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Flood risk management for the RUA of Hanoi

Importance of community perception of catastrophic flood risk in disaster risk planning

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Abstract

Purpose – This paper aims to investigate reasons for unusual overdevelopment of floodplain areas outside river dyke, provide an insight into the importance of community perception of catastrophic flood risk in the riverside urban areas (RUA) of Hanoi and establishes the need for participatory disaster management planning and disaster management education in the study location.

Design/methodology/approach – Structured survey was conducted in five wards in the RUA to understand how residents perceived flood risk.

Findings – The low perception of catastrophic flood risk among communities was found to be an important factor in the continued development of the RUA and led to the trust in their houses as a prominent protective solution. Moreover, the flood vulnerability of the areas has been increasing due to the missing link between local authorities and community.

Research limitations/implications – This paper examines community perception of flood risk as one of main factors. Other factors such as availability of options for housing, public participation and relevant policy interventions are beyond the scope of the paper and need to be studied in the same location.

Practical implications – To regulate the development of the RUA, community perception of catastrophic flood risk should be changed and community leaders should be motivated, with involvement of local authority at ward offices, to conduct comprehensive hands-on community education programs.

Originality/value – Few researches have been done on the overdevelopment and community perception in the flood-prone areas. This paper not only reaffirms the few studies made in the past but also suggests broad interventions for enhancing the flood risk perception among the community members.

Keywords Risk management, Floods, Urban areas, Vietnam

Paper type Case study

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Introduction

Inhabitation of floodplains is not unusual (Park and Miller, 1982; Handmer, 1995; Granger and Hayne, 2001) especially in Vietnam, where almost all cities and towns are located in riverside or coastal areas (Tinh and Herath, 2005). However, an unusual overdevelopment of floodplains outside dyke is happening in Hanoi, the capital of Vietnam. The city is highly vulnerable to flood and has thousand years history of building dyke to protect its inhabitants. Nevertheless, due to the rapid urbanisation during the last two decades, rapid inhabitation has taken place in the floodplain areas outside the dyke without proper planning. The overdevelopment of these areas, displacing places for flood inundation and obstructing the river flow, is considered as one of the main reasons for increasing the flood vulnerability of not only the riverside urban areas (RUA) but also the whole city (Uyen, 2002). Hence, RUA of Hanoi forms the present case study.

Rapid population growth of 1.6 times was recorded in these areas during 2000-2004 (Uyen, 2002). This development has continued even after the approval and implementation of construction regulations dealing with illegal construction, and Ordinances on Dyke protecting the dyke and regulating the growth of the RUA.

Among major reasons (other reasons such as availability of options, public participation and policy are beyond the scope of this paper) for the rapid increase of population and their building activities in the RUA were some related to location's advantages such as low land price and cool summer breeze that comes from the river. In addition to these, it was likely that the institutional measures such as regulating policies and implementation processes, which ignored community perception of flood risk, were unsuccessful in changing people behaviour. Thus, the question arises about what should be done to seek enhanced perception that changes residents' behaviour? This question has not yet been answered in the past studies of the RUA. As the problem is accelerating and residents are becoming more vulnerable, it is high time to investigate the role of community perception of catastrophic flood risk in the overdevelopment of the RUA.

This article provides an insight into flood risk, community structure and the unsustainable trend of urban development of Hanoi and the RUA; and analyses results of a structured survey of community in the RUA. Based on the findings, we also tried to suggest future measures for the RUA for overcoming the flood risk through appropriate community based interventions.

Background

The natural conditions of Hanoi make the city vulnerable to floods. Yet, the recent and future trend of city development did not intend to reduce this adverse situation. The various factors leading us to this conclusion are examined below.

