

Vulnerability Assessment of Phu Hao village, Khanh Phu commune, Ninh Binh City

I. Introduction

This research was conducted in Ninh Binh province from February to December 2017 by VNU- Central Institute for Natural Resources and Environmental Studies (the then Center for Natural Resources and Environmental Studies) (CRES), Vietnam National University (VNU), Hanoi. The research is financially supported by the Urban Climate Resilience in Southeast Asia Partnership (UCRSEA) project funded by the Social Sciences and Humanities Research Council of Canada and International Development Research Centre (IDRC). The field survey was focused on Phu Hao village, Khanh Phu commune, Ninh Binh city.

II. Objective of research

Assess the vulnerability of local community caused by the impact of urban development in the climate change context.

Activities of research:

- Map out stakeholders
- Develop research methodology and survey tools
- Pre-test and complete field survey tools
- Conduct field surveys
- Enter data and analyze data
- Organize workshop for local feedback
- Finalize report

III. Research Question

Based on the Conceptual Framework of Urban Climate Resilience in Southeast Asia Partnership

(UCRSEA), we down scale the questions to fit with our research context.

The questions are:

1. How has urbanization and climate change affected the local community?
2. How can research group, institutions, local authority and community adapt to climate change impact as well as difficulties due to poor planning?

IV. Research Methodology

To reach the research question, our team defined several methods to collect the data from learning site, they are including:

4.1. Research site

Ninh Binh is located in the south of Red River Delta/ Northern Delta from the latitude of north 19° 50' to 20° 27' of north and the longitude of east from 105° 32' to 106° 27' east. Ninh Binh is bordered by Ha Nam and Nam Dinh in the east and northeast, Thanh Hoa and East Sea in the south. Ninh Binh has two cities and six districts such as Ninh Binh and Tam Diep city, Hoa Lu, Gia Vien, Nho Quan, Yen Khanh, Yen Mo, Kim Son district. Yen Khanh district located in the southeast side of Ninh Binh city. In the development plan of Ninh Binh city to 2020 vision to 2030, Khanh Phu is one of two communes of Yen Khanh district will be merged into Ninh Binh city's area (Truc Quyen, 2016). *Figure 1* below illustrates the study site of this research.

Khanh Phu commune is located in the North of Yen Khanh district, Ninh Binh province, 5km distant from the city centre. The total area of Khanh Phu is 5.92 km² and the population is 5500 people. This commune includes 8 villages, including Phu An, Phu Long, Phu Tan, Phu Hai, Phu cuong, Phu Son, Phu Binh and Phu Hao. Khanh Phu is bordered by Khanh Hoa, Ninh Phuc (Ninh Binh city) and Khanh An (Yen Khanh district). Ninh Phuc Port located in Khanh Phu is the major one serving for Khanh Phu Industrial Zone. Khanh Phu Industrial Zone lies on two communes being Ninh Phuc (Ninh Binh city) and Khanh Phu (Yen Khanh district). This zone occupies $\frac{3}{4}$ area of Phu Hao village and covers almost all of this village (Khanh Phu People's Committee, 2016).

