

Community perceptions of social, economic and environmental impacts of flooding in central districts of Hanoi, Vietnam

MARIA PAOLA SCAPARRA, NGO CONG CHINH,
DANG THU PHUONG and TRUNG HIEU TRAN

Abstract: The impacts of flooding on road infrastructure in Hanoi are highly disruptive, despite recent progress by the Vietnamese authorities in improving the city's drainage systems. The GCRF–OSIRIS Project aims to optimise investment strategies to minimise the impacts of flood disasters, making disaster risk reduction more effective, by introducing operational research methods. In support of this objective, the project carried out an impact assessment in four of the city's central districts. The assessment considered locally perceived social, economic and environmental impacts on residents, local entrepreneurs, and on visiting street vendors and transport service providers. Impacts of flooding were found to be highly gender-differentiated. When roads are flooded, women—both resident and visiting—face greater conflicts between the need to maintain their incomes and the responsibilities of caring for vulnerable family members, resulting in increased stress and increasing risks to their health. The assessment suggests that such disproportionate impacts on women could be mitigated through public education and pre-emptive planning measures.

Keywords: Flood disasters, impact assessment, disaster risk reduction, gender.

INTRODUCTION

Vietnam is one of the most hazard-prone countries in Asia (GFDRR 2015). Riverine and coastal flooding represents one of the major natural risks faced by the country, due to its extended coastal areas, river basins and lakeshores. In a recent study by the World Resources Institute, Vietnam is ranked globally as the country with the fourth highest exposure to river flooding (Luo *et al.* 2015). In addition, flood risk, exposure and impact are expected to increase because of climate change. Current literature shows that rising temperatures as a result of climate change will result in an intensification

of rainfall (Arnell & Lloyd-Hughes 2014, Donat *et al.* 2016, Hettiarachchi *et al.* 2018, Lehmann *et al.* 2015) and, consequently, an increase in the frequency and intensity of floods (IPCC 2014, World Bank 2014).

Recent accelerations in population growth, changes in land-use patterns and fast urbanisation further exacerbate Vietnam's vulnerability to floods. The impact of land-use change and urbanisation on flooding has been widely documented in the literature (Huong & Pathirana 2013, Pham Anh 2013, Zope *et al.* 2016). As more people move to the cities, they inevitably turn green areas and soft surfaces into impervious areas; in addition, higher population density in urban flood-prone areas increases exposure to flood hazards (Hammond *et al.* 2015).

In Hanoi, the capital city of Vietnam, flood risk is especially acute. The city has seen increasing urbanisation and economic development during recent decades. However, the pace of supportive infrastructure development has lagged behind (Luo *et al.* 2018). The city has many hotspots that become waterlogged during heavy rain because of an outdated and overloaded drainage system (IMHEN-UNDP 2015). In 2008, an historic flood triggered by torrential rains killed eighteen people in the city and caused massive economic losses. According to Luo *et al.* (2018: 3),

up to one meter of water flooded the city's streets, and urban transportation was halted. Food prices, especially those of meat and vegetables, reached exorbitant levels in the city as the rains destroyed crops and livestock and crippled transportation corridors. The total economic loss due to this flood exceeded 177 million USD.

Following the 2008 flood, the city spent millions of US dollars on infrastructure improvements. Nevertheless, Hanoi continues to experience serious flooding every year and the drainage system remains substandard and inadequate (VIETNAMNET Bridge 2018).

As in many other countries facing similar flood disasters, flood impacts in Vietnamese cities are especially felt by the poorest segments of society, as their incomes are more dependent on weather and their housing and properties less protected (Bangalore *et al.* 2018, Hallegatte *et al.* 2016, 2017, Narloch & Bangalore 2018). For example, poor households may not be able to cover the cost of flood adaptation measures, such as wet-proofing their properties (Lasage *et al.* 2014). In addition, they are more vulnerable to increased food prices during and after floods, and less able to recover from property damage.

Women are another segment of society that is particularly vulnerable and highly affected by flood disasters. Differences in disaster vulnerability and impacts between men and women can be attributed to a variety of factors, including social roles (for example, care for children, elderly and sick; food provision; household duties), education, employment status, income, household finance responsibilities, and access to

community services and infrastructure (Fakhruddin & Rahman 2015, Rahman 2013). In addition, female-headed households are typically more vulnerable to income and asset losses, and therefore more severely impacted by disasters, although the vulnerability of female-headed household also depends on other influencing factors, such as headship type (for example, widows, never-married women or women with a non-resident partner) and country context (Flatø *et al.* 2017, Klasen *et al.* 2015). Many studies have highlighted the importance of considering gender responsiveness for effective disaster preparedness and for reducing disaster impacts. However, gender gaps and imbalances shaped by cultural and social structures are often ignored in risk assessment and disaster mitigation planning (De Silva & Jayathilaka 2014, Rakib *et al.* 2017, Reyes & Lu 2016).

