-level rise
- To investigate how prepared local government units were to handle sea-level rise and what adaptation strategies they had taken in the past
- To test the effects of information provision on decision-makers' perceptions of and actions on adaptation to sea-level rise by conducting a controlled experiment

## **2.0 RESEARCH DESIGN**

### **2.1 Study Sites**

Zhejiang Province is situated along the southeast coast of China within longitude 118°00'-123°00' East and latitude 27°12'-31°31' North. It is one of the most densely populated provinces in China. In recent decades, Zhejiang has experienced rapid economic growth. From 1978 to 2002, its GDP increased annually at a rate of 13% and the GDP per capita rose at an annual rate of 12% on average.

The study sites were 21 towns in Zhoushan City and Yuhuan County. Zhoushan City is located in the Zhoushan islands of northeast Zhejiang and is the only prefecture-level city in China established on an island. It is situated at the meeting point of the mouths of the Yangtze River, Qiantang River, and Yong River. Zhoushan City has jurisdiction over four districts with 35 towns and 9 other districts. The total population is 0.97 million.

Yuhuan County is located in the middle of the coastline in Zhejiang Province with an area of 2,279km<sup>2</sup>, including 1,929.61 km<sup>2</sup> of sea area. The total coastline of Yuhuan County is 329.14 km long. It has a total population of 395,000.

## **2.2 Study Sample**

The main sample for this study was local village leaders selected from 21 towns in Zhoushan City and Yuhuan County, which are coastal counties on islands. Three kinds of towns (tourism, fishery, and commercial towns) were selected to see whether the village leaders from different kinds of towns had different knowledge, perceptions, and policy actions on sea-level rise and adaptation.

Within each town, three villages were selected. All attempts were made to ensure that they were as homogenous as possible. For each village, only the village leader who made the main decisions was interviewed. The enumerator first contacted the village leader, explained our study and invited the person to participate in our study. If the village leader agreed, the enumerator then interviewed him/her face-to-face.

The three villages were randomly assigned into one control group and two experimental groups. In order to determine to which group the villages were assigned, a jar containing the numbers '0' and '1' in random order was used. We set 0 for the experimental group and 1 for the control group. If the number that the village leader chose was 0, then the village was the experimental group. Otherwise, the village was the control group.

We also conducted a survey involving local villagers in Phase III of the study. Eight villagers were randomly selected within each village. In total, 504 villagers were surveyed.

## **2.3 Intervention**

The intervention for the experiment was that the two villages in the experimental groups were provided with some information on sea-level rise and adaptation to it while the village in the control group would not receive any information. The information was delivered via a brochure.

On the first page of the brochure, a name and telephone number for those requiring assistance were provided. A summary of the information brochure followed. Then, three main sections were presented (see Appendix A).

The first section was an introduction about sea-level rise in general, and some details and evidence on sea-level rise along Zhejiang coast. Recipients were told that sea-level rise was primarily due to global warming. Zhejiang is a maritime province with rapid economic growth and a large part of the population lives in coastal areas. The elevation along the Zhejiang coast is only about 1.5 – 5 m, thus it is very sensitive to sea-level rise. However, the sea level along Zhejiang coast has been rising in the last 30 years at a rate higher than the country average. Human well-being and

wealth in coastal areas, especially on islands, will be at stake if the sea level continues to rise.

Section 2 covered the threats caused by sea-level rise, such as increased intensity and frequency of typhoons or storm surges, speeding up of coastal erosion, exacerbated coastal flooding, saltwater intrusion and soil salinization. The impacts of different threats on different socio-economic sectors were presented. The picture presented to the respondents showing the possible inundated areas in Yuhuan County if the sea level rises by one meter is given in Figure 1.



Figure 1. The picture showing possible inundated areas in Yuhuan County

Note: The lightly shaded areas along the coastline are the possible inundated areas

Some strategies and technologies for sea-level rise adaptation were offered in Section 3. Recipients were told that generally, communities in coastal areas had a choice of three basic adaptation strategies: protection, retreat or accommodation. Protection includes building dykes, sea-walls and dunes, or wetland restoration; while retreating could mean relocating homes or businesses, or demarcating certain zones as off-limits for development. Accommodation could involve establishing tougher building codes or strengthening early warning systems. Detailed information on each adaptation strategy was presented. Pictures were also provided in order to help the recipients better understand each adaptation strategy. The different roles that different sectors played in sea-level rise adaptation were also presented.

In order to help the subjects to better understand and assimilate the given information on sea-level rise and adaptation to it, a presentation based on the brochure was made by a well-trained enumerator. To give the respondents a picture or idea of what sea-level rise was, the enumerator used logged onto the website: <http://flood.firetree.net/?ll=33.8339,129.7265&z=12&m=7> to show them the potential inundated areas in Yuhuan County and Zhoushan City with different levels of sea-level rise: 1 m, 3 m and 5 m. After the presentation, the recipients were invited to ask any questions related to sea-level rise and adaptation to it.

The hypothesis to be tested was: The village without information and the two villages with information will produce different outcomes, but the two villages with information in the experimental group will produce similar outcomes.

Three outcomes were measured:

- Did local decision-makers use the information provided?
- Did local decision-makers change their knowledge, perceptions, and attitudes on sea-level rise and adaptation to it after the information provision?
- What kind of policy action was taken after information exposure?

## 2.4 Experimental Procedure

The experiment was conducted in three major phases (Figure 2).

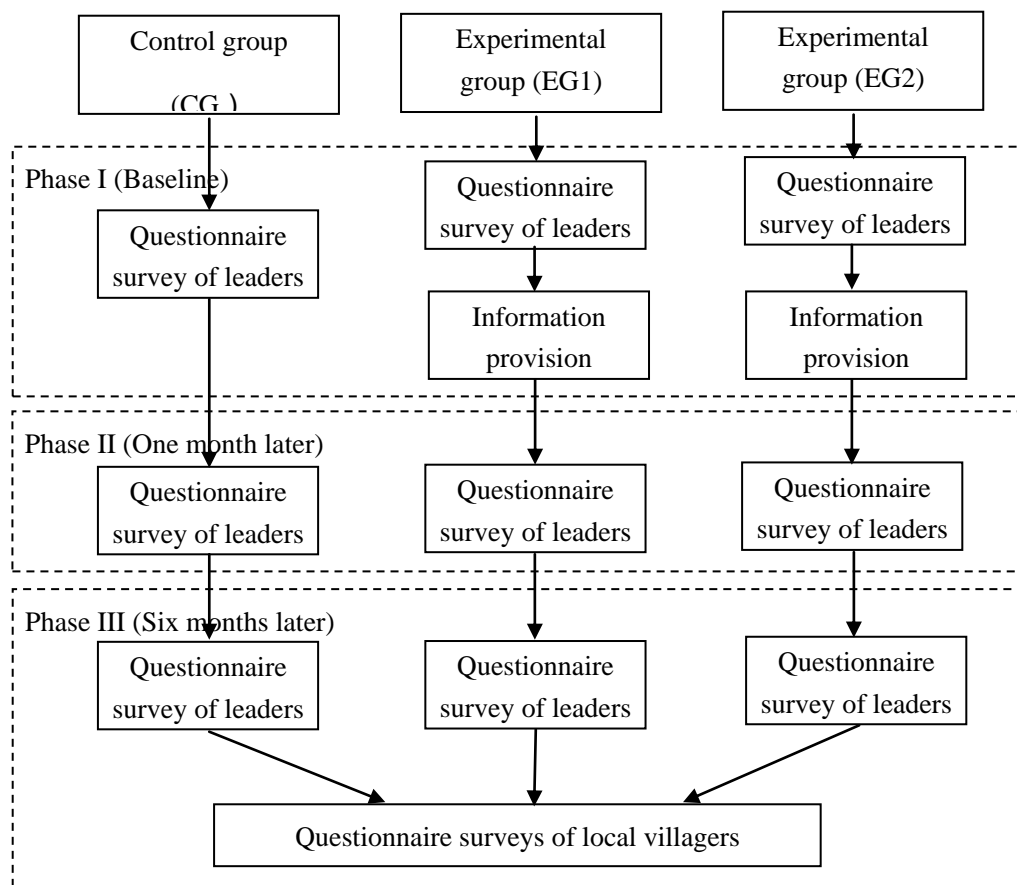


Figure 2. Experimental procedure

Phase I consisted of preliminary data collection for use as controls in our models. We interviewed the village leaders both in the control group and the two experimental groups with the same questionnaire. The respondents in the control group finished the first survey with the completion of the questionnaire. For the two experimental groups, however, after completing the questionnaire, the enumerators made a presentation

based on the information brochure to the village leaders. Subsequently, each village leader received the information brochure from the enumerator.

In order to give enough time to the respondents to read and assimilate the information provided, Phase II took place about one month later after Phase I and Phase III was conducted about 6-7 months after Phase I. For both Phase II and Phase III, the same questionnaire as that used in Phase I was used, plus several additional questions for both groups.

In Phase III, a survey was conducted among the local population to see whether the information that the researcher delivered went to the household level from the village leader. Eight respondents were randomly selected from each village. The individuals interviewed were selected according to pre-determined quotas of sex and age. The quotas were based on the actual weighting of different groups within the population considered for example, if 56% of the village population was male, then 56% of the respondents would be male.

The villagers were asked whether they had heard of sea-level rise, the means through which they had heard of it if so, whether their village councils had disseminated any information on sea-level rise and related adaptation to the local population, whether they would like to learn any information on sea-level rise, what information on sea-level rise they would like to have, and some questions on their socio-economic characteristics (see Appendix B).

## **2.5 Pilot Study**

### **2.5.1 Focus group discussions**

Focus group discussions (FGDs) were used to further develop the questionnaire and the information brochure so that the items in the questionnaire and the information in the brochure were practical and easy to understand. The research team requested assistance from the State Oceanic Administration to arrange the FGDs. In October 2007 and June 2008, a series of FGDs was conducted. The first group comprised four experts on climate change and sea-level rise. The second group was five experts on oceanography and coastal engineering. The third group consisted of five local village leaders. Two village leaders were from the commercial towns, another two were from the fishery towns, and one village leader was from a tourism town.

The objectives of the FGDs were:

- to collect more detailed information on sea-level rise along Zhejiang coast;
- to identify possible threats and impacts of sea-level rise on local communities and households;
- to identify potential solutions to sea-level rise;



- to discuss the information in the brochure; and
- to pretest the draft survey questionnaires.

For the FGDs, the most convenient meeting place was arranged for the participants to meet for three-hour sessions. The researcher began by clearly explaining the objectives and procedures to the participants. After that, the draft questionnaire and information brochure were handed out to each participant and then read out to them. The discussions were held in a neutral and non-threatening environment. The participants were encouraged to share their opinions with others. Each member was allowed to freely express his/her opinions regarding the discussion topic without any interference from other members. Then the research assistant recorded information and discussion results, operated the sound recording system during the meeting, and reminded the researcher of the topics that needed to be discussed. At the end of the meeting, the researcher expressed her gratitude and gave mementos and premiums to each participant. The final step consisted of gathering the minutes of the meeting from the research assistant and checking the information for correctness and clarity and finally, making adjustments and corrections on questionnaire items and the information brochure for a clearer and easier understanding. Discussion topics in the FGDs basically concentrated on the following issues:

- Details/information on sea-level rise along Zhejiang coast.
- Possible threats and impacts of sea-level rise affecting local villages and households.
- Possible sea-level rise adaptation strategies for local governments and households.
- Local village leaders' awareness of and attitudes towards sea-level rise and adaptation to it.
- The research design and implementation procedure of the experiment.
- The items in the draft questionnaire and the information brochure.