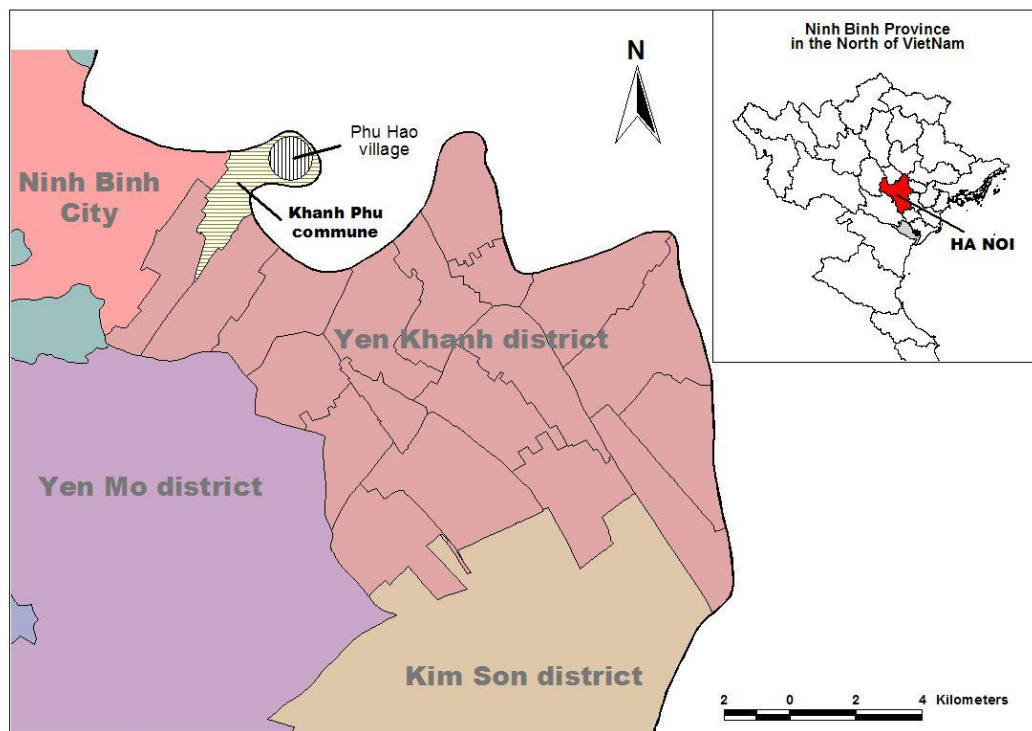


Figure 1. Location of the research site

Khanh Phu as well as Ninh Binh province has a tropical monsoon climate with 4 different seasons. There are two dominant monsoon winds, the southwest wind during the summer and northeast wind in winter. Summer and autumn in this region have high temperature and humidity. From May to October, typhoons and storms occur with strong winds and heavy rains. The average temperature is about 23°C. The average annual sunlight hours are about 1,100 hours, and the annual rainfall is 1,800mm. The volume of rainfall in summer and autumn from May to October is significantly higher than in the winter and spring time from November to April (ninhbinh.gov.vn, 2018).

Since the factories of the Khanh Phu industrial zone commenced operations, Phu Hao villagers have experienced impacts such as loss of productive land, loss of livelihoods, a high rate of unemployment, and a polluted environment. According to key informants, the water resources and air have been polluted which has resulted in the death of cattle, fish, and lower crop yields. Phu Hao village became a sunken area because it is surrounded by the Day Rive dyke and the elevated area of the factories. This makes Phu Hao a suitable area for carrying out research on peri-urban vulnerability to climate-related hazards, including floods, water-borne diseases, and health problems.

4.2. Research approach

The Framework for Climate Vulnerability Assessment in urbanizing and political ecology have been applied to the case study of Ninh Binh to examine flood vulnerability and resilience of the local community.

The analysis of vulnerability and resilience to floods in peri-urban area follows the Climate Resilience Framework (CRF) developed by Asian Cities Climate Change Resilience Network (ACCCRN) (Tyler & Moench, 2012). Due to the framework, three elements of urban resilience, namely *systems*, *social agents*, and *institutions*, will be taken into consideration along with *exposure* to understand the flood vulnerability of peri-urban communities. *Exposure* denotes the nature and degree to which a population or system is subject to environmental or socio-political hazards (Adger, 2006), and can be indicated by the magnitude and frequency of the hazards that the population experiences (Luers, 2005). Regarding *systems*, we will explore the conditions of natural and built (infrastructure) environment that affect the flood impacts. *Agent capacities* are assessed by examining the ability for preparedness, response, and recovery of different social groups. Finally, an institutional analysis will be carried out to investigate the strengths and weaknesses of institutions (laws, policies, organizations) that enable or constrain the abilities of agents to adapt to flood and water-related hazards (Tyler & Moench, 2012).