This study analyses flood impact perception among Hanoi urban households, with the aim of assessing the most important social, economic and environmental impacts that local communities experience during flood disasters in the city. The community-based assessment was carried out by the Asian Management and Development Institute, as part of the GCRF–British Academy project titled: ‘Optimal Investment Strategies to Optimize Flood Impact on Road Infrastructure Systems in Vietnam’ (OSIRIS). The OSIRIS project aims to identify gaps and inefficiencies in current infrastructure investment and maintenance programmes in Hanoi, especially in relation to climate change and flooding issues that affect transport. The project will then develop a multi-period optimisation model for strategic, long-term planning of mitigation actions which minimise the impact of floods on the urban road network, depending on different flood scenarios. The community-based assessment considers and compares local perceptions of social, environmental and economic flooding impacts on Hanoi’s road network. The findings of the assessment form the basis for flood-mitigation policy recommendations which take the local community’s needs into account. This analysis will therefore offer a comprehensive understanding of flood impacts borne by communities, and complement other findings of the OSIRIS project, based on the application of analytical models to assess the benefits of flood mitigation measures.

STUDY AREA

Hanoi has a population of approximately 7.7 million, with population density of 2,300 per km², and a growth rate a little over 2 per cent per year, compared to the national average of approximately 1 per cent. Growth is high due to rural–urban migration, supported by the rapid development of residential ‘satellite’ areas around the city. Being the capital city, it is a centre for political, cultural, economic and



Figure 1. The City of Hanoi. (Source: IMHEN)

districts are less affected by floods compared to newly established districts, partly because drainage systems in newer urban areas were planned in haste, received less investment, and remain partly dependent on former agricultural drainage systems.

Interviews were carried out in the following wards (subdivisions of districts): My Dinh, Me Tri, Co Nhue, Nhan My (Nam Tu Liem District); Kham Thien, Luong Dinh Cua, Kim Lien (Dong Da District); Van Quan, Duong Noi, Xa La, Yen Nghia, Phu Luong, Trieu Khuc, Kien Hung (Ha Dong District); Giap Bat, Tan Mai, Hoang Van Thu, Thinh Lien (Hoang Mai District).

RESEARCH PARTICIPANTS AND DATA COLLECTION

The assessment considered two broad groups of people. The first group are *residents* of the assessment areas, 55 per cent (164 out of 296) of whom are also local business people, trading from their homes, or from shops attached to their homes. Their businesses are mainly small grocery or food stores, coffee shops and iced tea stalls on pavements or by the roadside. The remaining 45 per cent of residents are primarily employees in governmental or private agencies, or retired. The second group are *visitors* to the assessment areas, who work as street vendors, motorcycle-taxi or car-taxi drivers, most of whom come to the area to sell their goods and services early in the day, and leave at the end of the day, or when their produce has been sold. Street vendors in this category usually come into the urban area from outlying districts of the city, bringing food or vegetables, or ready-made snacks, often by bicycle or motorcycle. The assessment gives special attention to the different impacts experienced by women and men.

Table 1. Respondents included in the assessment.

Respondents	Resident households		Visitors			Total
	Households doing trade	Households not trading	Street vendors	Motorcycle-taxi drivers	Car-taxi drivers	
Male	47 (9%)	65 (13%)	15 (3%)	86 (17%)	7 (1%)	220 (44%)
Female	117 (24%)	67 (13%)	88 (18%)	4 (1%)	1 (n.a.)	277 (56%)
Total	296 (60%)		201 (40%)			497

Table 2. Gender of resident respondents, by district.

Gender	District			
	Dong Da	Ha Dong	Hoang Mai	Nam Tu Liem
Male	20 (7%)	50 (17%)	24 (8%)	18 (6%)
Female	14 (5%)	79 (27%)	54 (18%)	37 (13%)
Total	34 (11%)	129 (44%)	78 (26%)	55 (19%)

The survey took place in the midst of Hanoi's stormy season, in mid-2018, following a series of torrential downpours. This could be considered as an advantage for the assessment, as local people were able to reflect quickly on their situation and to propose appropriate measures for dealing with the impacts of floods. The assessment comprised quantitative data collection among the two main stakeholder groups (residents and visitors), plus qualitative methods to corroborate (or otherwise) the data findings. Qualitative methods were focus-group discussions, in-depth interviews with subgroups or members of the two main stakeholder groups, consultations with local government, business and community-based organisations, and observations by the assessment team. Locally available literature such as government flood-damage assessments, were also consulted. Initial sets of indicators for social, environmental and economic impact were adapted into assessment questions. Different assessment forms were used for the two target groups—residents and visitors.

