Article:

Hudson, Paul orcid.org/0000-0001-7877-7854, Pham, My and Bubeck, Philip (2019) An evaluation and monetary assessment of the impact of flooding on subjective well-being across genders in Vietnam. Climate and Development. pp. 623-637. ISSN 1756-5537

https://doi.org/10.1080/17565529.2019.1579698

Climate and Development

ISSN: 1756-5529 (Print) 1756-5537 (Online) Journal homepage: https://www.tandfonline.com/loi/tcld20

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To cite this article: Paul Hudson, My Pham & Philip Bubeck (2019) An evaluation and monetary assessment of the impact of flooding on subjective well-being across genders in Vietnam, Climate and Development, 11:7, 623-637, DOI: 10.1080/17565529.2019.1579698

To link to this article: https://doi.org/10.1080/17565529.2019.1579698

CLIMATE AND DEVELOPMENT
2019, VOL. 11, NO. 7, 623–637
https://doi.org/10.1080/17565529.2019.1579698

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RESEARCH ARTICLE

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An evaluation and monetary assessment of the impact of flooding on subjective well-being across genders in Vietnam

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ABSTRACT
The intangible impacts of floods on welfare are not well investigated, even though they are important aspects of welfare. Moreover, flooding has gender based impacts on welfare. These differing impacts create a gender based flood risk resilience gap. We study the intangible impacts of flood risk on the subjective well-being of residents in central Vietnam. The measurement of intangible impacts through subjective well-being is a growing field within flood risk research. We find an initial drop in welfare through subjective well-being across genders when a flood is experienced. Male respondents tended to recover their welfare losses by around 80% within 5 years while female respondents were associated with a welfare recovery of around 70%. A monetization of the impacts floods have on an individual's subjective well-being shows that for the average female respondent, between 41% to 86% of annual income would be required to compensate subjective well-being losses after 5 years of experiencing a flood. The corresponding value for males is 30% to 57% of annual income. This shows that the intangible impacts of flood risk are important (across genders) and need to be integrated into flood (or climate) risk assessments to develop more socially appropriate risk management strategies.

ARTICLE HISTORY
Received 7 September 2018
Accepted 17 January 2019

KEYWORDS
Subjective well-being; flood risk; welfare; gender; resilience; intangible impacts

1. Introduction

Floods can impact societies in multiple ways, ranging from the loss of life, injuries and mental health effects to the destruction of assets (Bubeck, Otto, & Weichselgartner, 2017), which results flooding being considered as the most significant natural hazard to affect humanity (UNISDR, 2011). Asia is especially prone to flood impacts – for example, a typhoon in November 2017 resulted in around 110 deaths and a monetary loss of 650 million USD across the Philippines and Vietnam (Munich Re, 2018). Moreover, while the impacts of floods are large today, flood impacts are projected to increase due to socio-economic development and climate change. The effects of socio-economic develop and climate change could result in more people and assets being susceptible to harm (IPCC, 2014). To counteract the increasing threat posed by flooding a range of effective adaptation strategies are needed.

In order to develop effective and suitable adaptation strategies, there has been a growing focus on flood risk assessments at different spatial scales (De Moel et al., 2015). These risk assessments have largely focused on the tangible flood impacts that can be easily monetized, such as the destruction of houses or infrastructure. Even though the wider literature indicates the presence, of potentially large, intangible flood impacts – such as mental preoccupation, anxiety, or other mental or physical health issues (Berry, Waite, Dear, Capon, & Murray, 2018; Lamond, Joseph, & Proverbs, 2015; Rojas, Feyen, & Watkiss, 2013). Intangible losses are often neglected in risk assessments. The exclusion of intangible losses is problematic because an inadequate consideration of the entire range of negative impacts of flooding can lead to suboptimal adaptation or risk management decisions (Kreibich et al., 2014). Moreover, better insights into the intangible and potentially longer-lasting impacts of floods – such as mental health effects – are needed in order to support the recovery of individuals from flood events (Bubeck & Thieken, 2018) so that the long-run impacts of flooding are minimized as much as possible. This is necessary because aside from disaster prevention, a speedy and full recovery of welfare is a priority of risk management and resilience-building efforts. To help promote speedy recovery processes, welfare impacts outside of monetary impacts need to be measured so that socially appropriate risk management strategies reducing negative welfare effects from flood impacts can be developed and maintained over the required timespan.

An approach for directly investigating an individual's welfare regarding their flood experiences is to study their level of self-reported *subjective well-being* (SWB), which is an individual's overall happiness or welfare (MacKerron, 2011). Welfare is what socially optimal decisions should be based upon (Mas-Colell, 1995). Therefore, using SWB to measure the total tangible and intangible welfare impacts can allow welfare changes to be measured and managed (Welsch & Ferreira, 2014). The SWB approach has been used to value a range of welfare impacts, e.g. environmental amenities (Moro, Brereton, Ferreira, & Clinch, 2008), climate conditions (Ferreira et al.,

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2013; Rehdanz & Maddison, 2005; Sekulova & van den Bergh, 2013; van der Vliert, Huang, & Parker, 2004), or terrorism (Frey, Luechinger, & Stutzer, 2009), and medical issues (Powdthavee & van den Bergh, 2011).