In the FGDs, the participants confirmed the fact of sea-level rise along Zhejiang coast and provided some recent details on sea-level rise and its threats in Zhejiang's coastal areas, which were included in the brochure. Some participants pointed out that the sea level along Zhejiang coast had been rising, but it was a slow and gradual process. Sea-level rise had not yet caused serious impacts so the locals did not pay much attention to this problem. Also, local government participants said that sea-level rise was a global phenomenon; thus they could not do much about it.

Some participants claimed that local government officials could have some knowledge on sea-level rise, but they had no plans or policies in place to take it into account in short- or long-term decision-making. The main activity undertaken in local villages was focused on dealing with floods and typhoons. In order to get some positive results, the participants then suggested the experiment be conducted only on island villages, where local village leaders may have a better feeling about sea-level

rise and consider sea-level rise and adaptation problems more seriously. Participants also suggested that some questions in the draft questionnaire be omitted since they were not closely related to the research and more questions on knowledge should be included. In order to help local village leaders better understand the information in the brochure, more pictures and visual aids should be provided. The input from the FGDs was used to further revise the questionnaire and information brochure.

### **2.5.2 Pre-test survey**

From 1-7 July 2008, a pre-test survey was conducted in six coastal villages in Zhejiang. Three villages were in Zhoushan City and another three were in Yuhuan County. The pre-test survey served a number of objectives:

- to go over the language and the clarity of questions in the questionnaires
- to identify the formats used for answering each question
- to test whether the respondents understood the information in the brochure

The feedback from the pre-test was used to refine the questionnaire and the information brochure, which were thoroughly revised and simplified. More pictures, more specific information and more detailed statistics were added to the brochure.

## **2.6 Survey Questionnaires**

The questionnaire mainly consisted of four general sections (Appendix C). Respondents were told that their participation was voluntary and that confidentiality would be maintained. The first section addressed the respondents' knowledge of global warming and sea-level rise. It consisted of some closed questions and several statements where the answers were either 'True' or 'False'. The second section formulated some questions about the respondents' attitude towards sea-level rise and adaptation to it. Six statements were read out and the answers were given on five-point Likert-scales (ranging from strongly agree to strongly disagree).

The third section comprised some questions on policy actions and adaptation measures on sea-level rise. Respondents were asked about whether they had discussed about sea-level rise within their village councils, whether they had disseminated any information on sea-level rise to the local public in the last few months, whether they would disseminate the information on sea-level rise and adaptation to it to the local people in their communities, and whether they would propose sea-level rise adaptation to higher-level government units in the coming few months. The measures taken, current policies, and measures to be taken for sea level rise adaptation were explored. The last section requested some basic information about the respondents (age, gender and highest completed level of education) and about their villages (population size, per capita income, main economic activities, etc.).

In order to test out the effects of the information brochure on the respondents' knowledge of and attitude to sea-level rise adaptation and the policy changes they had

made, the same questionnaire was used in Phase II and Phase III for both the control and experimental groups. For the questionnaires in Phase II and Phase III, we asked the respondents in the experimental groups additional questions on how often they read the information brochure and the helpfulness, thoroughness and relevance of the information brochure (see Appendix D). For the control group, in addition to the basic questionnaire, the respondents were asked whether they had received any information on sea-level rise from other village councils in either the last one or six months.

### 3.0 EMPIRICAL RESULTS AND DISCUSSION

The first survey was conducted from 15 July through to 29 July, 2008. In total, 21 towns were selected. Among them, five were tourism towns, six were fishery towns, and ten were commercial towns. Eighty (80) village leaders were approached and 63 of them agreed to participate in this study; 21 in each group. The response rate was about 80%. The flowchart for the process is shown in Figure 3. The second survey took place from 16 to 30 August, 2008, and the third survey was done from 15 February to 10 March, 2009. The same respondents were interviewed for the three surveys.

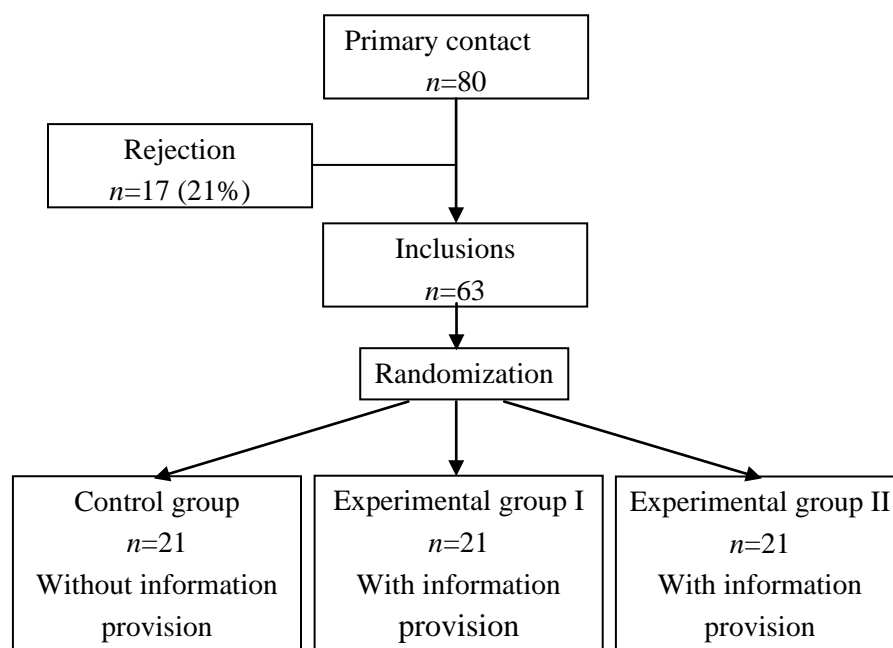


Figure 3. Flowchart for the surveys

#### 3.1 Basic Socio-economic Characteristics of the Sample

Table 1 shows the definitions of the socio-economic variables of the sample. The descriptive statistics of the main socio-economic characteristics of the respondents and the 63 villages approached are presented in Tables 2 and 3, respectively. The

mean age of the respondents was 46.86 years and 76% of them were male, which is almost the same as the proportion of male village leaders in the study areas. The average educational level was above senior high school. The average population size of the villages was 1,631 and the average yearly income per capita of the village was 8,565 yuan (USD 1,260).

Table 1. Definitions of socio-economic variables of the sample

Variable	Description
Age	Age of the respondent
Gender	Gender of the respondent, 1=male, 0=female
Education	Education of the respondent, 1=elementary, 2=junior high school, 3=senior high school, 4=college, 5=university and above
Population	Total population of the village
Income	Yearly income per capita of the village (RMB)

Table 2. Means of respondents' main socio-economic characteristics

Variables	Control group	Experimental group		Total sample
		Group 1	Group 2	
Age	46.86(8.79)	46.67(6.23)	46.71(5.96)	46.75(6.99)
Gender	0.76(0.43)	0.81(0.40)	0.76(0.43)	0.78(0.42)
Education	2.76(1.09)	2.76(0.83)	2.95(0.80)	2.83(0.91)

Note: Numbers in parenthesis are standard deviations.

Table 3. Characteristics of sample villages

Variables	Control group	Experimental group		Total sample
		Group1	Group2	
Population	1571(803)	1670(853)	1651(851)	1631(823)
Income (RMB)	8289(2040)	8854(2480)	8552(2528)	8565(2333)
Distance of village from nearest paved road (km)	0.67(0.39)	0.71(0.33)	0.67(0.36)	0.68(0.35)
Distance of village from nearest secondary school (km)	2.05(0.41)	2.18(0.40)	2.14(0.48)	2.12(0.42)
Distance of village from nearest hospital (km)	2.47(0.14)	2.43(0.25)	2.42(0.18)	2.44(0.19)

Note: Numbers in parenthesis are standard deviations.

A paired sample t-test for differences in the means of the socio-economic variables of the control group and the two experimental groups showed there were no statistical differences between the three groups. Therefore, one can assume that any differences in behavior or knowledge levels across the control group and the experimental groups are related to treatment effects, and not due to demographic or socio-economic characteristics.

### 3.2 Knowledge of Sea-level Rise and Adaptation to It

#### 3.2.1 General information

In Phases 1, II and III, the respondents were asked 11 questions on their knowledge of global warming and sea-level rise. They were asked to choose the correct answer to each question asked. The results are presented in Tables 4, 5 and 6, respectively.

Table 4. Knowledge of global warming and sea-level rise in Phase I (percentage of respondents with the correct answer)

Questions	Control group		Experiment group		Total sample	
	N	Correct response (%)	N	Correct response (%)	N	Correct response (%)
1. Causes of global warming	21	12(57%)	42	27(64%)	63	39(62%)
2. Effects of global warming	21	6(28%)	42	9(21%)	63	15(24%)
3. Types of greenhouse gas	21	10(48%)	42	18(43%)	63	28(44%)
4. Awareness of sea-level rise	21	14(67%)	42	29(69%)	63	43(68%)
5. Causes of sea-level rise	21	6(28%)	42	12(28%)	63	18(28%)
6. Effects of sea-level rise	21	5(24%)	42	9(21%)	63	18(28%)
7. Sea-level rise situation along Zhejiang coast	21	11(52%)	42	26(62%)	63	37(58%)
8. Sea-level rise is good for groundwater pumping.	21	17(81%)	42	38(90%)	63	55(87%)
9. Sea-level rise can decrease the intensity of typhoons or storm surges.	21	14(67%)	42	30(71%)	63	44(70%)
10. Sea-level rise can deepen the navigation channel.	21	10(47%)	42	24(57%)	63	34(54%)
11. Sea-level rise can cause soil salinization.	21	18(86%)	42	32(76%)	63	50(79%)
Overall average	21	11(53%)	42	23(55%)	63	34(54%)

The results of the study revealed that more than half of the respondents (62%) in Phase I knew that global warming was caused by the greenhouse effect. However, only about 24% of the total sample gave the correct answer to the possible effects of global warming and less than half (44%) knew about the types of greenhouse gases. About 68% of the respondents reported that they knew about sea-level rise. For the causes and effects of sea-level rise, only about 28% of the total sample gave the correct answers for both. More than half of the respondents (58%) knew that the sea level along the Zhejiang coast had been rising in the last few years while around 65% gave the correct answers to the questions on the impacts of sea-level rise. So, the respondents in the baseline had a little knowledge of global warming and sea-level rise.

Table 5. Knowledge of global warming and sea-level rise in Phase II (percentage of respondents with the correct answer)

Questions	Control group		Experiment group		Total sample	
	N	Correct response (%)	N	Correct response (%)	N	Correct response (%)
1. Causes of global warming	21	13(62%)	42	34(81%)	63	47(75%)
2. Effects of global warming	21	4(19%)	42	28(67%)	63	32(51%)
3. Types of greenhouse gas	21	7(33%)	42	38(90%)	63	45(71%)
4. Awareness of sea-level rise	21	15(71%)	42	42(100%)	63	57(90%)
5. Causes of sea-level rise	21	6(29%)	42	34(81%)	63	40(63%)
6. Effects of sea-level rise	21	10(48%)	42	37(88%)	63	47(75%)
7. Sea-level rise situation along Zhejiang coast	21	9(43%)	42	40(95%)	63	49(78%)
8. Sea-level rise is good for groundwater pumping.	21	16(76%)	42	40(95%)	63	56(89%)
9. Sea-level rise can decrease the intensity of typhoons or storm surges.	21	13(62%)	42	38(90%)	63	51(81%)
10. Sea-level rise can deepen the navigation channel.	21	11(52%)	42	35(83%)	63	46(73%)
11. Sea-level rise can cause soil salinization.	21	20(95%)	42	41(98%)	63	61(97%)
Overall average	21	11(54%)	42	37(88%)	63	48(77%)

The survey results revealed that the main source of information about sea-level rise for the respondents was the mass media. Almost half of the respondents knew about sea-level rise through television (48%). About 28% of those people interviewed cited magazines and books as the main sources of information on sea-level rise. Only 16% of the respondents had become aware of sea-level rise through the internet. Other sources (official training, conferences, radio) taken together only reached 8% of the respondents.