ANALYSIS OF COMMUNITY PRIORITIES AND FLOOD IMPACT PERCEPTION

The perception of floods among residents and visitors differed by district. Perceptions of floods between 2015 and 2018 were that they generally lasted less than one day, but in Ha Dong District, 46 per cent of respondents perceived floods to last generally between one and three days. Average flood depths were perceived mainly as between 0.2 m and 0.5 m (71 per cent of respondents). Some perceived average depths as between 0.5 m and 1 m (16 per cent of respondents).

Social impacts were assessed through interviews with the residents' group, not with the visitors' group. Prolonged traffic congestion, and children's absence from school were found to be the most important social impacts, with almost 90 per cent of respondents considering the traffic congestion as the second most important social impact of flooding (Figure 3). Interviews showed that traffic congestion was cited as important because it led to loss of time in traffic, turning normal journeys of 15 minutes into one-hour journeys characterised by stress (water, other impatient drivers pushing their motorbikes through traffic, fumes, and noise). Traffic congestion was also cited as important because it led to secondary impacts, including difficulty in taking children to school, difficulty in accessing health care services, and difficulty in receiving services such as utility maintenance at home. Secondary impacts of traffic congestion were also economic impacts, such as loss of time from work, loss of wages, and broken motorbike engines.

Children's absence from school affected families socially and economically, as households needed to find suitable care for their children at home. Fifty per cent of

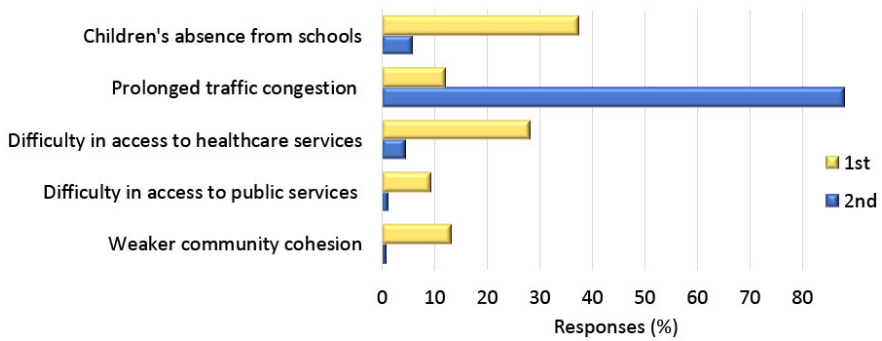


Figure 3. Residents' perception of the most important social impacts.

children were assessed to be absent from school during storms and flooding, with absence normally lasting one to two days. At those times, 75 per cent of home carers were perceived to be mothers and grandmothers, 25 per cent fathers, grandfathers, relatives or friends. These arrangements often required transport for children to grandparents' homes (or vice versa), or required one income-earner, usually the mother, not going out to work.

The assessment showed that both residents (trading and non-trading households) and visitors (street vendors, motorcycle-taxi and car-taxi drivers) were economically impacted. The greatest economic impact overall was considered to be damage to the road, pavement, and drainage system, which was surprising as these are public goods, while the second most important economic impact overall was considered to be damage to housing, belongings, and goods/stock (Figure 4).

More than half (58 per cent) of resident households normally experience flood waters entering their houses/stores/place of business during the flood season, causing damage to housing, belongings, and goods/stock. Trading households, such as coffee

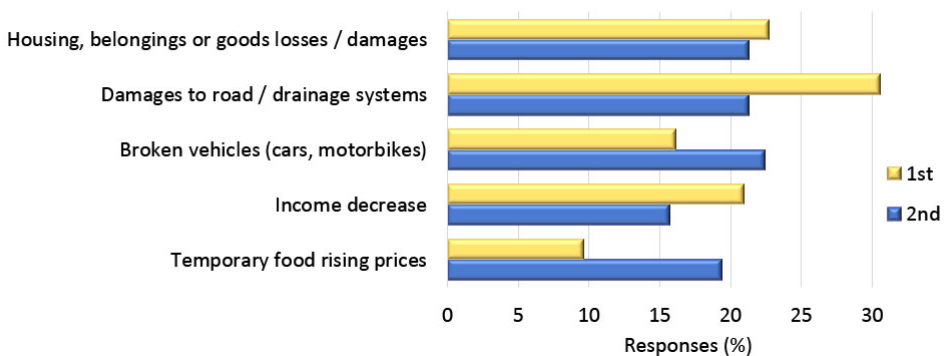


Figure 4. Household perception of the most important economic impacts.

shops, grocery stores, and food and beverage stalls along streets or pavements, were perceived as more vulnerable than non-trading households, due to their greater expenses for renting space, hiring staff, and the vulnerability of their stock. Expenses also rose as these households faced increased prices for cooking ingredients from wholesalers, and obstacles in transportation. However, only 10 per cent of trading households decided to increase the prices of their goods or services, to make up for their increased costs during the floods. Those with greater turnover were also those perceived as having greater losses during floods. Women were perceived as being more impacted than men, as women are more often working or trading from home. Resident men, on the other hand, were more likely to work away from home: for example, in construction or as employees.