4.3. Data collection

The collection of data was carried out in March and April in 2017. We applied mixed methods of data collection, including desk study, stakeholder consultation meeting, key informant interviews, household interviews, focus group discussion, and field observation.

Desk study: Desk study was conducted to collect relevant information from various resources, such as data from governmental organizations at levels from the province to communes including published reports/documents from the provincial, district and commune People's Committees and from research institutions. These data include social, financial, economic, and environmental aspects.

Stakeholders meeting: We organized a meeting with various stakeholders in Ninh Binh Province, such as the People’s Committee of Ninh Binh city (PCC); Ninh Binh Dept. of Natural Resources and Environment (DONRE); Ninh Binh Dept. of Science and Technology (DOST); Ninh Binh Dept. of Construction (DOC); Ninh Binh Dept. of Education and Training (DOET); Ninh Binh Provincial Union of Science and Technology Associations (PUSTAS); and the representatives from several communes and wards of Ninh Binh City. That meeting was aimed to identify the groups most vulnerable to climate change and the climate hazards with the most impacts on stakeholders which need further studies. Heavy and sudden rains and high temperature in the rainy season have been found to have the most impact on local communities.

Household interviews: A sample of 103 households, including rich, upper middle, middle and poor in Phu Hao village were selected for semi-structured interviews (*Table 1*). Semi-structured interviews were conducted with the head or the spouse of the head of each of 103 households sampled. In the household surveys, questions related to different assets were raised and discussed in order to understand how local people access available local resources and how they use them to cope with flooding. In addition, weather extreme events within 50 years period have been identified and bench marked for discussion and investigation.

Table 1. Number of sampled households in the field research

Village	Rich	Upper middle	Middle	Poor	Not answered	Total
Phu Hao, Khanh Phu Commune, Yen Khanh District	5	34	59	5	0	103

Source: Field research, 2017.

Key informant interviews: We used this method in order to obtain and gather needed information about Phu Hao community. The informants were from the Ninh Binh provincial Department (Dept.) of Plan and Investment, Dept. Natural Resources and Environment, Dept. of Construction, Dept. of Industry and Trade, Dept. of Science and Technology, and the Ninh Binh Industrial Zone Authority. Those informants not only have in-depth understanding of the issues of the study but also knowledge of Phu Hao community, and the Khanh Phu Industry Zone which is directly polluting Phu Hao village.

We used the personal interview technique with guiding questions as a semi-structured interview. There were 20 key informants selected for interviews. They were provincial, districts and commune authorities, village heads, heads of civic organizations, such as Women’s Union, Youth Union, Farmers Association...and elderly villagers. Several indexes and variables measured village resilience and vulnerability in the social, infrastructure, economic, and environmental dimensions.

Focus group discussion: We conducted 3 group discussions with 10 people in each, including a women-only group, a mixed group with both men and women and a group with members of the Village Management Board and representatives from civic organizations, such as the Women’s Association, the Farmers’ Association, the Veterans Association and the Youth Union. In addition, wealth ranking was conducted, and the other topics examined included: local people’s livelihood and occupation, rights and reproductive health, use and dependence on resources for daily living (water, energy, transportation and other natural resources), use of time, personal autonomy and social networks, involvement in public and civil organizations involved in rehabilitation and preparedness for disaster.

Field observation: Based on the information collected from interviews, we tried to figure out the actual living conditions as well as the environmental conditions of the community by taking photos. Those photos serve as evidence to support research findings upon which recommendation would be proposed.

IV. Research findings and analysis

5.1. Descriptive statistics

The study has surveyed on 103 respondents from Phu Hao village, in which all are household heads or spouses of household heads. Among them, 20 households (19.4%) are led by females. The average household size of the households surveyed is 3.5 persons, which is lower than the average household size of the entire country (3.8), but as the same as the figures of both rural and urban areas of Red River Delta (3.5) (General Statistic Office, 2015). There is a total of 184 males to 176 female members, denoting the sex ratio of approximately 1.045, higher than the national sex ratio of 1.028 (General Statistic Office, 2016). In addition, there are only 140 out of 360 people currently working, signifying the dependency ratio of around 1.57 (

Table).