Hanoi: characteristics and historic growth

Located at the center of the Red river delta, Hanoi is a consequence of unstable balance between the soil and the water and has witnessed the amicable and adverse relationship amid the two elements during a long history (Vuong and San, 1975; Pierre, 2003). Established as a small town in A.D 210, Hanoi grew from a harbour on the bank of the Red river to thriving city and was chosen to be the capital of Vietnam in 1010 as the site having advantages of physical, landscape and geomancy characteristics

(Vuong and San, 1975). However, the capital had also been confronting with difficulties due to the alluvial process raising the level of watercourse above its elevation forcing the inhabitants to take measures such as building dyke for preventing floods. Until the first half of the twentieth century, the dyke was not high and sturdy enough and could only protect Hanoi, which has average elevation of 6 m, from annual water levels varying between 8 m and 12.5 m. Up to 1990, as a result of 40 years of applying technical reinforcements and maintenances, the dyke had been raised from 12.0 m to 15.0 m, combining with the operation of Hoa Binh reservoir in the upstream of the Red river, could protect the city from floods like the disastrous one in 1971 which brought the water level to 14.13 m.

While often being constrained for implementing flood prevention plans, Hanoi continued to grow in the part inside the dyke. The city had expanded through different periods of monarchic, colonial and communist regimes during 1010-1873, 1874-1954, 1955-1985 (Vuong and San, 1975; Hung and Thong, 1995). From 1986 the capital had experienced significant development as a result of a reform in the country's political economy, which successively changed the planned economy to the market one and opened the way for a modern consumer society (Luan *et al.*, 2000). The pace of Hanoi's urbanization exceeded all previous expectations.

Nevertheless, this initial phase of urbanization in Hanoi has exposed the city to many dangers such as spontaneous construction works (Luan *et al.*, 2000). The city's population grew quickly from 1,870,000 in 1985 to 2,685,000 in 1999. This, combining with the growing demand for accommodation, as a result of inefficient public housing regime in socialist period, created a boom in housing construction by family households (80 per cent, mostly self-built) with common features of spontaneous diversity and irregularity (Luan *et al.*, 2000; Hung, 2005). Squatting and illegal construction, which started from the late of 1970s, has been spreading across the city and became persistent problem (Hung, 2005). Hanoi expanded through uncontrolled suburbanization processes leading to establishment of settlements in the flood zones outside the dyke called the riverside urban areas.

The riverside urban areas (RUA)

The current RUA is situated in those areas that were inundated in rainy season and cultivated in 1920s. These areas were later on converted into residential areas in 1970s and spontaneously developed in 1980s and 1990s. Having altitude in the range of 9.0-11.0 m and located near the central business district (CBD), the RUA was considered as place of good livelihood and dwelling due to cheap land prices by poor people and migrants. Operationalization of Hoa Binh reservoir has further reduced the flood threat to the RUA and has drawn attention of rich communities as well. There has been further rise in habitations after the approval of the revised Ordinance on Dyke in 2000 (Figure 1, Table I) making the RUA the most densely populated area in Hanoi with 24,000 persons per sq km in Chuong Duong ward (Hung, 2005). There has also been persistent expansion of settlements by embanking the riverbank and selling it to new residents (96 per cent in 2003 and 84 per cent in 2004) (Hung, 2005). Subsequently, the human settlements have reduced the river flow, decreased flood discharge capacity and raised the flood level of the Red river. According to the available data, flood level of the Red river in Hanoi has raised about 0.8 m in 60 years (1939 to 2000) with the same