Amongst trading and non-trading residents, those in apartments (12 per cent of those surveyed) were more impacted by electricity cuts during flooding, as cuts caused greater disruption to utilities such as water pumps and elevators. Perceived disproportional impacts on women include having to prepare meals in flooded kitchens, and running shops/restaurants/cafes in flooded conditions. The survey team observed that resident households were impacted by damp (mould and peeling paintwork inside houses) and subsidence, which householders attributed to persistent high water levels in the street. Both trading and non-trading households perceived damage to belongings, with 40 per cent of respondents reporting damage to their motorcycle. Others reported damage to their refrigerator (21 per cent), stock (20 per cent), furniture (19 per cent), and other kitchen items (18 per cent). Despite these property losses, only 12 per cent of residents had insurance for their belongings. Focus-group discussions with women residents showed that, during flood periods, the greatest perceived price rises were for fresh vegetables, with lesser but still troubling price rises for meat and fish. These price rises led to women spending more time searching for food in more markets and more distant markets. This increased their levels of stress.

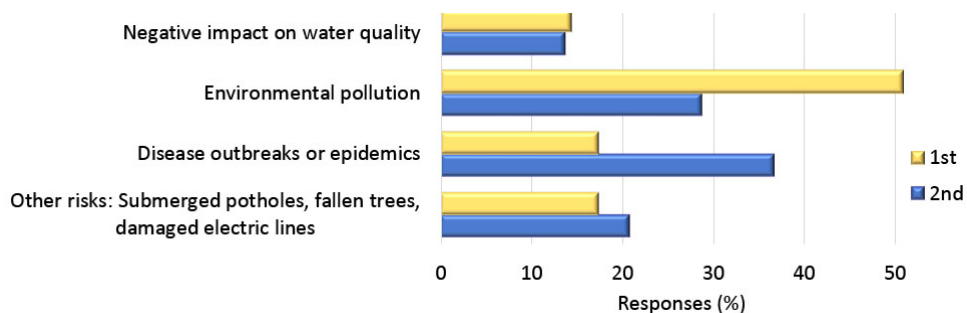


Figure 5. Household perception of the most important environmental impacts.

Amongst visitors, perceived economic impacts were also gender-differentiated. Most street vendors (88 out of 103) were women. In-depth interviews showed these were women who travelled into the city at 4:00AM or 5:00AM, mainly from more rural outlying areas of the city, carrying their goods/wares on the back or front of their bicycles/motorcycles. They would suffer most economic damage if their goods became wet, as they faced the risk of a bicycle or motorcycle falling in flood water. They also faced economic damage through reduced time at their selling location, and fewer customers deciding to stop to make purchases. However, in addition to economic impacts, women street vendors felt stressed by gender roles which required them to buy food for the evening family meal (with less income and temporarily higher prices), and to somehow also care for more vulnerable family members, (children and elderly), who were left at home. Most motorcycle-taxi and car-taxi drivers (93 out of 98) on the other hand, were men. In-depth interviews found that economic impacts on these drivers were twofold. First, from a decrease in incomes, because traffic congestion led to all journeys taking far more time to complete, with only slightly higher customer fares. Second, drivers had a significant risk of damaging their car or motorbike engines when flood water reached their exhaust pipes. Repair to engine damage was very expensive and time consuming.

Resident trading and non-trading households perceived themselves to be more vulnerable than visitors to the environmental impacts of flooding. The most critical impact was considered to be from environmental pollution, as residents' homes were threatened by overflow of wastewater from canals and streams, garbage carried by floodwaters, and foul smells from the pollution (Figure 5). Outbreak of disease or epidemic was considered the second most significant environmental impact, while other risks, especially from items submerged in the floodwaters, such as tree branches and open drains or potholes, were considered serious, especially to visitors (vendors and motorcycle-taxi drivers). Contamination of the water supply was also cited as a significant impact. Environmental impacts were also gender-differentiated, with the overall impact on women being greater than on men. Women, for example, were more affected by contaminated water when it became difficult to wash clothes and dishes, bathe children, and cook. Women were also more affected when children and elderly relatives became sick from environmental pollution. Women were also responsible for purchasing medicine or treatment for sick family members, and this became an additional economic impact for women during the flood period. Finally, the role of women in cleaning houses, kitchens and streets of garbage after floods subsided, was greater than the role of men.

During the assessment, residents expressed a high awareness of flood-risk management and mitigation, and showed significant experience in minimising risks and addressing impacts at household level. Fewer, but still significant, numbers

(67 per cent), were aware of the concepts of urban flooding and climate change. Fewer still were knowledgeable about proper waste disposal, and the role of garbage and construction materials in blocking drainage systems.