For the respondents of the survey, the mean age is around 56.32. Averagely, they have been in schools for around 7 years, with most respondents (76.7%) having only finished 1-8 grades. Only 19 persons (18.4%) have been in high schools, and less than 2% have professional high school or college degree. The sample is highly native, as 97.1% of the respondents have lived in the area for more than 20 years. 100% of respondents are Catholics.

Table 2. Demographic and socio-economic profile of the sample

Statistics		Statistics	
Total number of HHs	103	Migrants	2.9%

Household size	3.5 persons	Age of respondents	56.32 ± 13.74
Female-headed HH	19.4%	Education of respondents (number of school years)	7.01 ± 2.58
Male to female ratio	1.04	High school graduates	20.3%
Dependency ratio	1.57	Have lived here for more than 20 years	97.1%
Elders (>60 years old)	19.7%	Catholic	100%
Youth (<15 years old)	16.1%		

Source: Field research, 2017.

5.2. Exposure and impacts of flood and other hazards

Through focus group discussion and household interviews, we summarize several prominent flood events in the last 50 years and their impacts (Table 3). It is shown that major floods are not frequent to occur in the study area, with only the events in 1968 and 1980 remembered by local people. However, inundation caused by heavy rain occur on a regular basis each year, having various impacts on the livelihoods of local communities.

Table 3. Past flood events in Phu Hao village

Year	Event
Jun 1968	Heavy rain and storms occurred – the heaviest one 17 houses collapsed but no one was killed The state gave us some baskets of potatoes to help rebuild houses. At that time house walls were made of mud mixed with soil. No rice was given.
1980	Heavy rain caused severe flood, resulting in loss of potatoes and other crops. Fields were covered with water. The cooperative lost all its fish.
2016	Heavy rain occurred twice. The highest water level in relation to ground level reached 70-80cm and lasted up to two weeks' time. Sewage water from Khanh Phu Industrial Zone was spreading throughout Phu Hao village and causing death to cattle and fish. Surface water is heavily polluted in rainy season.
August 2017	Heavy rain caused flood. The highest water level in relation to ground level reached 35cm and lasted less than two days, but leading to loss of crops and rice.

Source: Key informant interview in the field, April and December 2017.

According to the narratives of key informants and households, the water level usually increases by 30-70 cm during the floods. It triggers the blowout of sewage water from industrial zones to all areas in Phu Hao village. As a result, the water becomes strongly contaminated and causes death to cattle and fish. This event did occur twice in 2016. In addition, surface water is heavily polluted in the rainy season. Furthermore, in the dry season from December to May, Phu Hao villagers have been suffering from lack of water for agriculture activities in the recent years.

In addition to water-related hazards, air pollution is also a massive problem to the local community. The air is polluted all the year round due to fumes and heat emission from factories in IZ and coal dust from the the uncovered coal on the dock in the village. Polluted air has affected the life and health of the locals, causing respiratory diseases. In December 2017 all villagers were protesting the Ninh Binh Coal Company that had been heavily polluting the area around the kindergarten. All the kids' hands and faces were black with coal dust. All the villagers were furious, and the local government had to call for a meeting between the company and the villagers. Agreements were finally reached, according to which the company had to follow the Vietnam Law on Environmental Protection of Vietnam. If the company violates the law, it will be penalized or even be requested to stop its operation in Phu Hao village.

5.3. Socio-ecological systems and infrastructures

5.3.1. Socio-economic development

From 2000s, in order to promote industrial and economic development, Ninh Binh People's Committee planned to establish several industrial zones located in Gia Vien, Hoa Lu, Nho Quan, Yen Mo, and Yen Khanh districts. In 2004, Khanh Phu commune, Yen Khanh district transformed 351 hectares (including agriculture and residential land) to industrial area, creating a new Khanh Phu Industrial Zone (Khanh Phu Industrial Zone, 2018). In 2005 the industrial zone started operation. Glass manufacturing factory was the first one to move here, and others followed later. Currently, the zone is almost filled with factories which are quite diverse, including shipbuilding, steel productions, advanced material processing, fertilizer, garment, warehouses, and logistic services.