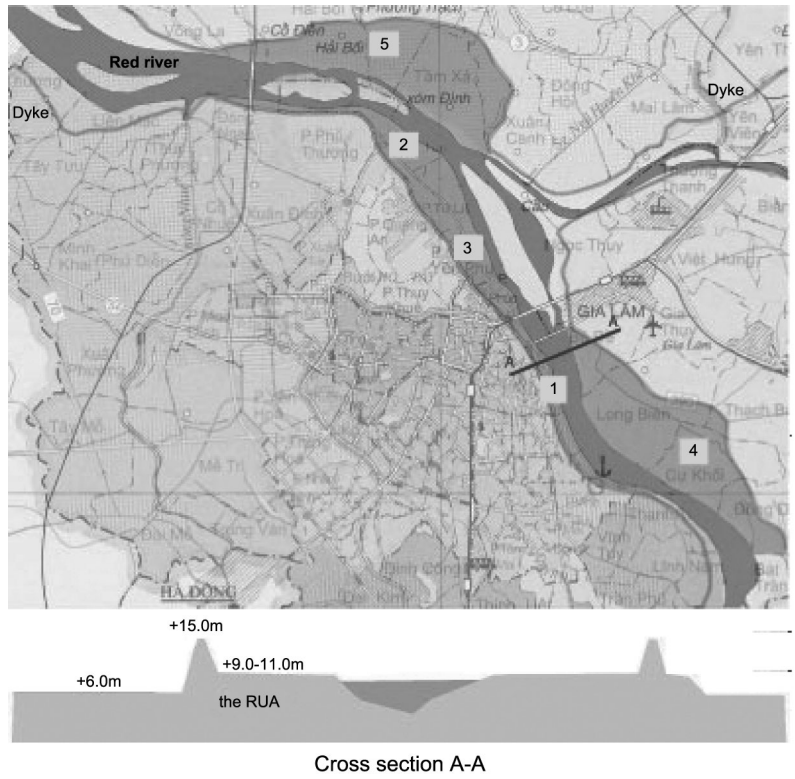


Figure 1.
Map of Hanoi and the RUA

	1925	1955	1975	1996	2000	2001	2004
Population	0	Negligible	33,476	75,202	107,634	140,425	160,602
Houses	0	Negligible	n.a.	12,533	19,569	27,700	32,012

Sources: Uyen (2002); Hung (2005)

Table I.
Number of population and houses in the RUA since 1925

water discharge. A rapid raise of 0.6 m was observed in the past 30 years (1970 to 2000) (Nghia and Chau, 2001; Uyen, 2002).

The formation of the RUA is the evidence of the state's failure in solving the problem of illegal construction, although a number of measures have been taken up. The City's People Committee (CPC) approved many regulations of construction in 1983, 1987, 1992 and 1994 (Hung, 2005). Yet, illegal houses have continuously grown in RUA, which also was the subject of Ordinances on Dyke issued in 1989 and 2000. As a result of regulations in 1987 and 1992, squatting and illegal houses on vacant public land were legitimated or given amnesties provided people vacate the land when the state

required it (Hung, 2005). This might have encouraged more squatters there after. Hence, due to the overlap of responsibilities between the city authorities and Ministry of Agriculture and Rural Development in RUA, nothing could improve the situation (Hung, 2005).

In 1995, the CPC has enforced strict regulations by demolishing illegal constructions in the RUA. Nevertheless only houses which directly break the dyke or undermine its foundation were destroyed or loped-off since the biggest quoted problem was the safety of dyke and Hanoi (the parts inside dyke) in possible future floods (Hung, 2005). This could not stop the illegal constructions in Hanoi and RUA.

Development plans of Hanoi

Due to the increasing impact of socioeconomic development, Hanoi has been growing speedily with little attention being paid to the risk of catastrophic flood. Currently covering an area of 920.97 sq.km. with the population of 3,055,300, Hanoi is the country's second largest city. The city's population is unevenly distributed. 52.9 per cent lives in nine districts of the inner city, which cover only 9.2 per cent of the total municipal area (Hung, 2005). According to the Hanoi Master Plan for the Year 2020, the capital will be developed fast with predicted population of more than 5 millions in 2020 (HCAO, 1997). In the near future, the priority will be given to build Hanoi New Town in the north of Red river. This would be the first time that the city will be developed over the river, developing the RUA from jumbled areas to the core of the future city. However the development plan was not based on an extensive flood risk management plan and might encourage people moving toward the flood prone areas.

Community structure in urban areas

Urban areas in Vietnam have a community structure through which the information on state policy is disseminated. Situated between ward, the lowest level of government administration having population from 10,000 to 15,000, and families, the community structure includes resident clusters at lower level and resident groups, comprising 25 to 30 households, at other level (Duc, 1998). Leaders of clusters and groups are usually middle-aged, long-term and well-behaved residents, which are nominated and elected by neighbours.

Resident clusters and groups are considered as extended hand of the ward reaching right up to families, with top-down manner, to mobilize the communities for supporting government initiatives. However, many times the leaders could not play the intermediary role between government and people and they neither had enforcement nor were considered by government as stakeholders in decision-making process. This explains why the state was failing to implement regulations.