Eighty three per cent of respondents were aware of floods prior to their occurrence, demonstrating that government early warning systems through public media are very effective. When asked to identify the main cause of urban flooding in the assessment area, 42 per cent of respondents said the main cause was the aged drainage system. Twenty eight per cent of respondents said the main cause was climate change, 17 per cent said the main cause was people's low awareness of the effects of garbage discharge into the drainage system, and 13 per cent blamed Hanoi's rapid urbanisation.

GENDER-DIFFERENTIATED IMPACTS

Several gender-differentiated impacts of flooding in Hanoi have been highlighted in the sections above. Prior to flooding, during flooding and following floods, women were perceived to work longer hours, and to take on more additional tasks both in the household and at work, especially those working as street vendors. The roles of men and women in the family are different, pre-flood, post-flood, and during floods. Before floods occur, women normally prepare food reserves, tidy the house, and move goods to higher places. Men carry out heavier tasks, such as flood-proofing the house to the extent possible, moving heavy furniture, and occasionally raising the height of doorsteps to prevent water entering the house, or clearing drainage systems. During floods, both women and men discharge water from the house and address immediate needs at home. Men often carry out further dredging of drainage systems. After floods, women carry out most of the tidying and cleaning work. The most strongly perceived impacts of floods on women were economic, as their reduced daily income could not match the higher costs for family food and living expenses during periods of flooding. Women vendors also faced economic impact when their stock or produce became wet or damaged. Apparently as a result of these gender-differentiated impacts, women also perceived greater impacts to their health and greater stress, than was perceived by men for themselves. Focus-group discussions showed that, while the decision-making power of women in Hanoi is greater than decision-making power of women coming from rural areas, this difference narrowed during flooding, as men took more decisions about mitigation measures. This also led to increasing conflicts between wives and husbands, often exacerbated by temporary, flood-induced, financial constraints.

Despite significantly assessed gender-differentiated impacts of flooding, when survey respondents were asked about solutions to better respond to flooding, they suggested improved storage of food, updated weather forecasts, raising floors and

doorsteps, and other measures, but few people suggested that housework should be more evenly shared, or that women should have a stronger role in the management of household-level disaster responses.

IMPLICATIONS

A range of implications can be drawn from the assessment results, which can feed into the design and analysis of flood-risk management interventions in Hanoi.

Regarding responsibilities, residents and visitors were able to identify mitigation measures which they themselves intended to carry out, and they were presumed to carry out these measures at their own cost. These included better clearing of garbage and construction materials from waterways; improving storage management for reserve food supplies; paying greater attention to weather forecasts; and better planning for the quick removal of furniture and belongings to higher places in the home. However, they also perceived the need for government to take responsible action by upgrading or reconstructing the relevant drainage systems.

Regarding location, the assessment highlighted the fact that flood risks and impacts on communities—including traffic congestion, inadequate drainage, water intrusion into houses, environmental pollution, and dangers from submerged hazards for vendors and taxi services—were experienced almost exclusively along roads. This implies that the road network can be considered as a framework for flood-risk management and mitigation measures.

Regarding risk reduction, local partners carrying out the assessment identified communication and awareness-raising about urban flood risks, and about the gender-differentiated impacts of flood, as priority measures to reduce risks effectively. Suggested gender-related measures include promotion of discussions between women and men to share their workload, reducing working times for women during floods, and joint decision-making between women and men regarding measures before, during and after floods, because these measures can be most cost-effective in reducing flood impacts at household level. Greater participation and integration of women in formal decision-making for disaster-reduction planning was also advocated. The suggested risk-reduction measures have implications for the work of civil society organisations and ‘mass organisations’ (the Women’s Union, Youth Union, and Fatherland Front), and for media organisations with a role in providing early warning and advice.

Waste disposal was considered a major contributing factor to the severity of Hanoi’s flooding, and, whilst residents and visitors identified their own responsibility in addressing the issue, they also suggested that wider awareness-raising was needed,

especially for street businesses/food outlets which regularly discharged their waste into the city's drainage system. Respondents to the survey also suggested that government should introduce tighter regulation and punitive measures for construction companies which allow construction materials to block drains, and that government agencies should ensure that waterways are clear prior to the rainy season. This has implications for municipal departments under the Hanoi People's Committee, and for the City Water Drainage Company of Hanoi.

Given the 'soft' nature of many of these recommendations, the appropriate agencies to follow through are likely to be civil society organisations and the 'mass organisations', such as the Women's Union, which exist in Vietnam. These organisations are able to facilitate preparations for households and local businesses prior to the flood season, and to promote gender-based measures for reducing flood risk. However, these agencies may require funding and resources to properly carry out these functions, either from city government, or from within internationally funded flood-risk reduction projects. The complexities of flood-risk management cannot be left to hard, infrastructural measures alone, but simultaneous complementary approaches are needed, including those which directly address the perceived needs of residents and visitors, women and men.