On the information that they needed for adaptation to sea-level rise, the following answers were given: related laws and policies of central government (26%), threats of sea-level rise on people's lives (19%), adaptation measures for sea-level rise (19%), technologies to control sea-level rise (13%), and causes of sea-level rise (13%). When we asked them through which channel that they would like to get this information, the answers given were: mass media (television and radio) (49%), official training (27%) and print media (the press) (24%).

Table 6. Knowledge of global warming and sea-level rise in Phase III (percentage of respondents with the correct answer)

Questions	Control group		Experiment group		Total sample	
	N	Correct response (%)	N	Correct response (%)	N	Correct response (%)
1. Causes of global warming	21	14(67%)	42	35(83%)	63	49(78%)
2. Effects of global warming	21	8(38%)	42	29(69%)	63	37(59%)
3. Types of greenhouse gas	21	10(47%)	42	39(93%)	63	49(78%)
4. Awareness of sea-level rise	21	14(67%)	42	41(97%)	63	55(87%)
5. Causes of sea-level rise	21	7(33%)	42	37(88%)	63	44(70%)
6. Effects of sea-level rise	21	11(52%)	42	37(88%)	63	48(76%)
7. Sea-level rise situation along Zhejiang coast	21	12(57%)	42	42(100%)	63	54(86%)
8. Sea-level rise is good for groundwater pumping.	21	17(81%)	42	40(95%)	63	57(90%)
9. Sea-level rise can decrease the intensity of typhoons or storm surges.	21	14(67%)	42	37(88%)	63	51(81%)
10. Sea-level rise can deepen the navigation channel.	21	12(57%)	42	36(86%)	63	48(76%)
11. Sea-level rise can cause soil salinization.	21	19(90%)	42	42(100%)	63	61(97%)
Overall average	21	13(60%)	42	38(90%)	63	50(80%)

### 3.2.2 T-test on the effects of information provision

In order to test the effects of information provision, knowledge of sea-level rise was scored by allocating a point for each correct response given by the respondents. The knowledge score was then computed by adding the points. Mean knowledge scores of the control group and the two experimental groups in Phase I, Phase II and Phase III are shown in Table 7.

Table 7. Mean knowledge scores in Phases I, II and III

Phases	Control group	Experimental group	
		Group 1	Group 2
Phase I	6.05 (1.77)	5.52 (1.33)	6.10 (1.81)
Phase II	5.90 (1.58)	9.67 (1.39)	9.71 (1.65)
Phase III	6.60 (2.05)	9.85 (1.09)	9.90 (1.33)

Note: Numbers in parenthesis are standard deviations.

The mean scores for the control group and the two experimental groups in Phase I were 6.05, 5.52, 6.10, respectively, out of total score 11. The paired sample t-test results showed that there were no significant differences between the control group and the two experimental groups on mean knowledge scores. These results imply that there was equality between the control group and the experimental groups on their knowledge about sea-level rise in the baseline survey.

In Phase II, one month later after information provision, the mean score for the control group was 5.90. The t-test results showed no significant difference between the control group's knowledge scores in Phase I and Phase II ( $P = 0.756$ ). The mean scores for the two experimental groups were 9.67 and 9.71, which were higher than the same two groups' knowledge scores in Phase I. The paired sample t-test results showed that the differences in knowledge scores of the two experimental groups before and after the information provision were statistically significant ( $P < 0.01$ ).

In Phase III, around six months after information provision, the mean score for the control group was 6.60. The paired sample t-test results showed that no significant difference was found between the control group's mean knowledge scores in Phase I and Phase III ( $P = 0.491$ ). The mean knowledge scores for the two experimental groups were 9.85 and 9.90, which were much higher than their scores in Phase I. The paired sample t-test results showed that the differences in knowledge scores of the two experimental groups before and after the information provision were significant ( $P < 0.01$ ).

Therefore, it can be concluded that the information brochure can improve the respondents' knowledge significantly. This is in accordance with expectations.

### 3.2.3 Variables associated with respondents' knowledge

In order to assess the relationship between respondents' knowledge scores and their socio-economic characteristics, the standard multiple linear regression method was employed with the mean knowledge score as the dependent variable, using the baseline data. The estimation results are shown in Table 8.

From Table 8, it can be seen that the coefficient for AGE is negative and significant, which indicates that an older respondent would have less knowledge of global warming and sea-level rise. As might be expected, the coefficient for the variable EDUCATION is positive and significant at the 1% level, which supports the



hypothesis that a respondent with a higher education level would have more knowledge of global warming and sea-level rise. Perhaps respondents with higher education levels are able to understand the information better and pay more attention to it. The coefficients for the variables TOURISM and COMMERCIAL are positive and significant, indicating that if the village belongs to a tourism or commercial town, the village leader would have more knowledge of sea-level rise, compared to a village leader in a fishery town.

Table 8. Variables associated with the respondents' baseline knowledge scores

Variables	Definitions	Coefficient	Std. error	t-value	p-value
CONSTANT		7.86***	2.45	3.2124	0.0023
AGE	Age of respondent	-0.07*	0.04	-1.9181	0.0606
GENDER	1 = male, 0 = female	-0.44	0.44	-1.0030	0.3205
EDUCATION	Education level of respondents (1=primary, 2=Junior high school, 3=Senior high school, 4=college and above)	1.18 ***	0.31	3.8339	0.0003
NPOPULATION	Number of people living in the village	0.44	1.44	0.3069	0.7602
NINCOME	Villagers' per capita income (10000Yuan/year)	-0.35	0.61	-0.5828	0.5626
TOURISM	Dummy variable denoting town category, 1=tourism town, 0=otherwise	1.36**	0.55	2.4689	0.0169
COMMERCIAL	Dummy variable denoting town category, 1=commercial town, 0=otherwise	0.92**	0.42	2.1909	0.0330
Statistics summary					
R square	0.63				
Observations	63				

Notes: \*\*\* Significant at  $p < 0.01$ ; \*\* Significant at  $p < 0.05$ ; \* Significant at  $p < 0.1$ .

### 3.2.4 Variables associated with respondents' knowledge improvement

The multiple linear regression method was used to find out which variables were associated with the respondents' knowledge improvement. The dependent variable is the change in the respondents' mean knowledge scores in Phase I and Phase III. The estimation results are shown in Table 9.

Table 9. Variables associated with the change in the respondents' knowledge scores between Phase I and Phase III

Variables	Definitions	Coefficient	Std. error	t-value	p-value
CONSTANT		0.40	3.22	0.1250	0.9010
AGE	Age of respondent	-0.10*	0.05	-1.9864	0.0524
GENDER	1 = male, 0 = female	0.41	0.69	0.5977	0.5527
EDUCATION	Education level of respondents (1=primary, 2=Junior high school, 3=Senior high school, 4=college and above)	1.04**	0.45	2.3250	0.0241
NPOPULATION	Number of people living in the village	0.00	0.00	-1.1023	0.2755
NINCOME	Villagers' per capita income (10000Yuan/year)	0.00*	0.00	1.9444	0.0574
TOURISM	Dummy variable denoting town category, 1=tourism town, 0=otherwise	0.18	0.86	0.2053	0.8382
COMMERCIAL	Dummy variable denoting town category, 1=commercial town, 0=otherwise	0.27	0.65	0.4214	0.6752
INFORMATION	Dummy variable denoting information provision, 1= with information, 0=without information	3.67***	0.59	6.2075	0.0000
Statistics summary					
R square	0.66				
Observations	63				

Notes: \*\*\* Significant at  $p < 0.01$ ; \*\* Significant at  $p < 0.05$ ; \* Significant at  $p < 0.1$ .

As Table 9 shows, the coefficient for AGE is negative and significant, suggesting younger village leaders are more likely to remember the information presented. The coefficient for EDUCATION is positive and significant. This is understandable because usually more educated people would understand the information presented better. The coefficient for NINCOME is positive and significant in this model, which suggests that village leaders of richer villages remember the information provided better. As expected, the dummy variable INFORMATION is positive and significant at the 1% level, which supports the hypothesis that information provision can help the village leaders to improve their knowledge level of sea-level rise and adaptation to it.

### 3.2.5 Treatment effect on knowledge

In this study, the difference-in-difference (DID) method was used to analyze the treatment effect on knowledge i.e. the effect of the experimental treatment, in this case, information provision, on the respondents' level of knowledge. The model is as follows:

$$y = \beta_0 + \beta_1 dB + \beta_2 dT + \beta_3 \cdot dB \cdot dT + \varepsilon$$

where  $y$  is the outcome (the knowledge score);  $\beta_1$  and  $\beta_2$  are regression coefficients,  $dB$  is a dummy variable, which captures possible differences between the treatment and control groups prior to the information intervention; and  $\varepsilon$  is the error term. The time period dummy,  $dT$ , captures aggregate factors that would cause changes in  $y$  even in the absence of an information intervention. The coefficient of interest,  $\beta_3$ , is the same as a dummy variable equal to one for observations in the treatment group in the second period. The estimation results are shown in Table 10.

Table 10. Treatment effect of information provision on the respondents' knowledge

Variables	Definitions	Phase I vs. Phase II	Phase I vs. Phase III
Constant		6.05 (0.35)***	6.05 (0.38)***
Treatment	Dummy variable, 1= treatment group, 0=control group	-0.24 (0.43)	-0.24 (0.47)
Period	Dummy variable, 1= second period, 0=baseline	-0.14 (0.49)	0.33 (0.54)
Treatment×Period	Dummy variable, 1=treatment group in the second period, 0=otherwise	4.02 (0.60)***	1.98 (0.66)***

Notes: Numbers in parenthesis are standard errors.

\*\*\*Significant at  $p < 0.01$ , \*\*Significant at  $p < 0.05$ , \*Significant at  $p < 0.1$ .

It can be seen that the coefficients for “Treatment×Period” are positive and highly significant, implying that the information intervention had a positive effect on the respondents' level of knowledge of sea-level rise and adaptation. This is consistent with our earlier findings.

### 3.3 Attitude towards Sea-level Rise and Adaptation to It

#### 3.3.1 General information

In Phase I, Phase II and Phase III, for both the control group and the two experimental groups, the respondents were asked about their attitude towards sea-level rise and adaptation to it. They were asked to give their answers to six statements on five-point Likert-scales (ranging from strongly agree to strongly disagree). When we analyzed the data, we converted their answers into a set of dichotomous independent variables using a dummy variable coding, i.e., if the respondents gave their answers as strongly agree or agree, we coded them as one. If they gave their answers as neutral, disagree or strongly disagree, we coded them as zero. Table 11 gives an overview of all attitude indices and their means and standard deviations for the experimental groups and the control group in Phases I, II and III.