Located in the Khanh Phu commune, all the taxes and environmental fees from the factories are paid directly to the provincial level, with the local community only getting benefits from the factory employment. Khanh Phu's economic growth rate is increasing year to year. In 2017 the economic growth of Khanh Phu was 6% while 2016 at 5%. The three main economic sectors of Khanh Phu are agriculture - fisheries, industry - construction and services. Agriculture and fisheries account for 37.51% of Khanh Phu's production value, industry-construction is 49.46% and services is 13.03%.

The percentage of poor households (according to multi-dimension poverty criteria) in the commune is 3,05% and near poor households are 6,83%. In 2017, among 2603 people in the working age (male from 18 - 60 and female from 18 - 55), there are 1912 people with permanent jobs and 691 people have part time jobs. Over 1000 people are working as builders, masons, or electricity- and water-related employees with salaries of about 5 to 7 million Vietnam dong per month (equal to 220 to 310 USD).

The expansion of industrial zones has been coupled with the decline in agriculture production. Due to the conversion of arable lands into industrial areas, the land available for growing rice has been significantly diminished. Previously, people had grown two crops of rice per year, but now it is reduced to only one crop in spring. Other crops include maize, potato, sweet potato, winter melon, black, green and soya bean and some traditional herbs. The reductions in agricultural products are also attributed to the shortage of labor, as most young people would become workers at industrial zones rather than farmers.

5.3.2. Infrastructures

Housing is classified into three main types: permanent, semi-permanent, and temporary houses. In Phu Hao, the majority of the households owned permanent houses. Only 13 (less than 18%) households (3 middle, 7 middle and 3 poor) owned semi-permanent houses and 3 middle households (less than 3%) of households in the sample had temporary homes.

Public infrastructure for water management and flood prevention in Phu Hao is poorly planned and managed. The controlling canal of Khanh Phu Industrial Zone is over 4 km long, covering around Phu Hao village and cultivated area of 17ha of agricultural land of 300 households. However, the canal is located just a hundred meters from the Phu Hao hamlet, provoking strong smells that disrupt the activities of about 375 households with 1,450 people affected.



Figure 2. Canal surrounding Phu Hao village and the agricultural area. In 2014 and 2015, it was polluted due to the heavy rain, causing death to fish and other aquatic organisms.

Source: Ly Bui Ha and internet

Khanh Phu Industrial Zone is built on a ground, which is 1 meter higher than the foundation of the village. Consequently, Phu Hao village is trapped between the Day river dyke (the elevation of about 7m compared to the field and the industrial zone), so since then Phu Hao is regularly flooded during the summer time. In the rainy season with the rainfall of about 50mm rice fields will be flooded, when the sun is out the hot water will cause death to rice. The village is often flooded 4 times/year and each time lasts about 1-2 weeks. Phu Hao presently has only 35 ha and only the spring crop is grown. This has adversely affected more than 200 households in the village.

5.4. Agent capacities

Income

The economic reforms started in 1986 and have brought about the following changes: (1) they eliminated the cooperative's monopoly on agriculture and forestry, (2) they introduced short-term land use rights (up to 20 years for agriculture and 50 years for forestry), and (3) encouraged privatization and market liberalization. Like any other places in the Red River Delta, the market liberalization period saw significant diversification of household income strategies in Khanh Phu commune with the most significant one – working as waged laborer in the industrial zone.

The analysis of the distribution of household incomes revealed relatively high inequality in income. Diversification from agricultural income into sources of non-agricultural income was considered one cause of rise in inequality. This has been exacerbated by the booming industrial zones in the region. Full-time employment in the private sector and full-time employment in nearby factories are the sources of income that have contributed to inequality in household income. In order to measure household incomes, semi-structured interviews with the heads of the 103 households included in the sample were conducted in Phu Hao village. Net cash income has been imputed.