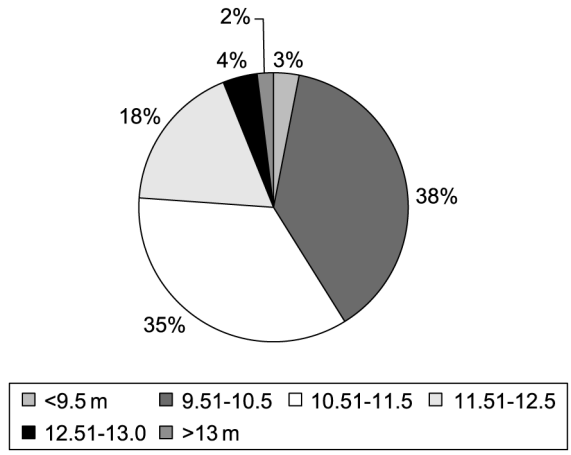
Catastrophic floods in the RUA

A number of catastrophic floods take place each year in different parts of the world leading to very high economic and social losses (Herath and Shaw, 2003). Hanoi is one of such affected city in Vietnam. Influenced by the Asian monsoon, the average annual rainfall in the Red river delta and upstream areas is high (about 1,800 mm) and is unevenly distributed (80 per cent concentrate in rainy season). Water discharge in the delta in rainy season accounts for 75-85 per cent of the annual volume especially some years in August, it accounts for over 40 per cent of the total volume (MWR, 1994;

Imamura and To, 1997; Nghia and Chau, 2001). As a consequence, big flood is of common occurrence in rainy season.

Catastrophic flood history

Floods have been the most dangerous and persistent disaster to the delta and Hanoi area in the past. From the tenth century to the nineteenth century, there were 188 big floods breaking the dyke (Vuong and San, 1975; MWR, 1994). Two great floods in the nineteenth century were in 1821 and 1893, among which the event in 1893, having flood peak of 13 m in Hanoi, caused heaviest damages (MWR, 1994). From 1902 to 2001 floods regularly occurred and there were two disastrous events in 1945 and 1971 in the delta and Hanoi areas (Figure 2, Table II). Though making up of 2 per cent of occurrence, these floods caused heaviest losses leaving deep impression on the people and are evaluated by experts as catastrophic events of the twentieth century (MWR, 1994; Nghia and Chau, 200; Uyen, 2002; NOAA, 2004).



Sources: MWR (1994); Nghia and Chau (2001); Uyen (2002)

Figure 2.
Flood frequency in Hanoi during 1902-2001 (as water level)

Type of data	The 1945 flood	The 1971 flood
Flood discharge (Son Tay gauging station)	34,250 m3/s	37,800 m3/s
Actual flood peak	13.68 m	14.13 m
Calculated flood peak (in case no dyke break)	14.43 m	14.82 m
Inundated area	3,120 sq.km.	2,500 sq.km.
Affected people	3 mil. people	2.9 mil. families
Human loss	n.a.	100,000 people[a]
Damage value (as the exchange rate of 1990)	51.5 mil US$	79.9 mil US$
Percentage of national GDP	n.a.	5.7% GDP
Return period flood	100 years	125 years

Sources: [a] NOAA, 2004
MWR (1994); Nghia and Chau (2001)

Table II.
Data of historical floods in 1945 and 1971

Possibility of future catastrophic floods

The possible increase in rainfall magnitude and frequency associated with the global warming suggests higher chances of future catastrophic floods in Hanoi area that could lead to very high human and economic losses (Thang *et al.*, 2004; Tinh and Herath, 2005). With the increase of population and wealth, the city has continuously increased the design targets and constructed flood control system (e.g. raising height of dyke in Hanoi and constructing reservoirs) that could withstand even higher flood magnitudes. Flood frequencies, consequently, reduced attracting more people and investment in the RUA even being located outside the dyke. Hanoi is now faced with the dilemma where it had become extremely difficult to increase design standards any more (Nghia and Chau, 2001; Uyen, 2002) whereas an event beyond the design level would bring huge loss. The threat of increase in rainfall intensities and magnitudes could amplify the problem. There is a possibility of sudden big floods in case the dams such as Hoa Binh and Thac Ba located in upstream area of the Red river fail in the event of a heavy rainfall and water discharge (Thang *et al.*, 2004; Fahmida, 2005).