Table 11. Respondents' responses to six attitudinal statements in Phases I, II and III

Phases	Groups	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6
Phase I	CG	0.38(0.50)	0.29(0.46)	0.48(0.51)	0.57(0.51)	0.62(0.50)	0.48(0.51)
	EG1	0.33(0.48)	0.24(0.44)	0.52(0.51)	0.62(0.50)	0.67(0.48)	0.48(0.51)
	EG2	0.38(0.50)	0.29(0.46)	0.52(0.51)	0.62(0.50)	0.57(0.51)	0.43(0.51)
	Total	0.37(0.49)	0.27(0.45)	0.51(0.50)	0.60(0.49)	0.63(0.48)	0.46(0.50)
Phase II	CG	0.33(0.48)	0.29(0.46)	0.67(0.48)	0.62(0.50)	0.57(0.51)	0.52(0.51)
	EG1	0.62(0.50)	0.48(0.51)	0.81(0.40)	0.90(0.30)	0.86(0.36)	0.38(0.50)
	EG2	0.67(0.48)	0.43(0.51)	0.76(0.44)	0.86(0.36)	0.95(0.22)	0.38(0.50)
Phase III	CG	0.43(0.51)	0.33(0.48)	0.43(0.51)	0.62(0.50)	0.67(0.48)	0.52(0.51)
	EG1	0.57(0.51)	0.71(0.46)	0.86(0.36)	0.90(0.30)	0.90(0.30)	0.24(0.44)
	EG2	0.62(0.50)	0.67(0.48)	0.81(0.40)	0.90(0.30)	0.90(0.30)	0.29(0.46)

Notes:

- 1) The figures are the means of the total number of agreements by the respondents. (If the respondent agreed with the statement, we coded it as 1. Otherwise, we coded it as 0. The figures given above are the means of the total number of agreements.) Numbers in parenthesis are standard deviations.
- 2) CG = Control Group; EG1 & EG2 = Experimental Groups 1 and 2
- 3) Statement 1: Sea-level rise is an important environmental problem in our village.
- 4) Statement 2: I am concerned about the problem of sea-level rise.
- 5) Statement 3: Sea-level rise will affect people's lives in the future.
- 6) Statement 4: There is a need to adapt to sea-level rise in our village.
- 7) Statement 5: Government units should take adaptation measures to mitigate the impacts of sea-level rise.
- 8) Statement 6: Sea-level rise is a global issue and we cannot do anything about it.

In Phase I, only about one-third of the total sample agreed that sea-level rise was an important problem in their villages. Less than one-third of the total respondents were concerned about the problem of sea-level rise. Around half of the whole group agreed sea-level rise would affect people's lives in the future. Of all the respondents, about 60% thought there was a need to adapt to sea-level rise and more than half of them agreed government units should take adaptation measures to mitigate the impacts of sea-level rise. Less than half of the respondents agreed that sea-level rise was a global issue and people could not do anything about it. Thus, the respondents in the baseline were not very concerned about sea-level rise, but they had a positive attitude towards sea-level rise adaptation.

When we asked the respondents about which threat of sea-level rise they were most worried about, half of them answered that they were most worried about the increasing destructiveness of typhoons or storms. The second threat that they were most worried about was the decrease in the capacity of the sea wall to prevent flooding. The reason for these choices is the fact that the Zhejiang coast is subject to typhoons and storm surges every year.

The respondents were also asked their opinion about who should take the responsibility for sea-level rise adaptation. The survey results revealed that more than half of them (53%) stated that it should be the central government. Only 17% thought that the local government should be responsible for sea-level rise adaptation and 12% of the respondents believed that enterprises should take the responsibility. So, although the respondents in the baseline had some positive attitudes towards sea-level rise adaptation, majority of them did not think that it was the local government's responsibility.

Then the respondents were asked to indicate whether their villagers were concerned about sea-level rise or not. The results revealed that more than half of the respondents (63%) thought their villagers were not concerned about sea-level rise while only 23% thought their villagers were concerned about it.

The respondents were also asked to cite the three most important environmental problems in their villages out of seven specific choices and one option for other problems ("Others"). The results showed that sea-level rise ranked far below in importance. Only around 5% of the respondents considered sea-level rise as the most important environmental problem in their village. The respondents gave greater weight to water pollution, solid waste management and air pollution.

### **3.3.2 T-test on the effects of information provision**

The effect of the information brochure was evaluated by a paired sample t-test. The test results on the differences between the experimental and the control groups on the attitudinal questions in Phases I, II and III are shown in Table 12. We combined the results of both experimental groups. We also combined the results of the

experimental group and the control group. From Table 12, it can be seen that in Phase I, there were no significant differences in attitudes towards sea-level rise and adaptation between the control group and the two experimental groups.

Table 12. *T*-test results on differences between the experimental and control groups on the attitudinal questions in Phases I, II and III

Phases	Paired Groups	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6
Phase I	CG1-EG11	0.33	0.37	-0.37	-0.33	-0.70	-0.37
	CG1-EG12	0.00	0.00	-0.44	-0.37	0.33	0.00
	EG11-EG12	-0.37	-0.37	0.00	0.00	1.00	0.37
Phase I vs. Phase II	CG1-CG2	0.33	0.00	-2.17**	-1.00	1.00	0.00
	EG11-EG21	-2.83***	-2.50**	-2.83***	-2.83***	-1.83*	3.51***
	EG12-EG22	-2.83***	-1.83*	-2.50**	-2.50**	-3.51***	2.83***
Phase I vs. Phase III	CG1-CG3	-0.29	-0.33	0.37	-0.37	-0.33	1.28
	EG11-EG31	-2.50**	-4.26***	-2.09**	-2.83***	-2.02*	4.69***
	EG12-EG32	-1.75*	-2.96***	-2.03*	-2.83***	-3.16***	3.29***
Phase III	EG31-EG32	-0.57	0.57	0.44	0.00	0.00	-0.44

Notes:

- 1) Numbers are *t*-statistics
- 2) \*\*\*Significant at  $p < 0.01$ , \*\*Significant at  $p < 0.05$ , \*Significant at  $p < 0.1$ ;
- 3) CG1- Control group in Phase I, EG11-Experimental group 1 in Phase I, EG12-Experimental group 2 in Phase I, CG2- Control group in Phase II, EG21-Experimental group 1 in Phase II, EG22-Experimental group 2 in Phase II. CG3- Control group in Phase III, EG31-Experimental group 1 in Phase III, EG32-Experimental group 2 in Phase III
- 4) Paired Groups: CG1-EG11 means comparing the control group's attitudes with the experimental group 1's attitudes in Phase I. CG1-EG12 means comparing the control group's attitudes with the experimental group 2's attitudes in Phase I. The procedure for the other paired groups can be similarly described.
- 5) Statement 1: Sea-level rise is an important environmental problem in our village.
- 6) Statement 2: I am concerned about the problem of sea-level rise.
- 7) Statement 3: Sea-level rise will affect people's lives in the future.
- 8) Statement 4: There is a need to adapt to sea-level rise in our village.
- 9) Statement 5: Government units should take adaptation measures to mitigate the impacts of sea-level rise.
- 10) Statement 6: Sea-level rise is a global issue and we cannot do anything about it.

When we compared the experimental groups' attitudes towards the six statements in Phase I and after the information brochure was presented in Phase II, we found that there were statistically significant changes (Table 12). For example, in Phase I, only around 35% of the respondents in the experimental groups agreed that sea-level rise was an important problem, while in Phase II, more than half of the respondents in the experimental groups (64%) thought so. The percentage increase was significant. However, within the control group, comparing the respondents' attitude to the six statements in Phase I and Phase II, we found that there were no significant changes, with the exception of Statement 3. The reason for this could be that the respondents were interviewed for a second time with the same questionnaire about sea-level rise. The respondents had however apparently changed their attitude about Statement 3 and agreed that sea-level rise would affect people's lives in the future. But when we look at Table 11, we can see that the increase in agreement responses is not as much as that for the experimental groups. The experimental groups with information provision had more positive attitudes than the control group with no information provision.

We also compared the three groups' attitude in Phase I with their attitudes in Phase III. The data shows that for the control group, the respondents' attitudes did not change significantly after six months. For the two experimental groups, about six months after information provision, however, the respondents' attitude in terms of the six statements changed significantly. So, it can be concluded that information provision can change local village leaders' attitudes towards sea-level rise and adaptation to it positively.

### **3.3.3 Tests for the treatment effect of information provision on respondents' attitudes**

The DID method was used to evaluate the treatment effect of information provision on the respondents' attitudes. The logit estimation results are shown in Table 13. The results show that the coefficients for "Treatment x Period" are positive and significant for the first five statements and significantly negative for the last statement ("Sea-level rise is a global issue and we cannot do anything about it."). The findings confirm that information provision had a positive treatment effect on the respondents' attitudes toward sea-level rise and adaptation to it.

Table 13. Treatment effect of information provision on the respondents' attitudes

		Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 6
Phase I vs.	Constant	-0.49(0.45)	-1.45(0.56)***	-0.10(0.44)	0.29(0.44)	0.49(0.45)	0.92(0.48)*
Phase II	Treatment	-0.10(0.55)	0.41(0.66)	0.19(0.54)	0.20(0.54)	0.01(.55)	0.12(0.60)
	Period	-0.21(0.65)	0.96(0.72)	-1.07(0.67)	0.20(0.63)	-0.20(0.63)	0.01(0.68)
	Treatment ×Period	1.38(0.79)**	0.17(0.85)*	0.69(0.80)*	1.32(0.85)*	1.96(0.88)**	-1.42(0.83)*
Phase I vs.	Constant	-0.49(0.45)	-0.92(0.48)*	-0.10(0.44)	0.29(0.44)	0.49(0.45)	0.92(0.48)*
Phase III	Treatment	-0.10(0.55)	-0.12(0.60)	0.19(0.54)	0.20(0.54)	0.01(0.55)	0.12(0.60)
	Period	0.20(0.63)	0.22(0.67)	-0.19(0.62)	0.20(0.63)	0.21(0.65)	-0.82(0.65)
	Treatment ×Period	0.78(0.77)*	1.62(0.83)**	1.71(0.81)**	1.57(0.88)*	1.56(0.89)*	-1.25(0.82)*

Notes:

- 1) Numbers in parenthesis are standard errors
- 2) \*\*\*Significant at  $p < 0.01$ , \*\*Significant at  $p < 0.05$ , \*Significant at  $p < 0.1$ ;
- 3) Statement 1: Sea-level rise is an important environmental problem in our village.
- 4) Statement 2: I am concerned about the problem of sea-level rise.
- 5) Statement 3: Sea-level rise will affect people's lives in the future.
- 6) Statement 4: There is a need to adapt to sea-level rise in our village.
- 7) Statement 5: Government units should take adaptation measures to mitigate the impacts of sea-level rise.
- 8) Statement 6: Sea-level rise is a global issue and we cannot do anything about it.

### 3.4 Policy Actions on Sea-level Rise Adaptation

#### 3.4.1 Use of information brochure

In order to assess the actual use of the information brochure, the two experimental groups were asked to fill in several additional questions. It turned out that almost all the village leaders (98% in Phase II and 100% in Phase III) had read the whole brochure; only one village leader in Phase II reported not reading it. This result implies that the leaders were very interested in the brochure. Most subjects read the information brochure once (57% in Phase II and 59% in Phase III), and a significant proportion read it twice (36% in Phase II and 36% in Phase III). Two



respondents reported reading the brochure three times or more. The number of times of reading the brochure did not change much between Phase II and Phase III. A significantly positive correlation was found between 'number of times read' and knowledge scores (Pearson Correlation=0.285, P=0.01, two-tailed), showing that the respondents who read the information brochure more often would have a higher knowledge score on sea-level rise.

Of all experimental group respondents, 76% in Phase II and 83% in Phase III reported that the information brochure was helpful to them. About 67% of the respondents in Phase II and 72% in Phase III thought that the brochure was detailed. Eighty-one per cent (81%) thought that the brochure was related to their jobs. Half of the respondents thought the second part (threats of sea-level rise) was most helpful to their work and only 31% thought that the third part (adaptation measures for sea-level rise) was most helpful to them. This result implies that the respondents paid more attention to the threats of sea-level rise than to adaptation measures for sea-level rise. Almost all the respondents stated that the information in the brochure was accurate and thought that the information brochure had improved their knowledge and awareness of sea-level rise.