The upper middle and middle households in the sample had the most diverse sources of income, while the rich had the least diverse. Khanh Phu in general and Phu Hao is traditionally a farming community. However, The data shows that the four groups earned income from farming, however this accounts for very small percentage of the total household income. The rich earned 0.15 million VND per member, accounting for less than 1% of the total household income, the upper middle earned 0.9 million VND per member making up 1% of the total income, the middle 0.1 million VND per member constituting 1% of the total income and the poor 0.27 million VND per member accounting for less than 2% of the total income.

In contrast, the income sources of full-time employment in nearby factory and full-time employment in the private sector contribute a very significant percentage to total household income and were considered one cause of the rise in inequality. The rich, upper middle and middle households earned from full-time employment in private sector. The poor were the only group that did not earn any income from this source. The data analysis shows that the upper middle household earned the most per member – 4.5 million VND accounting for 34% of the total income, the rich earned 3.2 million VND per member making up 15% of the total income and the middle earned 1.9 million VND per member constituting about 19% of the total income. Furthermore, the rich and the poor earned the most per member from full-time employment in the Khanh Phu Industrial Zone, followed by the upper middle and the middle. The rich earned 11.7 million VND per member from this source of income accounting for 55% of their total income. The poor earned 6.7 million VND per member from this source of income accounting for 55% of the total income. The upper middle earned 0.8 million VND per member making up about 8% of total income.

The rich households were the only group in the sample that did not earn income from full-time employment in the government sector. The poor earned the most per member at 4 million VND accounting for more than 20%, the middle 0.3 million VND and upper middle 0.19 million VND per member accordingly. The figures also reveal that the rich and the poor were not engaged in animal husbandry at all. Only the upper middle and middle were

engaged in this activity and earned 0.7 million per member accounting for 5% of the total income and 0.4 million VND making up less than 4% accordingly. Similarly, the upper middle and the middle were the only two groups that earned wage income for farm jobs, but accounting for a small percentage of the total household income. Only the middle and the poor households were engaged in aquaculture and this source of income constitutes a relatively small percentage of the total household income. The upper middle and the middle were the two groups who owned small local enterprises, such as construction, house repair or painting. The upper middle earned 0.3 million VND per member from this source of income accounting for 2% of total income and the middle less than 1 million VND constituting 10% of the total income. The figures also show that the poor were the only group with income from remittances from relatives working outside the community.

In summary, traditional income sources, such as farming, animal husbandry, aquaculture and state wage accounted for small percentages of the total household income and contributed less to inequality than their overall share of income. In contrast, non-farming activities, such as full-time employment in nearly factory and full-time employment in the private sector contributed more to inequality than their overall income share. Thus, these were the income sources driving inequality. The rich earn the most from highly paid occupations and the poor earn least of all. The rich were more often the households that could take up off-farm opportunities created by the Khanh Phu Industrial Zone which has emerged as a major source of income since 2005. In total, the middle earned the least per member compared with the other three groups followed by the upper middle. The poor earned even more than the upper middle and middle. The reason they are in the poor group is that they had household members suffering from health problems. Three out of five poor households had members that were suffering from cancer and consequently medical expenses absorbed a disproportionately large part of their income.

5.5. Institutions

A cooperative (Hop tac xa) provides services such as clean water, sanitation service, the commune's market management and other kinds of basic services. In 2017, this cooperative invested in expanding the water system and upgrading kiosks in Ve Market to meet the demand from the local community.