CONCLUSIONS

Hanoi, as many other cities in developing countries, is frequently exposed to severe flood disasters, which pose great risk to the life and livelihood of its urban communities and jeopardise its socio-economic development. Rapid urbanisation, an aging drainage system and climate change impacts exacerbate the problem of floods in the city.

The impact assessment carried out in Hanoi as part of the OSIRIS project revealed that improving drainage systems remains the highest priority for communities, to reduce flood risk. It also highlighted that the impacts of urban flooding in Hanoi are felt most acutely, and have the greatest economic and social impacts, along roads. Perhaps this is not surprising, as roads are the arteries of the city, and the busiest places in Hanoi. Therefore, maintaining the efficiency of roads during the frequent periods of flooding is a priority for local and national government investment.

At community level, in areas of Hanoi which have rapidly urbanised, flooding has high social, economic and environmental costs for both resident households and for visiting traders. These costs are absorbed at personal and household level, with little or no recognition or support from government or non-government institutions. Most of these costs are also not included in official flood-damage assessments.

A group especially vulnerable to the impacts of urban flooding are women who live in outlying, often rural, areas near the edge of the city, who travel, with their wares for sale, into the city each day, by motorcycle, bicycle or bus. The study confirms findings already documented in the literature, that the impacts of flooding are gender-differentiated, with women experiencing greater impacts than men. However, gender measures were not identified by communities or visitors, as solutions to the impacts of flooding, implying that gaps still exist between knowledge, attitudes and practice on gender equality at community level.

An important recommendation emerging from the study is that government and communities urgently need to address the issue of poor solid waste disposal practices. Action in this field will need to be taken with industry, infrastructure development stakeholders, small businesses and households.

Acknowledgements

The authors gratefully acknowledge the financial support of the British Academy's Cities and Infrastructure Programme and the Global Challenges Research Fund. The authors wish to thank Professor Caroline Knowles, the director of the Cities and Infrastructure Programme, for her continuous support and insightful discussions. They also thank the staff of the Asian Management and Development Institute, especially Mrs Ta Linh Chi and Mrs Tran Mai Huong, for their contributions to this study. Finally, a special thanks to Mr Graham Adutt for his precious inputs on this paper.

REFERENCES

- Arnell, N. W. & Lloyd-Hughes, B. (2014), 'The Global-scale Impacts of Climate Change on Water Resources and Flooding Under New Climate and Socio-economic Scenarios', *Climatic Change*, 122: 127–40. <https://doi.org/10.1007/s10584-013-0948-4>
- Bangalore, M., Smith, A. & Veldkamp, T. (2018), 'Exposure to Floods, Climate Change, and Poverty in Vietnam', *Economics of Disasters and Climate Change*, 3(1): 79–99. <https://doi.org/10.1007/s41885-018-0035-4>.
- De Silva, K. & Jayathilaka, R. (2014), 'Gender in the Context of Disaster Risk Reduction; A Case Study of a Flood Risk Reduction Project in the Gampaha District in Sri Lanka', *Procedia Economics and Finance*, 18: 873–81. [https://doi.org/10.1016/S2212-5671\(14\)01013-2](https://doi.org/10.1016/S2212-5671(14)01013-2)
- Donat M. G., Lowry A. L., Alexander L. V., O'Gorman P. A. & Maher N. (2016), 'More Extreme Precipitation in the Dry and Wet Regions', *Nature Climate Change*, 6: 508–13. <https://doi.org/10.1038/nclimate2941>
- Fakhruddin, S. H. M. & Rahman, J. (2015), 'Coping With Coastal Risk and Vulnerabilities in Bangladesh', *International Journal of Disaster Risk Reduction*, 12: 112–18. <https://doi.org/10.1016/j.ijdr.2014.12.008>