However, only 12% of the respondents in Phase II reported that the brochure had affected their village policy actions in the last month. Around 19% in Phase III stated that the brochure had affected their village councils' policy actions in the last six months. Only 19% of the respondents in Phase II and 23% of the respondents in Phase III stated that some actions based on the information brochure had been taken. About 43% in Phase II and 40% in Phase III stated that the information brochure would affect their policy actions in the future. In Phase II, 36% of the subjects reported they had used the information in the brochure in the last month, mainly for public dissemination (40%) and discussions with colleagues (40%). In Phase III, 55% of the respondents stated that they had used the brochure in the last six months, mainly for public dissemination (47%), discussions with colleagues (17%), preparation of government proposals (13%) and preparation of coastal zone response mechanisms (13%).

### **3.4.2 Policy actions in the three phases**

In order to see whether the information brochure had some effect on policy actions, in Phases I, II and III, for both the control and the experimental groups, we asked the village leaders whether they had discussed with their village councils about sea-level rise and adaptation to it, whether they had disseminated any information on sea-level rise and related adaptation to the local public, and whether their village councils had reported the problem of sea-level rise to higher-level government units.

The survey had three phases. In the first phase (baseline), the respondents were asked whether their village councils had reported the problem of sea-level rise to higher-level government units in the previous few months. In the second phase, one month after the first phase, the respondent was asked whether their village councils

had reported the problem of sea-level rise to higher-level government units in the previous (one) month. In the third phase, six months after the first phase, the respondents were asked whether their village councils had reported the problem of sea-level rise to higher-level government units in the previous six months.

The respondents were also asked about whether they would disseminate the information on sea-level rise and related adaptation to the local population and raise the problem of sea-level rise to higher-level government units in the next few months. They were also asked about what they could do in terms of sea-level rise adaptation and what kind of measures their villages had taken in this respect. Table 14 shows the number of villages which had taken policy actions on sea-level rise in Phases I, II and III.

Table 14. Respondents' policy actions in Phases I, II and III

Phases	Groups	Action 1	Action 2	Action 3	Action 4	Action 5
Phase I	CG1	5(24%)	1(5%)	2(10%)	7(33%)	5(24%)
	EG11	4(19%)	0(0%)	1(5%)	9(43%)	5(24%)
	EG12	5(24%)	0(0%)	2(10%)	9(43%)	3(14%)
	Total	14(22%)	1(2%)	5(8%)	25(40%)	13(21%)
Phase II	CG2	6(29%)	2(10%)	3(14%)	8(38%)	5(24%)
	EG21	11(52%)	3(14%)	2(10%)	13(62%)	6(28%)
	EG22	9(43%)	6(28%)	4(19%)	14(67%)	5(24%)
Phase III	CG3	6(28%)	2(10%)	3(14%)	8(38%)	6(28%)
	EG31	12(57%)	4(19%)	3(14%)	14(67%)	7(33%)
	EG32	9(43%)	6(28%)	4(19%)	15(71%)	7(33%)

Notes:

1. Numbers in parenthesis show the percentage of responses to different policy actions on sea-level rise.
2. Action 1: We have discussed about sea-level rise within the village council.
3. Action 2: We have disseminated the information on sea-level rise and adaptation to it to the local public.
4. Action 3: We have raised the problem of sea-level rise with higher-level government units.
5. Action 4: We will disseminate the information on sea-level rise and adaptation to it to the local public in the next few months.
6. Action 5: We will raise the problem of sea-level rise with higher-level government units in the next few months.

### ***3.4.2.1 Policy actions in Phase I***

From Table 14, it can be seen that very few policy actions on sea-level rise and adaptation to it were taken in Phase I. For the total sample, only around 22% of the respondents stated that they had discussed about sea-level rise within their village

councils. Only one respondent (2%) reported that he had disseminated the information on sea-level rise and adaptation to the local population. About eight per cent of the village leaders stated they had proposed the problem of sea-level rise to the higher-level government units. About 40% of the respondents stated that they would disseminate the information on sea-level rise and adaptation to it to the local public in the next few months. Finally, only about one-fifth of village leaders responded that they would raise sea-level rise problems with their higher-level government units in the coming months.

For the measures on sea-level rise adaptation that their villages could do, most of the respondents stated that they could plant more trees and protect the environment (68%). About 62% of the respondents said they could disseminate sea-level rise information to the local public and 55% of them said they would propose to high-level government units to take corresponding measures. Around half of the respondents (48%) thought their villages should take sea-level rise adaptation measures as soon as possible and 40% thought they should build higher sea walls in their villages. The main measures the respondents felt needed to be taken were improving public awareness on sea-level rise, relocating threatened buildings, dune or wetland restoration or creation, and beach replenishment.

The main adaptation measures that the villages had already taken were building dykes, seawalls, tidal barriers and breakwaters; implementing early warning and evacuation systems and improved drainage systems. Ongoing measures were mainly higher design standards for tide and flood control engineering.

When we asked them what the main difficulty in taking action on sea-level rise adaptation in their villages were, 38% of the respondents said it was that sea-level rise was not considered an urgent problem in their villages. Thirty-one per cent (31%) of them stated lack of money and staff for sea-level rise adaptation measures while 26% said their higher-level government units paid little attention to sea-level rise and did not ask them to take any action. The remaining 5% stated that their knowledge on sea-level rise was not enough for them to take any action. Thus, information provision on sea-level rise and adaptation to it was not a very important factor for village leaders to take policy actions in their villages.

#### ***3.4.2.2 Policy actions in Phase II***

In Phase II, for both the control group and the experimental groups, the number of respondents who said they had discussed sea-level rise with their village councils in the previous one month increased. This may be partly due to the fact that we interviewed their village leaders with a questionnaire on sea-level rise and the village leaders had talked with their colleagues about the problem. Within the experimental group, after the information brochure was presented, although very few villages reported that they had disseminated the information on sea-level rise and adaptation to it to the local public, the percentages increased significantly compared to Phase I ( $P < 0.01$ ). For policy action on raising the problem of sea-level rise to their

higher-level government units, the number of village leaders who had done this increased in Phase II, but not significantly ( $P=0.262$ ). The numbers of village leaders who would disseminate the information to the local population increased significantly in the experimental groups. However, the number of village leaders who would raise sea-level rise problems with their higher-level government units did not change substantively.

### **3.4.2.3 Policy actions in Phase III**

For the control group in Phase III, only 10% of the village leaders reported that they had disseminated the information in the brochure to the local population in their villages. The main dissemination method was posters. The main reason for the others (58%) not disseminating the information to the local population was that they had not received any instructions from higher-level government units while about 37% stated that their main reason was that they had thought that the local public was not concerned about sea-level rise. Only 14% of the respondents reported they had raised sea-level rise problems with higher-level government units in the last six months. However, the main method that they used was personal communication rather than more formal methods. About 65% of the respondents said that the main reason for not raising sea-level rise problems was that the higher-level government units had never emphasized the importance of sea-level rise and related adaptation problems.

Only 38% of the village leaders in the control group said that they would disseminate the information on sea-level rise and adaptation to the local people. Less than one-third of them stated they would raise the problem of sea-level rise to higher-level government units. The main measures that the villages in the control group had taken were improving the drainage system in their villages and implementing typhoon early warning and evacuation systems.

For the experimental groups in Phase III, less than one-third of the respondents reported that they had disseminated the information in the brochure to the local population in their villages. The main dissemination methods were through the radio and posters. The main reason for disseminating the information to the local population was that they thought the local people would contribute to implementing adaptation actions if they had some knowledge on sea-level rise and how to adapt to it (40%). The main reasons for not disseminating the information to the local population were: no instructions from high-level government units (49%), the local public was unconcerned about sea-level rise problems (31%), not enough funds in the budget (11%), and no responsibility of local village councils to disseminate the information (9%).

Only 16% of the total respondents in the experimental groups reported they had proposed sea-level rise problems to higher-level government units in the last six months. The main methods used were face-to-face discussions (50%), personal communication (40%), and policy suggestions (10%). The main reasons for raising

sea-level rise problems with higher-level government units were that the village leaders believed that the former would take better policy actions and they could get more budget support. On the main reasons for not doing so, about 47% of the respondents said it was because their higher-level government units had never emphasized the importance of sea-level rise and related adaptation problems while about 28% thought that sea-level rise was not a priority problem in their villages.

The main adaptation measures that the villages had taken were typhoon early warning and evacuation systems (88%) and improving the drainage system in their villages (81%). The measures taken were not significantly different from the measures cited in Phase I. Around 70% of the village leaders said that they would disseminate the information on sea-level rise and adaptation to it to the local people. Only around one-third of them stated they would raise the problem of sea-level rise with higher-level government units.

When we asked the respondents what additional help that they needed from higher-level government units to support sea-level rise adaptation, the answers given were: more technical assistance (25%), more policy support (47%), more budget support (42%), and more information support (23%).

#### ***3.4.2.4 Possible factors associated with policy actions in Phase III***

In order to find out who did in fact disseminate the information to people in their villages in Phase III, we pooled the data from the experimental groups and the control group. The binary logit regression model was used to identify possible factors associated with disseminating information decisions. The dependent variable was a dummy variable, denoting whether the village disseminated the information on sea-level rise to the local population. The estimation results are shown in Table 15.

From Table 15, it can be seen the coefficient for EDUCATION is positive and significant, implying that more educated village leaders were more likely to disseminate the information on sea-level rise to the local public. The coefficients for TOURISM and COMMERCIAL were also positive and significant, showing that village leaders from the tourism and commercial towns were more likely to disseminate the information to people in their communities. The coefficient for INFORMATION was insignificant, which implies that information provision had no significant effect on the decision to disseminate sea-level rise information to the local public.

Table 15. Logit regression results on factors associated with information dissemination

Variables	Definitions	Coefficient	Std. error	<i>p</i> -value
CONSTANT		-0.33	0.79	0.9968
AGE	Age of respondent	0.08	0.08	0.3202
GENDER	1 = male, 0 = female	-0.73	1.17	0.5359
EDUCATION	Education level of respondents (1=primary, 2=Junior high school, 3=Senior high school, 4=college and above)	1.79**	0.82	0.0297
TOURISM	Dummy variable denoting town category, 1=tourism town, 0=commercial or fishery town	2.71**	1.27	0.0325
COMMERCIAL	Dummy variable denoting town category, 1=commercial town, 0=tourism or fishery town	2.63**	1.24	0.0336
INFORMATION	Dummy variable denoting information provision, 1= with information, 0=without information	2.03	0.80	0.9980
Model summary				
-2 Log likelihood	30.29			
Cox & Snell R <sup>2</sup>	0.33			
Observations	63			

Note: \*\*\* Significant at  $p < 0.01$ ; \*\* Significant at  $p < 0.05$ ; \* Significant at  $p < 0.1$ .

### 3.4.3 Treatment effects of information provision on policy actions

The DID method was also used to evaluate the treatment effect of information provision on policy actions. The logit estimation results are shown in Table 16. The results showed that the coefficients for “Treatment x period” were insignificant, suggesting that the information provision had no treatment effect on local village leaders’ policy actions on adaptation to sea-level rise. The reason for this could be that top-down planning was still very prominent in the Chinese government hierarchy. Usually it is the higher-level government units which give instructions to local lower-level government units. Moreover, information provision cannot be the sole motivation for local village leaders to take action on sea-level rise adaptation. Some adaptation measures such as building dykes, seawalls, tidal barriers, and breakwaters take time to complete and more budget and technical staff support is needed.