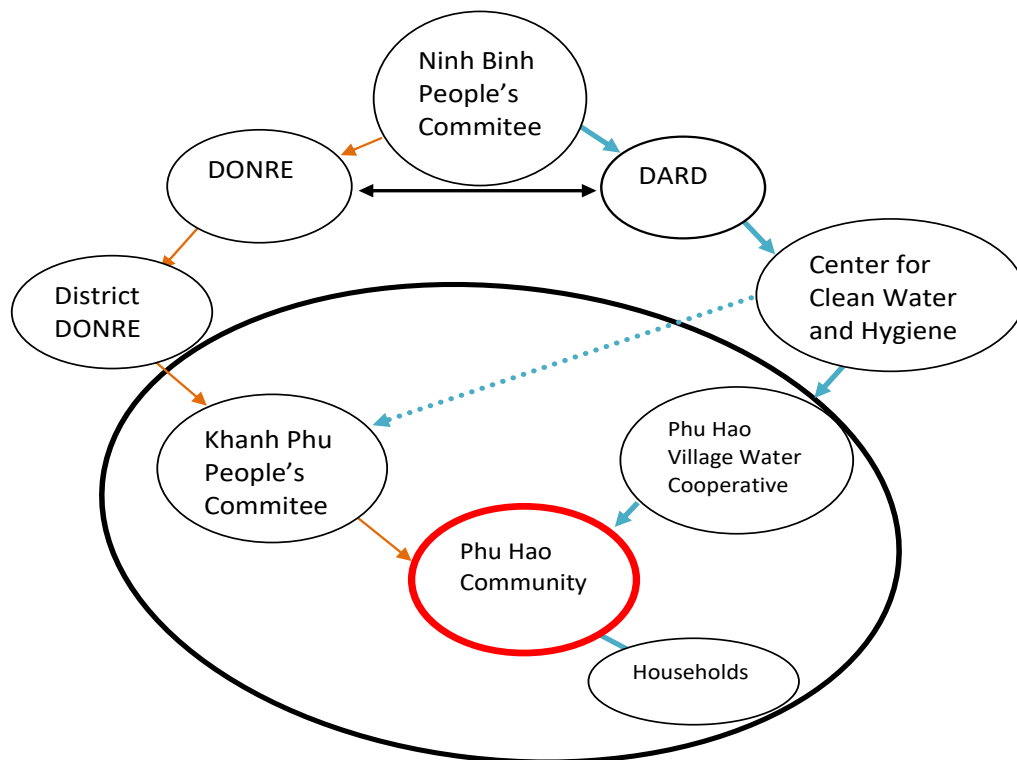


Figure 3. Mapping institutions responsible for supplying clean water at Phu Hao village

Drivers of Vulnerability, Water Stresses and Impacts

As discussed earlier, Khanh Phu commune lost 300 ha of its best land for the establishment of Khanh Phu Industrial Zone (IZ). In return, the villagers were promised that they would be provided jobs by the industrial zone and that they would have a much better life. Interviews with key informants during the field research revealed that almost all houses and remaining rice paddy in Phu Hao village are trapped between IZ and the Day river dyke. The whole village and its surrounding area flooded for about 1 week when 50mm precipitation occurred. Cultivated land of Phu Hao is abandoned for 6 months from June to November every year due to flooding. Consequently, income of the poor and old households is adversely affected. Many people have lost one crop per year while others have lost two crops per year.

In reality, in Khanh Phu commune, 800 out of 6000 people of working age are hired by IZ (Khanh Phu Commune People's committee, 2016). According to Phu Hao village head, 200 out of 850 people of working age are hired to work in IZ in Phu Hao. According to results from group discussions, although the Phu Hao villagers were promised jobs before their land was taken away by IZ, in fact people from other villages/communes that did not lose land were also offered jobs. Many interviewees expressed their worries that social evils would definitely occur in the context with loss of land and no jobs available.

Phu Hao villagers depends on the so-called “clean water” source from the Day river, which receives sewage from the upstream, including Hanoi and Ha Nam province before going to the sea. A clean water project was funded and supported by the Ministry of Agriculture and Rural Development in 2003. At present, the Phu Hao Clean Water Cooperative is managing the clean water. Due to the terrain in Phu Hao, groundwater is not available and therefore surface water is used. A big hole was dug, and surface water is pumped from the Day River into the hole. Sometimes oil, greases, black scum and even leeches are seen in the water. The water price is at 6,600VND / m³. It was reported that the clean water system is far below the demand of local people and the workers at the water station are poorly trained. Further, water storage and treatment processes are not adequate. Therefore, most people have to buy a water filter and most of the time it takes the whole night to purify enough water for home use. The rich can buy water purifiers for 10 million VND and the poor buy them for 5 million VND. Results from group discussions showed that villagers want the water hole to be dug deeper and with walls to keep out buffaloes and cattle. In addition, water must be treated and filtered better to ensure quality. Authorities need to ensure water quality and health for the villagers.