- Flatø, M., Muttarak, R. & Pelsler, A. (2017), 'Women, Weather, and Woes: The Triangular Dynamics of Female-headed Households, Economic Vulnerability, and Climate Variability in South Africa', *World Development*, 90: 1–62. <https://doi.org/10.1016/j.worlddev.2016.08.015>
- GFDRR (2015), 'Country Profile–Vietnam', Global Facility for Disaster Reduction And Recovery. <https://www.gfdr.org/sites/gfdr/files/region/VN.pdf>
- Hallegatte, S., Bangalore, M., Bonzanigo, L., Fay, M., Kane, T., Narloch, U., Rozenberg, J., Treguer, D. & Vogt-Schilb, A. (2016), 'Shock Waves: Managing the Impacts of Climate Change on Poverty', *Climate Change And Development Series*, World Bank, Washington, DC. <https://doi.org/10.1596/978-1-4648-0673-5>
- Hallegatte, S., Vogt-Schilb, A., Bangalore, M. & Rozenberg, J. (2017), 'Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters', *Climate Change and Development Series*, World Bank, Washington, DC. <https://doi.org/10.1596/978-1-4648-1003-9>
- Hammond, M. J., Chen, A. S., Djordjević, S., Butler, D. & Mark, O. (2015), 'Urban Flood Impact Assessment: A State-of-the-art Review', *Urban Water Journal*, 12: 14–29. <https://doi.org/10.1080/1573062X.2013.857421>
- Hettiarachchi, S., Wasko, C. & Sharma A. (2018), 'Increase in Flood Risk Resulting from Climate Change in a Developed Urban Watershed—The Role of Storm Temporal Patterns', *Hydrology and Earth System Sciences*, 22: 2041–56. <https://doi.org/10.5194/hess-22-2041-2018>
- Huong, H. T. L. & Pathirana A. (2013), 'Urbanization and Climate Change Impacts on Future Urban Flooding in Can Tho City, Vietnam', *Hydrology and Earth System Sciences*, 17: 379–94. <https://doi.org/10.5194/hess-17-379-2013>
- IMHEN-UNDP (2015), *Viet Nam Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (Hanoi, Natural Resources and Environment Publishing House).
- IPCC (2014), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, Cambridge University Press).
- Klasen, S., Lechtenfeld, T. & Povel, F. (2015), 'A Feminization of Vulnerability? Female Headship, Poverty, and Vulnerability in Thailand and Vietnam', *World Development*, 71: 36–53. <https://doi.org/10.1016/j.worlddev.2013.11.003>
- Lasage, R., Veldkamp, T. I. E., de Moel, H., Van, T. C., Phi, H. L., Vellinga, P. & Aerts, J. C. J. H. (2014), 'Assessment of the Effectiveness of Flood Adaptation Strategies for HCMC', *Natural Hazards and Earth System Sciences*, 14(6): 1441–57. <https://doi.org/10.5194/nhess-14-1441-2014>
- Lehmann, J., Coumou, D. & Frieler, K. (2015), 'Increased Record-breaking Precipitation Events Under Global Warming', *Climatic Change*, 132: 501–15. <https://doi.org/10.1007/s10584-015-1434-y>
- Luo, T., Maddocks, A., Iceland, C., Ward, P. & Winsemius, H. (2015), 'World's 15 Countries with the Most People Exposed to River Floods', World Resources Institute. <https://www.wri.org/blog/2015/03/world-s-15-countries-most-people-exposed-river-floods> (accessed 3 February 2019).
- Luo, P., Mu, D., Xue, H., Ngo-Duc, T., Dang-Dinh, K., Takara, K., Nover, D. & Schladow G. (2018), 'Flood Inundation Assessment for the Hanoi Central Area, Vietnam Under Historical and Extreme Rainfall Conditions', *Scientific Reports*, 8: 1–11. <https://doi.org/10.1038/s41598-018-30024-5>
- Narloch, U. & Bangalore, M. (2018), 'The Multifaceted Relationship Between Environmental Risks and Poverty: New Insights from Vietnam', *Environment and Development Economics*, 23(3): 298–327. <https://doi.org/10.1017/S1355770X18000128>
- Pham Anh, T. (2013), 'Water Urbanism in Hanoi, Vietnam: An Investigation into Possible Interplays of Infrastructure, Urbanism and Landscape of the City's Dyke System', PhD dissertation, KU Leuven.

- Rahman, M. S. (2013), 'Climate Change, Disaster and Gender Vulnerability: A Study on Two Divisions of Bangladesh', *American Journal of Human Ecology*, 2: 72–82.
<https://doi.org/10.11634/216796221302315>
- Rakib, M. A., Islam, S., Nikolaos, I., Bodrud-Doza, M. & Bhuiyan M. (2017), 'Flood Vulnerability, Local Perception and Gender Role Judgment Using Multivariate Analysis: A Problem-based "Participatory Action to Future Skill Management" to Cope With Flood Impacts', *Weather and Climate Extremes*, 18: 29–43. <https://doi.org/10.1016/j.wace.2017.10.002>
- Reyes, D. D & Lu, J. L. (2016), 'Gender Dimension in Disaster Situations: A Case Study of Flood Prone Women in Malabon City, Metro Manila', *International Journal of Disaster Risk Reduction*, 15: 162–8. <https://doi.org/10.1016/j.ijdr.2015.11.001>
- VIETNAMNET Bridge (2018), 'Hanoi's Water Drainage System Overloaded'.
<https://english.vietnamnet.vn/fms/society/213332/hanoi-s-water-drainage-system-overloaded.html> (accessed 3 February 2018).
- World Bank (2014), 'Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience'.
http://www.worldbank.org/content/dam/Worldbank/document/Full_Report_Vol_2_Turn_Down_The_Heat_%20Climate_Extremes_Regional_Impacts_Case_for_Resilience_Print%20version_FINAL.pdf
- Zope, P. E., Eldho, T. I. & Jothiprakash, V. (2016), 'Impact of Land Use Change And Urbanization On Flooding: A Case Study of the Oshiwara River Basin in Mumbai, India', *Catena*, 145: 142–54.
<https://doi.org/10.1016/j.catena.2016.06.009>

Notes on the authors:

Maria Paola Scaparra is Professor of Management Science at the Kent Business School, University of Kent. Her research interests include the application of operational research (OR) techniques to critical infrastructure protection planning, disaster management and humanitarian logistics. She has published many papers and book chapters on these topics in premier academic journals, and has been involved in several international, multidisciplinary and consultancy projects, including projects funded by the British Academy, the Engineering and Physical Sciences Research Council (EPSRC) and Innovate UK.