Table 16. Treatment effects of information provision on policy actions

		Action 1	Action 2	Action 3	Action 4	Action 5
Phase I vs.	Constant	-1.16(0.51)**	-2.99(1.03)***	-2.25(0.74)***	-0.69(0.46)	-1.16(0.51)**
Phase II	Treatment	-0.14(0.64)	-0.18(0.62)	-0.31(0.96)	0.41(0.56)	-0.28(0.65)
	Period	1.26(0.67)	0.74(1.26)	0.46(0.97)	0.21(0.65)	0.01(0.73)
	Treatment ×period	-0.05(0.83)	0.19(0.62)	0.31(1.22)	0.67(0.79)	0.41(0.90)
Phase I vs.	Constant	-1.16(0.51)**	-2.99(1.02)***	-2.25(0.74)***	-0.69(0.46)	-1.16(0.51)**
Phase III	Treatment	-0.14(0.64)	-0.18(0.62)	-0.31(0.96)	0.41(0.56)	-0.28(0.65)
	Period	0.25(0.70)	0.74(1.27)	0.46(0.97)	-1.10(0.78)	-1.09(0.90)
	Treatment ×period	0.77(0.86)	0.20(0.62)	1.41(1.18)	0.35(0.91)	0.93(1.07)

Notes:

1. Numbers in parenthesis show the percentage of responses to different policy actions on sea-level rise.
2. \*\*\*Significant at  $p < 0.01$ , \*\*Significant at  $p < 0.05$ , \*Significant at  $p < 0.1$ .
3. Action 1: We have discussed sea-level rise with our village councils.
4. Action 2: We have disseminated the information on sea-level rise and adaptation to it to the local public.
5. Action 3: We have raised the problem of sea-level rise with higher-level government units.
6. Action 4: We will disseminate the information on sea-level rise and adaptation to it to the local public in the next few months.
7. Action 5: We will raise the problem of sea-level rise with higher-level government units in the next few months.

### 3.5 Surveys of Villagers

We also conducted a survey involving local villagers in Phase III. Eight villagers were randomly selected within each village. In total, 504 villagers were surveyed. The survey results revealed that sea-level rise was not widely known about by the local people. Only about 51% of the villagers interviewed said that they had heard of sea-level rise, against 49% who indicated that they had never heard about sea-level rise.

The main methods through which the villagers had learned about sea-level rise were television (39%), books and newspapers (35%), and the internet (21%). About 85% of the respondents stated that their village councils had not disseminated any

information on sea-level rise to the local population in the last six months. The respondents who had received some information from their village councils were mainly from the tourism towns (62.5%). Only 41% of the respondents stated that they would like to learn about sea-level rise. The information that they were interested in was: threats of sea-level rise to the local people (35%), causes of sea-level rise (20%), related laws and policies of the Chinese government (18%), adaptation measures on sea-level rise (16%), future sea-level rise situation (14%), and technology on controlling sea-level rise (12%).

Thus, it can be seen that the local villagers had little knowledge of sea-level rise and few of them had received the information on sea-level rise and adaptation to it from their village councils. The village leaders from the tourism towns paid more attention to the sea-level rise problem than those from the commercial and fishery towns.

In order to find the possible associations between the respondents' knowledge on sea-level rise and their socio-economic variables, a binary logit regression was run. The dependent variable was a dummy variable denoting the respondents' knowledge on sea-level rise. If the respondent knew about sea-level rise, it was coded as one. The estimation results are shown in Table 17.

Table 17. Variables associated with the villagers' knowledge of sea-level rise

Variables	Definitions	Coefficient	Std. error	p-value
CONSTANT		-2.79***	0.70	0.0001
AGE	Age of respondent	-0.03***	0.01	0.0042
GENDER	1 = male, 0 = female	0.49**	0.23	0.0337
EDUCATION	Education level of respondents (1=primary, 2=junior high school, 3=senior high school, 4=college and above)	1.44***	0.16	0.0000
TOURISM	Dummy variable denoting town category (1=tourism town, 0=commercial or fishery town)	0.67**	0.34	0.0463
COMMERCIAL	Dummy variable denoting town category (1=commercial town, 0=tourism or fishery town)	0.61**	0.29	0.0321
INFORMATION	Dummy variable denoting with or without information provision (1=with information, 0=otherwise)	0.33	0.28	0.2391
Model summary				
-2 Log likelihood	465			
Cox & Snell R <sup>2</sup>	0.37			
Observations	512			

Notes: \*\*\* Significant at  $p < 0.01$ ; \*\* Significant at  $p < 0.05$ ; \* Significant at  $p < 0.1$



The estimation results showed that almost all the explanatory variables had the expected signs and were significant. The coefficient of AGE was negative and significant at the 1% level, which indicates that the older villagers had less knowledge of sea-level rise. The coefficient for GENDER was positive and significant, which showed that male respondents knew more about sea-level rise than female respondents. As expected, the coefficient for EDUCATION was positive and statistically significant, which supports the hypothesis that more educated respondents would have more knowledge on sea-level rise. We also included the town category variable in the model. The coefficients for TOURISM and COMMERCIAL were positive and significant, showing that villagers from tourism and commercial towns had more knowledge of sea-level rise than villagers from fishery towns. The coefficient on INFORMATION was, however, not significant, suggesting that villagers from the treatment villages were not significantly different from those in the control villages. This confirms that the village leaders in the experimental groups did not disseminate the information they had received to their local communities.

#### **4.0 CONCLUSIONS AND POLICY IMPLICATIONS**

Learning about local decision-makers' opinions with regard to sea-level rise and adaptation to it is essential in order to provide relevant information to support the design of related policies. One goal of this study was to assess how local decision-makers in the coastal villages on the islands of Zhejiang Province perceived sea-level rise and adaptation to it and how they acted on these perceptions.

Studies in other countries have shown that information has a positive effect on decision-making on environmental problems. Another objective of this study was to investigate the effects of an information brochure on local decision-makers' knowledge and awareness of, and policy actions on sea-level rise adaptation.

The results showed that local village officials in the coastal villages on the islands of Zhejiang Province had little knowledge of global warming and sea-level rise. Sea-level rise was also not widely known by the general local population. In order to facilitate the formulation of better sea-level rise adaptation policies, local village leaders should be provided with more information on related laws and policies of central government, the possible threats of sea-level rise, and specific sea-level rise adaptation measures. The main source of information for the local village leaders and population about sea-level rise was found to be the mass media. Based on this fact, using the mass media (especially television) more effectively to improve the perception, knowledge and awareness of local decision-makers and communities of sea-level rise and related adaptation in Zhejiang Province is recommended.

The main sea-level rise adaptation measures that the villages have taken are building dykes, seawalls, tidal barriers and breakwaters; installing early warning and evacuation systems; and improving drainage systems. Ongoing measures include higher engineering design standards for tide and flood control projects. The main measures that need to be taken are improving public awareness of sea-level rise,

relocating buildings at risk, dune or wetland restoration or creation, and beach replenishment<sup>1</sup>.

The multiple linear regression results revealed that the respondents' age and education level as well as the town category were positively associated with the respondents' knowledge of sea-level rise. The younger and more educated village leaders from tourism and commercial towns tended to have better knowledge of sea-level rise compared with the older and less educated respondents from fishery towns. Thus, increased investment in education and communication programs can enhance the knowledge and perceptions of local officials about sea-level rise and adaptation.

With regard to the attitude of local village leaders, the data showed that the local village leaders were not very concerned about sea-level rise and adaptation. Sea-level rise ranked low in importance, compared with other environmental problems such as water pollution and solid waste management. The results also revealed that although the respondents in the baseline survey had a positive attitude towards sea-level rise adaptation, majority of them believed that it was not the local government which should take responsibility for this.

In our study, we found that providing the respondents with information on sea-level rise and adaptation to it increased their knowledge significantly and changed their attitude towards sea-level rise and adaptation positively. However, receiving the information brochure did not significantly contribute to the local village leaders taking specific policy actions on sea-level rise adaptation, regardless of the fact that the information brochure had been read by almost all of the respondents in the experimental groups who reported appreciation of and satisfaction with it. The process of top-down planning is still a very prominent feature of the Chinese government system and information provision cannot be the sole factor in getting local village leaders to take measures on sea-level rise adaptation. Budget, the availability of technical staff, and policy support are just as if not more important. This needs to be taken into account in any plan to increase the adaptive capacity of local government units.

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<sup>1</sup> Beach replenishment is a technique used to restore an eroding or lost beach or to create a new sandy shoreline. It involves the placement of sand fills with or without supporting structures along the shoreline to widen the beach.

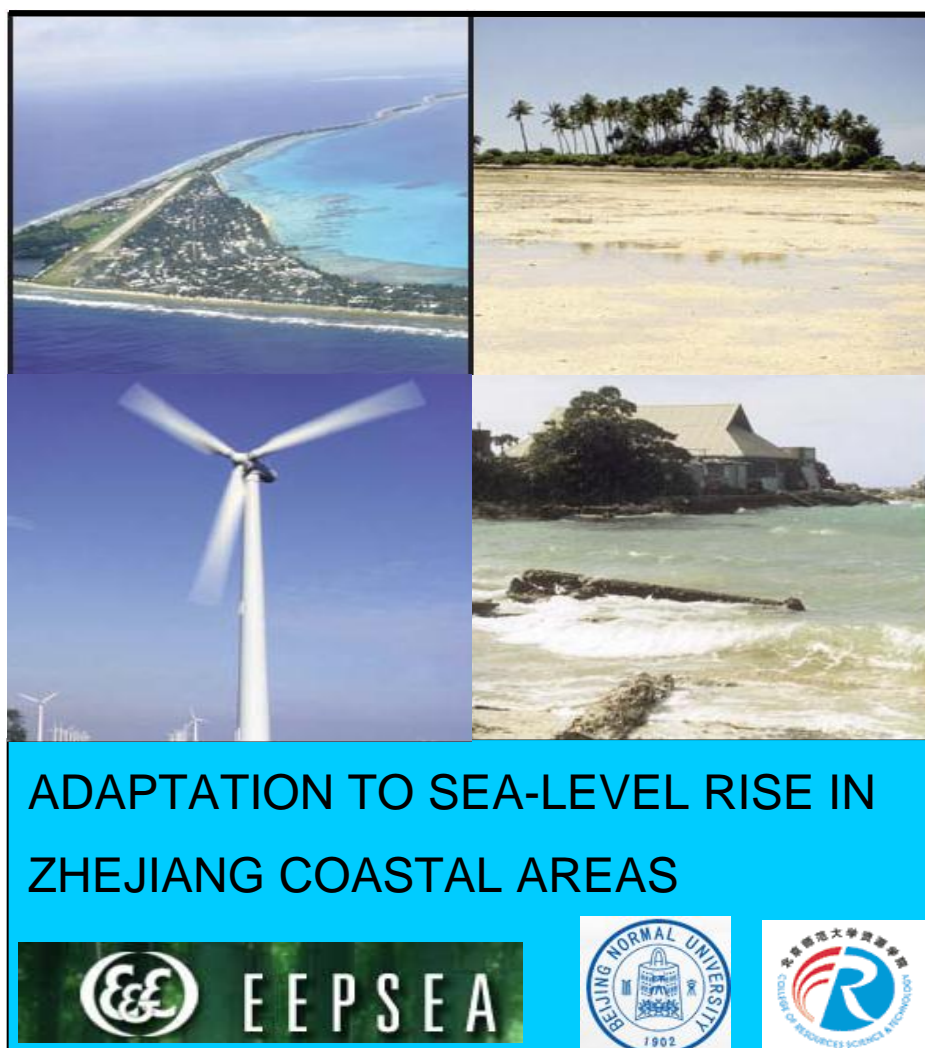
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## APPENDICES

### Appendix A. Information Brochure



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## Summary

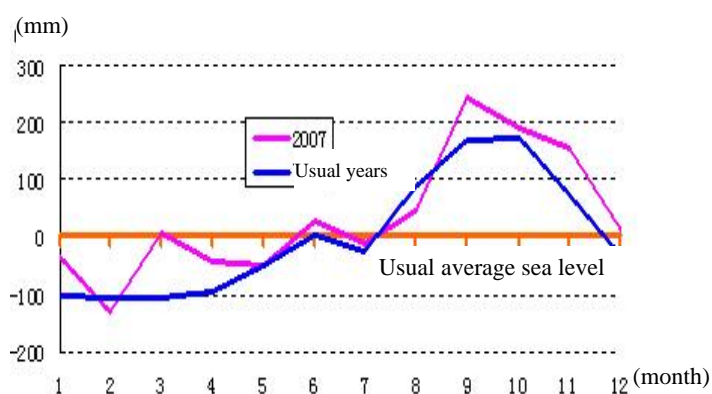
Sea-level rise due to climate change is a serious global threat. Zhejiang is a maritime province. Rapid economic development is ongoing in its coastal areas where a large part of its population lives. Human well-being and livelihood in Zhejiang coastal villages are at stake if the sea level continues to rise. Adaptation, which refers to finding and implementing sound ways of adjusting to the adverse effects of sea-level rise, is becoming an urgent priority.