Interviewees were asked if there anyone in your household who was chronically sick or disabled. Results from group discussions and field observation confirmed that there was no sewage plan designed for the whole community during the time the research was being carried out. Polluted water has caused water borne diseases for locals, such as red eyes, itches, dermatitis...

Table 4. Household members who is chronically sick or disability

		Type of households				Total
		Rich	Upper middle	Middle	Poor	
<i>Is there anyone in your household who is chronically sick or disability?</i>	No	1	30	37		68
	Yes	4	3	19	5	31
Total		5	33	56	5	99

Source: Field research, 2017.

The air is polluted all the year round due to fumes and heat emission from factories in IZ and coal dust from the the uncovered coal on the dock in the village. Polluted air has affected the life and health of the locals, causing respiratory diseases In December 2017 all villagers were protesting the Ninh Binh Coal Company that had been heavily polluting the area around the kindergarten. All the kids' hands and faces were black with coal dust. All the villagers were furious and the local government had to call for a meeting between the company and the villagers. Agreements were finally reached, according to which the company had to follow the Vietnam Law on Environmental Protection of Vietnam. If the company violates the law it will be penalized or even be requested to stop its operation in Phu Hao village.

Table 4 shows that the majority of the rich and the poor and more than half of the middle were sick. The upper middle had the smallest number of household members who were sick. Most of them have been suffering from cancer, stomach ache, kidney stones, and chronic bronchitis, among other ailments.

V. Conclusions and recommendations

As the case of Khanh Phu illustrates, located in a peri-urban area of Ninh Binh province the commune is subject to heavy pressure between development of the Khanh Phu Industrial Zone and environmental problems. Water stresses and water pollution and air pollution have been noticed and concerned by the villagers. Cattle and fish were killed, and the villagers' health has been adversely affected, although no technical research has been carried out yet to directly establish and explain the causal relationship between degraded water quality in the commune and the health status of the local population. Water pollution has resulted in the scarcity of the clean water for drinking purposes.

Since 2003 clean water has been supplied to households in Phu Hao village. However, many people complain about the quality of the clean water supplied to households and a number of households use the rain water and deep boreholes when the clean water becomes scarce in February. Most people have bought water filters. The rich buy water filters that are twice as much if compared with those of the upper middle and the middle. Meanwhile the poor only depend on the water supplied by the cooperative for drinking purposes.

The research findings also demonstrate that the local institutions have also responded to water stresses and air pollution to facilitate the face-to-face discussion between the Khanh Phu Industrial Zone and Phu Hao villagers and help ease villagers' anger to some extent. However, due to lack of local participation in the designing and building of the water supply station, local people are not satisfied the quality of the water. Villagers have become more vulnerable than ever. The reasons are two-fold. First, the local institutions are weak in managing complex peri-urban systems that are nested, interlinked and operating across administrative boundaries. Second, lack of regulations and unplanned built environment, under-developed water infrastructures for supply, sanitation, storm drainage and pollution pose more severe challenges to an already strained and ill-developed existing adaptive capacity in the area.

In order to resolve the situation that villagers in Khanh Phu are facing the local institutions need to be strengthened so that they could function with a wide range of changing and uncertain responsibilities, and the legal constraints of their mandate and remit, or of their financial and human resources. Clear delineation of responsibilities between and strong coordination between the Ninh Binh Industrial Zone Management Board, the Ninh Binh Provincial Department of Natural Resources and Environment, the Ninh Binh Provincial People's Committee and the Ministry of Natural Resources and Environment is urgently needed so that appropriate policies for managing of industrial zones will be designed in order to make use of the local comparative advantages in the development process and at the same time ensure green growth and efficiency .

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