Risk perception survey

The overdevelopment of the RUA has mainly been contributed by the increase of population and housing construction. Regulating policies and implementation processes were unsuccessful in changing people behaviour and the community perception of flood risk. This motivated our study to find out a suitable solution for the future possible flood threat.

Flood risk perception

The importance of risk perception in shaping people's behaviour and disaster risk management is affirmed in several studies. For instance, Slovic (1987) emphasized the role of risk perception by indicating that the public relies on risk perception to evaluate hazard situation. Risk perception can influence both the design and operational aspects of disaster risk management (Michael and Fasil, 2001). Wilson (1990) indicated that perception could be viewed as a process of transforming inputs (e.g. flood warning) to out put (e.g. public mitigation response) (Burn, 1999). People who perceive that they are vulnerable are more likely to respond to warnings and undertake protective measures (Michael and Fasil, 2001). Thus, understanding how people will perceive the risks communicated to them will influence how effective a flood management strategy or policy will be.

Society perception of risk has its roots in social, cultural and moral acceptability factors (Slovic, 1987; Wilson, 1990; Burn, 1999). These factors influence the way people perceive risk and may ignore the probability of the event's occurrence. Perhaps, the biggest factor affecting risk perception is the past hazard experience of the people. For instance, flood event can act as reinforcement in the behaviour of people at risk (Wilson, 1990). However, misleading personal experience can lead to risks being misjudged (Slovic, 1987), so past flood experience can have either a positive or negative impact on the response of potential flood victims.

Once individuals have determined an assessment of a particular risk, their opinions can be difficult to change. This seems to be particularly the case if they feel they know something about the subject (Botterill and Mazur, 2004). But people are more likely to be swayed by expert opinion in areas about which they know nothing (Siegrist and

Cvetovich, 2000; Botterill and Mazur, 2004). It is apparent that in the case people lack experience and knowledge about the subject, such as catastrophic hazard event, the common suitable public perception of risk, which is needed for effective policy implementation, derives from the expert or authority opinion of the risk. Hence, the experts and authorities need to educate the community leaders and community for disseminating right information to help community gain appropriate perception of flood risk. The same was revealed in our study in the RUA.

Methods

A questionnaire survey was conducted in October and November 2004 to find out how communities in the RUA perceive flood risk. 588 residents (including 36 community leaders) of five different wards of the RUA participated in the survey. The sites chosen were Chuong Duong, Phu Thuong, An Duong, Cu Khoi and Hai Boi, from riverbank to the dyke (Figure 1). This sequence also reflects the order of density of population, as the first three wards were urban while the remaining was suburban. The officials of the ward's construction section were contacted with the help of Central Committee for Flood and Storm Control (CCFSC) who, in turn, facilitated carrying out the study.

Model and questionnaire

As shown in Figure 3, awareness and code of conduct are perceived in the sequence of knowing, belief and action, as gradual change behaviour from knowing to code of conduct (Shaw *et al.*, 2004). In this case, knowledge only comes from experience, which is constituted of experience of regular and catastrophic flood. These parts combine with values including attractiveness of the locality and satisfaction of resident leading

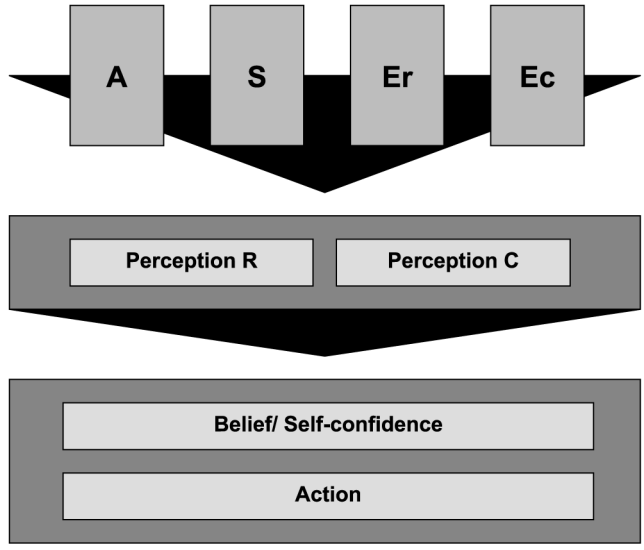


Figure 3.
Model showing concept of the survey

Notes: A: Attractiveness, S: Satisfaction, Er: Experience of regular flood, Ec: Experience of catastrophic flood; for Perception: R: Regular flood, C: Catastrophic flood
Source: Modified from Shaw's model, Shaw *et al*. (2004)

to perception, which divide into two parts: perception of regular and of catastrophic floods. All these compose residents' belief or self- confidence and gradually result into action.