This brochure presents a brief introduction on sea-level rise in general and particularly in the coastal areas of Zhejiang. It summarizes and illustrates the threats of sea-level rise and possible strategies that can be taken to implement sound and practical adaptation actions at the local level.

## Introduction to Sea-level Rise

The burning of fossil fuels and other developments have been increasing the atmospheric concentrations of certain gases – chiefly carbon dioxide, methane and nitrous oxide – called greenhouse gases (GHGs). There is a significant body of evidence that suggests the increase of GHGs in the atmosphere has resulted in a warming of the Earth in this last century. Global sea level and the Earth's climate are closely linked. In the 20th century, the global average sea level has risen by 10-20 cm, primarily due to global warming. Scientific predictions indicate that sea level rise will continue, and possibly accelerate over the next century and beyond.

Zhejiang is a maritime province with 2,161 islands and the longest continental coastline totaling 2,200 kilometers in China. Rapid economic growth is ongoing in its coastal areas where a large part of its population lives. However, the elevation along Zhejiang coast is only about 1.5-5 m, which makes it very sensitive to sea-level rise.



Monthly average sea level in Zhejiang in 2007

According to the Sea Level Report in 2007 released by the State Oceanic Administration of China, the sea level along the Zhejiang coast has been rising in the last 30 years at a rate higher than the country average. In 2007, the average sea level

along Zhejiang coast was 76 mm higher than normal. The relative sea level along the Zhejiang coast is projected to rise by 20-40 cm by the year 2050, compared with the sea level in 2000. Human well-being and livelihood in Zhejiang coastal villages are at stake.

### Threats of Sea-Level Rise



Stronger typhoons and storms



Saltwater intrusion



Lowland submergence



Speeding up of coastal erosion



Exacerbated flooding



Affecting fishery

Scientists have pointed out that sea-level rise is a slow and gradual process. Although people may not be able to notice its rising, it can affect existing coastal constructions and also the ecological environment in coastal areas. It is a gradual natural disaster which threatens people's life and development.

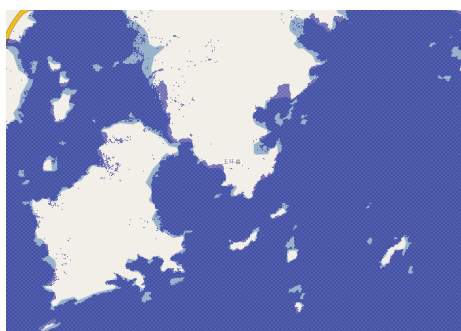
Sea-level rise can cause different kinds of threats, such as increasing the intensity and frequency of typhoons or storm surges, speeding up coastal erosion, exacerbating coastal flooding, causing salt water intrusion and soil salinization, etc.

### Submergence of lowlands

The most obvious impact of sea-level rise is that it will cause the submergence of vast areas of land, especially the weak regions along the coast where the elevation is less than or equal to 5 m. If the relative sea-level rise is 400 mm, the submerged area in Zhejiang is estimated to be 17,241 km<sup>2</sup>. This will not only seriously destroy the natural landscape of the tidal beach, but also wipe out the habitats and reproduction sites for economically important fish, shrimp, crab and shellfish, and put an end to many rare valuable endangered animals and plants. The following figures show the



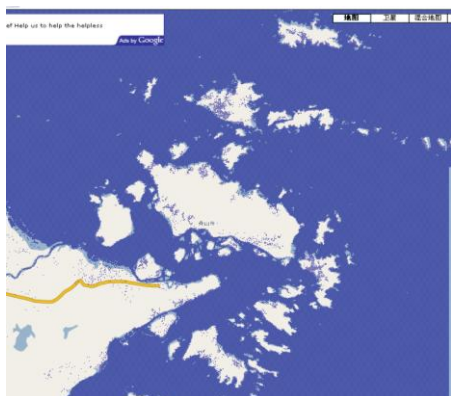
possible submerged area in Yuhuan and Zhoushan counties if the sea-level rise is 1 m and 5 m, respectively.



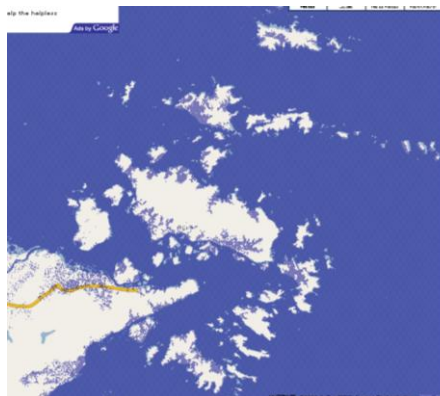
Possible submerged area in Yuhuan County if sea-level rise is 1 m



Possible submerged area in Yuhuan County if sea-level rise is 5 m



Possible submerged area in Zhoushan City if sea-level rise is 1 m



Possible submerged area in Zhoushan City if sea-level rise is 5 m

### **Increased destructiveness of typhoons or storms**

Sea-level rise will increase the frequency and intensity of typhoons or storm surges. Zhejiang's coastal areas are often subject to typhoons accompanied by storm tides. Sea-level rise hampers the functions of the sea shore, sea embankments and tide gates, and greatly enhances the destructive potential of typhoons. In 2006, Taizhou City in Zhejiang Province experienced two severe storm surges; 'Bi Li Si' and 'Shang Mei', which caused direct economic losses of 5.14 billion yuan.

### **Speeding up of coastal erosion**

Sea-level rise increases the water depth, and thus the volume of the tide and the strength of sea waves and tide currents. It will hasten and increase coastal erosion. Coastal erosion in Zhejiang's coastal areas is common, especially along Dongsha beach in Zhoushan City which has been retrograding (eroding backwards).



## Exacerbated floods and water-logging

With the rise of sea-level, the levels of rivers responsive to tides are certain to get higher, which will compromise urban sewage and water discharge capacity. What's more, cities will suffer from large-area water-logging, sewage back-flow, heavy river deposits, blockade of navigation and harbor facilities, and significant reduction of agricultural output.

## Saltwater intrusion

Sea-level rise strengthens tide currents, which help seawater flow into rivers, surface water and groundwater, and enhances the scale and speed of salt water intrusion. This in turn threatens freshwater resources. Saltwater intrusion in turn lowers the bearing capacity of building foundations. Cities along the coastal regions are no longer safe, but exposed to danger. The socio-economic impacts of sea-level rise on different sectors are indicated in the following figure.

Socio-economic impacts of sea-level rise

	More frequent floods	Erosion of coast	Inundation by sea water	Rise in water table	Intrusion of salt water	Changes in biological processes
Water resources			✓	✓	✓	✓
Agriculture	✓		✓	✓	✓	
Human health	✓		✓			✓
Fisheries	✓	✓	✓		✓	✓
Tourism	✓	✓	✓			✓
Human settlements	✓	✓	✓	✓		

## Adaptation to Sea-Level Rise

The threats of sea-level rise have aroused widespread concern and demands for action. Generally, there are two main strategies to address sea-level rise: mitigation and adaptation. Mitigation involves finding ways to slow the emissions of GHGs, to store them, or to absorb them in forests or other carbon sinks. Adaptation, on the other hand, involves coping with sea-level rise—taking measures to reduce the negative effects, or exploit the positive ones, by making appropriate adjustments.

Mitigation is important. However, even if global GHGs emissions were to cease immediately, global warming would still have impacts until 2050 due to a time lag of reaction. Thus, adaptation is inevitable and essential.

Communities in coastal areas have a choice of three basic adaptation strategies: protect, retreat or accommodate. Protection could mean building dykes; retreating could mean relocating homes or businesses, or demarcating certain zones as off-limits

for development; while accommodating could involve establishing stronger building codes, or strengthening early warning systems. A selection of the options is shown as follows.

### Measures for adaptation to sea-level rise

Protect	Retreat	Accommodate
<ul style="list-style-type: none"> <li>• <i>Hard structures</i> – dykes, sea-walls, tidal barriers, detached breakwaters</li> <li>• <i>Soft structures</i> – dune or wetland restoration or creation, beach nourishment</li> <li>• Indigenous options walls of wood, stone or coconut leaf, afforestation</li> </ul>	<ul style="list-style-type: none"> <li>• Establishing set-back zones</li> <li>• Relocating threatened buildings</li> <li>• Phasing out development in exposed areas</li> <li>• Creating upland buffers</li> <li>• Rolling easements</li> </ul>	<ul style="list-style-type: none"> <li>• Early warning and evacuation systems</li> <li>• Hazard insurance</li> <li>• New agricultural practices, such as using salt-resistant crops</li> <li>• New building codes</li> <li>• Improved drainage</li> <li>• Desalination systems</li> </ul>



For **protection**, the most visibly reassuring option may be to build hard structures such as sea-walls. However, apart from being very expensive, these can have damaging side effects, for example, by displacing erosion and sedimentation. It may be better therefore to consider soft options that involve restoring dunes or creating or restoring coastal wetlands, or continuing with indigenous approaches such as afforestation

For **retreat**, the simplest approach might be to establish a set-back zone requiring development to be at a specified distance from the water's edge. There are also intermediate options in the form of 'easements'; legal agreements that restrict the size or density of structures within areas at risk and specify permitted types of shoreline stabilization. The area to which these apply can also be designed to automatically move or 'roll' landward as the sea advances.

For **accommodation**, there is a variety of options. These will include warning systems for extreme weather events, as well as longer-term measures such as new building codes, or improving drainage systems by increasing pump capacity or using wider pipes.

Action for adaptation can involve many organizations or institutions, but in practice the responsibility tends to fall on the public sector. In coastal areas, sea-level rise is likely to affect food and water security, biodiversity, and human health and safety; collective goods and systems for which governments have prime responsibility. Nevertheless, at all stages, the government should ensure continuous public consultation. This is mainly because people have a right to participate in the decisions that affect their lives; indeed they will demand it as communities all over the world are becoming increasingly resistant to top-down planning. But local acceptance and cooperation is also vital because most measures will depend on local expertise for implementation and maintenance.

In some cases, the private sector may also have an incentive to invest, as would be the case for combating beach erosion at tourist resorts. The private sector could also play a stronger role in transferring technology, given appropriate incentives in the form of investment subsidies or tax relief.

There are also opportunities for non-governmental organizations. In addition to raising public awareness, they can act as intermediaries; identifying technologies, facilitating investment, and providing management, technical and other assistance.

## Action for Adaptation

Sea-level rise has caused and will bring serious threats to our coastal villages. To some degree, this will affect everyone. In order to protect people's health, well-being and livelihoods, it is time for local governments and local inhabitants to take action on sea-level rise adaptation.



## Appendix B. Questionnaire for Villagers

Good day! I am part of the Beijing Normal University research team. First, I would like to thank you for your participation in our first round of interviews. Now we are conducting a villager survey. We would like to assure you that whatever information you reveal during this interview will be kept confidential and will only be used for this research. Please don't hesitate to ask me any questions if there is anything that is not clear to you. There is no right or wrong answer. It is very important that you would give us your honest opinion.