Recently, she has been exploring how OR can contribute to the achievement of the UN Sustainable Development Goals and help solve intractable challenges in developing countries. Professor Scaparra is the Principal Investigator of the British Academy GCRF–OSIRIS project and the EPSRC project 'Improving Community Resilience and Sustainability Through Operational Research Capacity Building in Southeast Asia' (CREST-OR).

m.p.scaparra@kent.ac.uk

Recent publications:

- Esposito Amideo, A., Scaparra, M. & Kotiadis, K. (2018), 'Optimising Shelter Location and Evacuation Routing Operations: The Critical Issues', *European Journal of Operational Research*.
<https://doi.org/10.1016/j.ejor.2018.12.009>.

Starita, S., Scaparra, M. & O'Hanley, J. (2016), 'A Dynamic Model for Road Protection against Flooding', *Journal of the Operational Research Society*, 68:74–88.
<http://dx.doi.org/10.1057/s41274-016-0019-0>

Ngo Cong Chinh is the Managing Director of the Asian Management and Development Institute (AMDI) and the Research Director of Research Center for Disaster Risk Reduction and Climate Change, in Hanoi, Vietnam. He is also a current PhD candidate of the University of Wageningen. His research interests are climate change, risk perception, risk communication, and disaster risk management.

Recent publications:

Gustafson, S., Cadena, A. J., Ngo, C. C., Kawash, A., Saenghkaew, I. & Hartman, P. (2017), 'Merging Science into Community Adaptation Planning Processes: A Cross-site Comparison of Four Distinct Areas of the Lower Mekong Basin', *Climatic Change*, 149(1): 91–106.
<https://doi.org/10.1007/s10584-016-1887-7>

Ngo, C. C., Marijn Poortvliet, P. & Feindt, Peter H. (2019), 'Drivers of Flood and Climate Change Risk Perceptions and Intention to Adapt: An Explorative Survey in Coastal and Delta Vietnam', *Journal of Risk Research*. <https://doi.org/10.1080/13669877.2019.1591484>

Dang Thu Phuong is an Honorary Research Associate at the University of Kent, with a Master's degree in Regional and Rural Development Planning from the Asian Institute of Technology (AIT) in Thailand. She regularly carries out assignments for United Nations agencies in Africa and Southeast Asia, and has focussed her research interests on gender, disaster risk reduction, climate change adaptation and mitigation, and capacity development.

Recent publications:

Le, S. & Dang, T. P. (2014), 'Indigenous Knowledge and Experience in Adapting to Drought in Vietnam', in *Community-based Adaptation to Climate Change, Emerging Lessons, Practical Action*, Rugby.
Jobbins, G. & Dang, T. P. (2014), 'The Case of Vietnam, Advancing Integration of Disaster, Environment and Climate Change', *Advancing Integration Series*, Overseas Development Institute, London.

Trung Hieu Tran is a Leverhulme Research Fellow at the University of Nottingham. His research interests include the application of operational research techniques such as agent-based modelling and machine learning for sustainable urban development.

Recent publications:

Tran, T. H., Mao, Y., Nathanail, P., Siebers, P. & Darren, R. (2019), 'Integrating Slacks-based Measure of Efficiency and Super-efficiency in Data Envelopment Analysis', *Omega*, 85: 156–65.
<https://doi.org/10.1016/j.omega.2018.06.008>

Tran, T. H. & Nguyen, T. T. B., (2019), 'Alternative Fuel Station Network Design under Impact of Station Failures', *Annals of Operations Research*. <https://doi.org/10.1007/s10479-018-3054-1>

To cite the article: Maria Paolo Scaparra, Ngo Cong Chinh, Dang Thu Phuong and Trung Hieu Tran (2019), 'Community perceptions of social, economic and environmental impacts of flooding in central districts of Hanoi, Vietnam', *Journal of the British Academy*, 7(s2): 137–154.

DOI <https://doi.org/10.5871/jba/007s2.137>

This article is licensed under a
Creative Commons Attribution-NonCommercial-NoDerivs 4.0 Unported License.

Journal of the British Academy (ISSN 2052–7217) is published by



10–11 Carlton House Terrace, London, SW1Y 5AH
www.thebritishacademy.ac.uk