The questionnaires included a mixture of open-ended and closed questions. Subsection of the questionnaire included questions on advantages and disadvantages of living in RUA, living conditions, previous experience with, expectation of and information on flood; individual response to a flood; perception of flood and future flood; and housing information.

Results and discussion

Age group of the respondents in RUA as distinguished with that of Hanoi: the vulnerable (younger than eight and older than 60) and school group (9-17) were high among the respondents. Respondents had diverse occupation with many of them are engaged in agriculture or were unemployed (11 per cent and 8.1 per cent). Among five wards, An Duong ward has more number of respondents residing for more than 33 years (32 per cent), who are also well experienced with the past flood incidences. Chuong Duong and Phu Thuong wards have large percent of respondents residing for less than five years (21 per cent and 17 per cent). Respondents possessing medium and big-sized houses were considerable in comparison with housing indexes of Hanoi, especially 61 per cent respondents in Phu Thuong, An Duong, Hai Boi wards possessed sizeable (120-200 sq.m.) building plots and three or four storied houses.

Regarding the community leaders, 53 per cent were older than 60 and 47 per cent in the range of 53 to 60; 58 per cent have been residing in the RUA from 7 to 32 years and 42 per cent more than 33 years (see Table III).

Respondents expressed levels of satisfaction of living in the RUA and were attracted by the location's advantages such as cheap prices of land and house, cool air, proximity to the CBD and suitable livelihood options as number of people in Hai Boi and Cu Khoi wards could cultivate vegetables or flowers selling to the city's inhabitants. The respondents identified poor infrastructure and frequent flood as

	Criteria	The RUA (%)	Hanoi (%)
Age group	≤ 8 and ≥ 60	27.2	23.2
	9-17	20.1	15.9
	18-59	52.7	60.9
Occupations	Housewife	7.9	n.a.
	Retired	7.2	n.a.
	Civil employee	12.5	20
	Skilled worker	19.3	24
	Skilled agriculture related	11	25
	Unskilled worker	32	36
	Unemployed	8.1	5.6
Residing time	$\leq$ 32 years	84	n.a.
	$\geq$ 33 years	16	n.a.
Average housing area per person	$<$ 15 sq.m.	1.1	2.6
	15-36 sq.m.	16.8	25.9
	37-59 sq.m.	34.3	33.9
	$\geq$ 60 sq.m.	47.8	37.6

Table III. Respondents' background

disadvantages of living in the RUA and interestingly only 8.2 per cent of the respondents rated the flood as a major disadvantage (Figure 4). It reflects low levels of awareness about the hazard and the poor preparedness. Those who have experienced the 1971 flood consider that the risk to their life is low and that the flood mainly causes damage to their possessions. Similar observations were also made in the USA and New Zealand and concluded that the attractiveness of floodplains tend to counteract any perception of flood risk and result in widespread acceptance of the risk and cause urbanization of floodplains (Park and Miller, 1982; Gough, 2000; Marincioni, 2001).

Community perception of flood risk was evaluated at two scales: perception of regular and catastrophic flood risks.

Flood experience has played a major role in shaping the risk perception of the RUA residents. All the respondents had flood experience and expressed their knowledge of regular flood events. Nearly two-thirds of the respondents took actions to cope with regular flood, e.g. raising house foundation and lifting possessions to higher places, while a few others prepared small boats for using during flood (Figure 5). It seemed that living outside the dyke and having experience of regular flood helped residents to take suitable steps to cope with such event.