1. Have you heard about sea-level rise?
  - 1). Yes
  - 2). No
2. If so, how did you know sea-level rise? (Please choose one answer.)
  - 1) Newspapers and books
  - 2). TV/Video
  - 3). Radio
  - 4). Internet
  - 5). Information from village council
  - 6). Others (specify): \_\_\_\_\_
3. Has your village council disseminated any information on sea-level rise to the local population in the last six months?
  - 1). Yes
  - 2). No
4. If so, what was the main dissemination method?
  - 1). Radio
  - 2). Leaflet
  - 3). Posters
  - 4). Others (specify): \_\_\_\_\_
5. Would you like to get any information on sea-level rise?
  - 1). Yes
  - 2). No
6. If so, what kind of information on sea-level rise would you like to have?
  - 1 (most wanted): \_\_\_\_\_
  - 2: \_\_\_\_\_
  - 3: \_\_\_\_\_
  - 1) International convention
  - 2) Laws and policies in our country
  - 3) Knowledge on how to control sea-level rise
  - 4) Experiences in other countries
  - 5) Sea-level rise impacts on human beings
  - 6) Causes of sea-level rise
  - 7) Strategies for sea-level rise adaptation
  - 8) Sea-level rise in future
  - 9) Others (please specify): \_\_\_\_\_
7. What's your age? \_\_\_\_\_ years old
8. Gender: \_\_\_\_\_
  - 1). Male
  - 2). Female
9. Education Attainment (highest level):
  - 1) Primary school
  - 2) Junior high school
  - 3) Senior high school
  - 4) College
  - 5) University or above



7. What is your level of knowledge on sea-level rise?  
 1) Professional 2) Something 3) A little 4) Nothing
8. From the following, which one will cause the sea level to rise?  
 1) deforestation 2) fossil fuel burning 3) wastewater 4) species extinction
9. From the following, which one is not caused by sea-level rise?  
 1). Lowland submergence 2). Increase in typhoon disasters  
 3). Saltwater intrusion 4). Increase in floods  
 5). Coastal erosion broadened 6). Navigation and harbor facilities blockage  
 7). Dyke flood-control capacity decreased 8). Ozone hole enlarged
10. In your opinion, the sea-level along Zhejiang coast has been:  
 1) Increasing 2) Decreasing 3) No change 4) No regular pattern  
 5) Don't know
11. Sea-level rise is good for water resource shortage. 1) True 2) False
12. Sea-level rise can decrease the intensity of typhoons or storm surges.  
 1) True 2) False
13. Sea-level rise can deepen the navigation channel. 1) True 2) False
14. Sea-level rise can cause soil salinization. 1) True 2) False
15. What kind of information on sea-level rise would you like to have?  
 1 (most wanted): \_\_\_\_\_ 2: \_\_\_\_\_ 3: \_\_\_\_\_  
 1) International convention 2) Laws and policies in our country  
 3) Knowledge on how to control sea-level rise  
 4) Experiences in other countries 5) Sea-level rise impacts on human beings  
 6) Causes of sea-level rise 7) Strategies for sea-level rise adaptation  
 8) Sea-level rise in future 9) Others (please specify): \_\_\_\_\_
16. How would you like to get this information?  
 1) Mass media (TV/Radio) 2) Official training 3) Internet  
 4) Others (specify): \_\_\_\_\_

## 2. Attitudes towards sea-level rise

17. For the following statements, please tell us your opinion on a scale of 5 (strongly agree) to 1 (strongly disagree).

STATEMENT TO AGREE/DISAGREE ON...	5	4	3	2	1
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a. Sea-level rise is an important environmental problem in our village.					
b. I am concerned about the problem of sea-level rise.					
c. Sea-level rise will affect people's lives in the future.					
d. There is a need to adapt to sea-level rise in our village.					
e. Local government units should take some measures to mitigate the impacts of sea-level rise.					
f. Sea-level rise is a global issue and we cannot do anything about it.					

### 3. Policy actions on sea-level rise

18. Have you discussed about sea-level rise within your village council in the last few months ?

- 1) Yes                      2) No

19. Has your village council ever disseminated any information on sea-level rise to the local public?                      1) Yes                      2) No

20. If so, what's the main reason for disseminating the information on sea-level rise to the local public?

- 1) Sea-level rise is a vital problem for local villagers.
- 2) Our village council has the responsibility to do this.
- 3) Local villagers will contribute to implementing adaptation policies if they have some knowledge of sea-level rise.
- 4) Others (specify): \_\_\_\_\_

21. If not, what's the main reason for not disseminating the information on sea-level rise to the local public?

- 1) We have not received any instructions from higher-level government units.
- 2) Our village has no budget for this.
- 3) Our village council has no responsibility to do this.
- 4) Local villagers are not concerned about sea-level rise problems.
- 5) Others (specify): \_\_\_\_\_



22. Will your village council disseminate any information on sea-level rise to the local public in the coming months?
- 1) Yes                      2) No
23. If so, which channel will you employ?
- 1) Broadcast              2) Leaflet              3) Posters              4) Others
24. Has your village council raised the problem of sea-level rise with your higher-level government units in the last few months?
- 1). Yes                      2). No
25. If so, what's the main reason for raising the problem of sea-level rise with your higher-level government units?
- 1) Sea-level rise is a very important problem.
- 2) Higher-level government units can make more suitable policies.
- 3) It will help our village to get more budget support.
- 4) Others (specify): \_\_\_\_\_
26. If not, what's the main reason for not raising the problem of sea-level rise with your higher-level government units?
- 1) Sea-level rise is not a very important problem in our village.
- 2) Higher-level government units have never emphasized sea-level rise problems.
- 3) Our village council has not enough information on sea-level rise.
- 4) Others (specify): \_\_\_\_\_
27. Will your village council bring up sea-level rise problems to higher government units in the coming few months?
- 1). Yes                      2). No
28. If so, how will you do this?
- 1) Official reports    2) Policy suggestions
- 3) Meeting discussions    4) Personal communication
29. From the following measures to adapt to sea-level rise, what kind of measures has your village council taken, what kind of measures is your committee taking and what kind of measures is your committee going to take?

30.

Measures	Has taken	In process	Will take
1. Improve the drainage system			
2. Set higher engineering design standards for tide and flood control projects			
3. Introduce early warning and evacuation systems			
4. Improve public awareness of sea-level rise			
5. Relocate threatened buildings			
6. Dune or wetland restoration or creation, or beach replenishment			
7. Phase out development in exposed areas			
8. Introduce hazard insurance			
9. Build dykes, seawalls, tidal barriers, breakwaters			
10. Others (pls specify) : _____			

31. In your opinion, who should be responsible for sea-level rise adaptation?

- 1) Central government      2) Provincial government      3) Local government
- 4) Enterprises              5) Communities and organization      6) Local public

32. In your opinion, are the villagers in your village concerned about sea-level rise?

- 1) Yes                      2) No

33. In your opinion, what can your village council do in terms of sea-level rise adaptation?

- 1) Propose higher-level government units to take measures
- 2) Plant more trees
- 3) Build higher dykes in our village
- 4) Disseminate information on sea-level rise information to the local population
- 5) Take adaptation actions in our village as soon as possible
- 6) Others (specify):\_\_\_\_\_

34. From the following threats of sea-level rise, which one are you most worried about?

- 1) Lowland submergence      2) Exacerbated floods and water-logging
- 3) Increased destructiveness of typhoons or storms      4) Saltwater intrusion
- 5) Speeding up coastal erosion      6) Others (specify):\_\_\_\_\_

35. What do you think are the THREE MOST IMPORTANT environmental problems in your village?

- 1) Air pollution      2) Water pollution      3) Solid waste management

4) Sea-level rise    5) Deforestation    6) Others (specify):\_\_\_\_\_

36. What is the main difficulty for your village to take action on sea-level rise adaptation?

1) People don't think sea-level rise is an urgent and priority problem in our village.

2) Higher government units have paid little attention to sea-level rise and did not ask us to take any actions.

3) Lack of finance and personnel

4) Others, please specify: \_\_\_\_\_

37. What additional help do you need in order to take policy actions on sea-level rise adaptation?

1) More technological support    2) More policy support    3) More budget

4) More information support    5) Others (specify):\_\_\_\_\_

#### **4. Demographic information**

*Now, I would like to ask you some questions about you and your village. Your answers will help us analyze the results of this survey.*

38. What's your age?\_\_\_\_\_ years old

39. Gender: \_\_\_\_\_    1) Male    2) Female

40. Education Attainment (highest level):

1) Primary school    2) Junior high school    3) Senior high school  
4) College    5) University or above

41. What is the local public's main economic activity in your village?

1) Fishery    2) Business    3) Tourism    4) Industry    5) Planting    6) others

42. What is your town's main economic activity?

1) Fishery    2) Business    3) Tourism    4) Industry    5) Planting    6) others

43. What's the total area of your village? \_\_\_\_km<sup>2</sup>

44. What's the total area of cultivated land in your village? \_\_\_\_km<sup>2</sup>

45. What's the total population in your village? \_\_\_\_\_

How many are fishermen? \_\_\_\_\_

46. How much was the per capita income in your village last year? \_\_\_\_\_yuan

47. How far is your village to the nearest paved road? \_\_\_\_\_km

48. How far is your village to the nearest secondary school? \_\_\_\_\_km

49. How far is your village to the nearest hospital? \_\_\_\_\_km

This is the end of the interview. Thank you very much for your contribution to this survey. If you have any concerns or opinions that you would like to share concerning the questionnaire or sea-level rise, please use the space provided below:

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**Appendix D. Questionnaire on Sea Level Rise**  
**(For the experimental groups in Phase II and Phase III)**

Good day! I am part of the Beijing Normal University research team. First, I would like to thank you for your participation in our first round of interviews. Now we are conducting a second interview. Again, I would like to assure you that whatever information you reveal during this interview will be kept confidential and will only be used for this research. Please don't hesitate to ask me any questions if there is anything that is not clear to you. There is no right or wrong answer. It is very important that you give us your honest opinion.

Basic Information:	
Name of local government unit:	_____
Location:	_____
Date of Interview: _____	Interviewer: _____
Time Interview Started: _____	Time Interview Ended: _____

**1. Use of information brochure**

1. Have you read the information brochure that we disseminated earlier?
  - 1). Yes
  - 2). No (**Continue to Questionnaire in Appendix C**)
2. How many times have you read it?
  - 1). Once
  - 2). Twice
  - 3). Three times
  - 4). More than 3 times
3. Did you have difficulty in understanding the information in the brochure?
  - 1). Yes, very difficult
  - 2). Yes, a little difficult
  - 3). Not at all
4. Do you think the information provided is detailed?
  - 1). Yes
  - 2). No
5. Do you think the information provided is relevant to your job?
  - 1). Yes
  - 2). No
6. Do you think the information provided is accurate?
  - 1). Yes
  - 2). No
7. Do you think the information brochure is helpful?
  - 1). Yes
  - 2). No
8. Did the information provided improve your knowledge on sea-level rise?
  - 1). Yes
  - 2). No

9. Did the information provided improve your awareness of sea-level rise?  
1). Yes                      2). No
10. Has the information provided affected your decisions in the last one month?  
1). Yes                      2). No
11. If so, please explain: \_\_\_\_\_
12. Have you used the information provided in the last one month?  
1). Yes                      2). No
13. If so, what did you use the information for?  
1). Writing government reports                      2). Communication with colleagues  
3). Preparation of government proposals                      4). Public dissemination  
5). Preparation of coastal zone response mechanisms  
6). Others, please explain: \_\_\_\_\_
14. Was any action taken based on the information provided?  
1). Yes                      2). No
15. Will the information provided affect your policy decisions in the future?  
1). Yes                      2). No

***Then the subject will be interviewed with the questionnaire used in the baseline.***