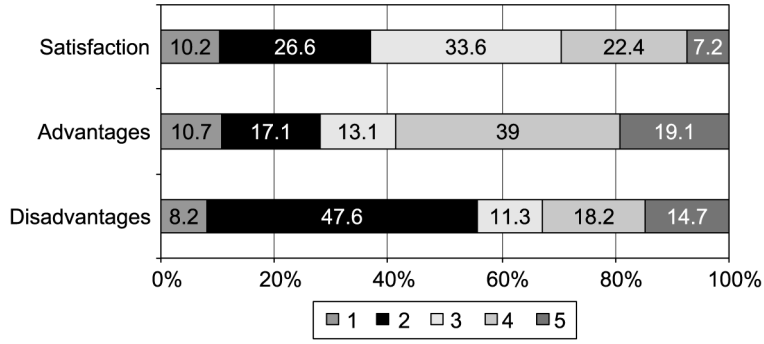


Figure 4.
Satisfaction levels of respondents about the living conditions in RUA

Satisfaction – 1: Very good, 2: Good, 3: Fair, 4: Poor, 5: Very poor; **Advantages** – 1: Proximity to the CBD, 2: Cool air, 3: Suitable livelihood, 4: Cheap land price, 5: Do not know; **Disadvantages** – 1: Flood as danger; 2: Flood as inconvenience, 3: Lack of public facilities, 4: Poor infrastructure, 5: Do not know

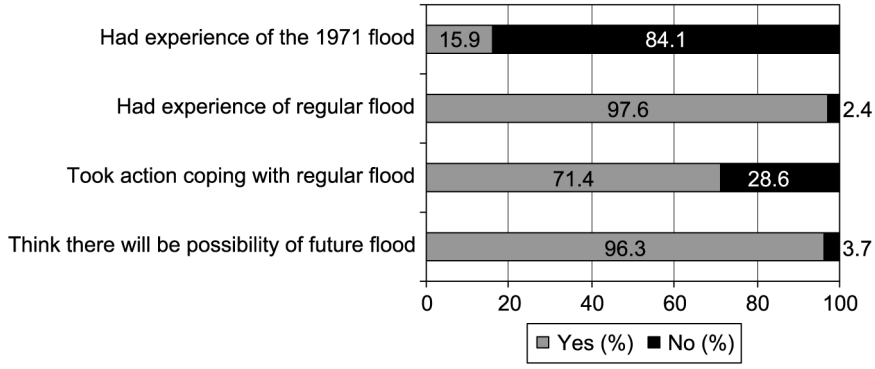


Figure 5.
Flood experience and perception among the respondents

Majority of the respondents ($n = 567$) expressed chances of possible future flood in the next 20 years. Respondents who had catastrophic flood experience expected higher levels of future flood levels. For instance, the high flood water level of 1.51 to 2 m was expected by those people having the 1971 flood experience than people who do not have (34.4 per cent versus 11.6 per cent). Similarly, more non-experienced respondents (47.1 per cent) expected low future flood water levels of below 0.5 m than the experienced ones (23.5 per cent) (Table IV). This corroborates with other studies that suggest the importance of flood experience in shaping the perception of flood risk.

However, communities of the RUA had low perception of catastrophic flood risk despite of their higher experience with the regular flood events. Majority of respondent expected the future flood water levels as below 1.5 m and no one thought that it would surpass the levels of 2.5-3 m, which was observed in 1971. 48.9 per cent of the respondents did not believe that flood event of 1971 would occur within next 70 years since the understood return period of such flood is more than 100 years. 37.8 per cent of respondents believed that catastrophic floods could be avoided by using existing reservoirs and other structural solution and 13.3 per cent could not provide a solution to the problem. Regarding possible mitigation measures for the future flood of catastrophic in nature, 23.6 per cent ($n = 137$) believed that measures such as raising house foundation, lifting possessions to higher places and partial small embankments designed for coping with the regular flood would be adequate. A total of 65.2 per cent ($n = 383$) could identify the inadequacy of preparedness. However majority of respondents (78.3 per cent ($n = 443$), believed that their family would be safe in case of a catastrophic flood due to the presence of Hoa Binh reservoir (20.5 per cent) and their houses have been built at higher elevations (57.8 per cent). This suggests that respondents viewed the future possible catastrophic flood in the RUA as less destructive and less terrifying than the one in 1971, just as raising water level higher than regular event.

People are inadequately sensitized on catastrophic flood with a large number of them living there with no experience and without knowing what to expect in a really severe event and suggests poor understanding on natural processes and the impacts on them. This can be compounded by poor judgement regarding the magnitude and frequency or return period of catastrophic flood. Studies elsewhere showed that structural flood protection measure increase the attractiveness of the floodplain for habitation, by increasing the perceived safety or reducing the perceived risk (Michael and Fasil, 2001). However, for people in the RUA, the structural measures were not only reservoirs and other irrigation works provided by the government but also their

			Experience of 1971 flood			
			Yes		No	
Water levels	Number of people	Per cent	No.	Per cent	No.	Per cent
More than 2.5m (great)	0	0	0	0	0	0
2.01m-2.5m (high-2)	13	2.3	3	3.2	10	2.1
1.51m-2m (high-1)	87	15.3	31	34.4	56	11.6
0.51m-1.5m (moderate)	222	39.1	35	38.9	187	39.2
Less than 0.5m (small)	245	43.3	21	23.5	224	47.1

Table IV. Future flood levels as expected by the respondents

own private houses (57.8 per cent). The housing as a protection might create a wrong sense of security with people assuming that catastrophic flood (if occur) will not affect their lives. Thus, residents of the RUA were more likely to reside and build bigger houses in the areas to cope with flood risk.

Suggested future measures for the RUA

Hanoi and the RUA have been going through rapid development, with little attention paid to the growing flood risks. Unfortunately, as reflected in the survey, communities in the RUA are not aware of this danger. This implies that the communities need to be informed and convinced about the real magnitude of the catastrophic flood before they accept and implement the management strategies.

To address this problem, there are two suggestive options that could be undertaken at the ward level:

(1) Changing the communities' perception of catastrophic flood risk which enhances their preparedness.

(2) Conducting comprehensive hands-on community level education programs with objectives to provide residents the knowledge of catastrophic flood and its interaction with the overdevelopment of the RUA, interest to take initiative to put that knowledge into practice, and enhanced capacity to respond to future possible catastrophic event.

Pilot areas should be two survey locations in An Duong ward, where residents had relatively high experience of catastrophic flood, and in Chuong Duong ward, where the education program should be incorporated with a future structural mitigation measure of relocating residents and building a pilot 1 km-long channelised embankment. These education programs should be conducted by the construction section of the ward level administration and empower the community structure (leaders of resident clusters and resident groups) as a stakeholder in order to reveal their ability of motivating ordinary residents in the community. Being trusted and respected residents in community and having supports of ward officials, these leaders could play a very important role in promotion and dissemination of community level flood preparedness measures and ensuring behavioural change of their communities and would also reinforce the community-local authority linkages. Apart from that, since the rate of pupil in the RUA was high, the community education program should integrate into school education. Thus, community leaders and school teachers should be the priority trainees.

The design of program should consider the suitable number of trainees about 25 with program's duration, methods and materials are accepted by trainees and has scope for trainees to make comments and give their views based on experience. Community leaders should be trained more on techniques of motivation, which help them to promote flood preparedness at family level and measures for reduction of vulnerabilities. Consequently they should make their own action plans for performing their specified duties and responsibilities.

After these programs are implemented, its impact should be assessed in both qualitative and quantitative terms to find how effective the community leaders have worked and how community residents have changed their attitude. The successes, failures and its causes should be reviewed as lessons learned and feedback into future

programs in the other wards of the RUA. Finally, these activities should be reflected in the plans and policies of the Hanoi People's Committee.

Conclusion

In summary, the nature of Hanoi makes the city and the RUA vulnerable to floods and the overdevelopment of these at high-risk areas have amplified the problem. Among some of main reasons, an important factor in the overdevelopment of the RUA was found to be low public perception of catastrophic flood risk. In addition, the residents had higher confidence on their houses as a prominent protective solution and this caused the spread of housing construction. Thus, to regulate the development of the RUA by effective policy and strategy, which can reduce flood vulnerability, there is a need to: (1) increase community perception of flood, especially catastrophic flood, risk and (2) involve local authority and community leaders in conducting comprehensive hands-on community education program.

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