This is a developing field of study and as such there are relatively few studies that have examined the interactions between flooding and SWB, which needs further development to guide optimal risk management (Hudson, Botzen, Poussin, & Aerts, 2017; Lamond et al., 2015; Luechinger & Raschky, 2009; Sekulova & van den Bergh, 2016; Von Möllendorff & Hirschfeld, 2016; Welsch & Ferreira, 2014). For instance, to the best of our knowledge there are, currently, very few studies linking the flood risk domain to SWB (Calvo, Arcaya, Baum, Lowe, & Waters, 2015; Hudson et al., 2017; Luechinger & Raschky, 2009; Sekulova & van den Bergh, 2016).

While the aforementioned studies have investigated the link between flooding and SWB, none examine gender differences in welfare impacts. The wider literature has shown that there is a gender-gap in flood resilience, and this gap is mainly caused by disadvantages in socio-economic, cultural, and political domains (Bubeck et al., 2018; Neumayer & Plümper, 2007). For example, fewer girls learn how to swim, and there is a reduced mobility of women during disasters due to their social roles. Women also tend to face more difficulties in recovering from floods – such as due to having less access to resources and relief or due to the detrimental effect disasters can have on the level of respect for women's rights (Detraz & Peksen, 2017). Also, women's ability to adapt to and prepare for future floods is often lower. The lower ability to adapt or prepare may be due to the systematic gender differences in educational attainment (World Bank, 2018). The importance of documenting gender differences in disaster impacts has been recently highlighted (Cutter, 2017). Another shortcoming of the existing literature is its focus on industrialized countries, despite the fact that the majority of flood-affected people live in developing countries, mainly in Asia (Bubeck et al., 2017). Consequently, there is currently a lack of insights into the cross-comparability and transferability of the impacts of floods on SWB.

The research presented in this paper follows on the recommendations made in Gaillard et al. (2016), Cutter (2017), and Rodríguez, Donner, and Trainor (2018), among others to identify a fuller range of human flood impacts. Therefore, the two objectives of this paper are: First, the paper investigates the potential gender differences regarding the SWB impacts of flooding. Second, the paper conducts an analysis of flooding's SWB impacts in a non-European cultural context. Thereby, establishing the degree to which previous findings and methods can be generalized across the globe by using a very different flooding context. Moreover, understanding these impacts in central Vietnam, as a recent study for a neighbouring province (Quang Ngai) has a monetary tangible flood risk equal to 3.5% of GDP, with an 11 deaths and 100 injuries to flooding expected annually (Vu & Ranzi, 2017). Furthermore, Vu and Ranzi (2017) classify deaths and injuries as intangible losses, which out study expands upon through SWB. Additionally, we extend the previous studies by examining the temporal rate at which SWB recovers after a flood, further developing our knowledge of the recovery pillar of resilience.

We use a survey of residents from a province of central Vietnam, which was embedded in the disaster-science literature (Botzen, Kunreuther, & Michel-Kerjan, 2015; Bubeck et al., 2015; Bubeck & Thieken, 2018; Hudson et al., 2017; Poussin, Botzen, & Aerts, 2013; Sekulova & van den Bergh, 2016). This data was studied using a mediation style regression analysis in line with previous studies in order to capture the direct and indirect effects of flooding on SWB as a proxy for welfare.

This research can have a wide range of implications for flood risk management. This is because we argue that when designing climate change adaptation or risk reduction policy a wider range of impacts needs to be considered as well as how they experienced across different groups in society. In particular after a flood we suggest that psychological assistance should be provided. Moreover, climate risk management strategies and assessments need to account for the fact that there may be incomplete recovery from previous disaster experiences, unless suitable and sustainable recovery mechanisms are in place. Finally, intangible impacts should be more robustly included in the cost–benefit studies that drive investments in flood and climate risk management to avoid suboptimal decisions.

2. Data and methodology

2.1. Case study area and survey data collection

2.1.1. Case study area

The selected study location is Thua Thien Hue province a coastal area of Central Vietnam (Figure 1). The provincial population is just over 1.1 million (General Statistics Office of Vietnam, 2016). A hydrological feature of the province is the Huong River that flows through Hue city into the Tam Giang Lagoon. These features are the lifeline for many residents as up to 300,000 individuals rely on the lagoon directly or indirectly (Tuyen, Armitage, & Marschke, 2010). Additionally, the province faces increasing pressure on local-ecosystems from the disappearance of natural areas (MONRE, 2011).

The province suffers from flooding that originates from rivers, heavy rainfall, and the sea. However, not all provincial residents are affected every year, even though the entire province is at risk. The worst flood in the recent history occurred in 1999, which killed at least 547 people and resulted in economic damage as high as 200 million US$ as well as the destruction or damaging of more than 600,000 homes (Valeriano et al., 2009). A second large scale flood impacted Thua Thein Hue province (in addition to 11 other provinces) in September 2009. This event caused widespread impacts, particularly within the provinces of Quang Nam and Quang Ngai. Overall, across the provinces affected, the flood is associated with 179 deaths, 1140 injuries, and US$305 million USD in monetary losses (IFRC, 2010). However, detailed information on the impacts within Thua Thein Hue is to the best of our knowledge currently unavailable. The most recent flood event occurred in early November 2017 due to the Typhoon Damray, which led to US$ 36.6 million of economic damage and the loss of nine lives in Thua Thien Hue province.

2.1.2. Data collection

The method of data collection was a face-to-face survey of 1010 residents in the Quang Loi coastal commune and the citadel

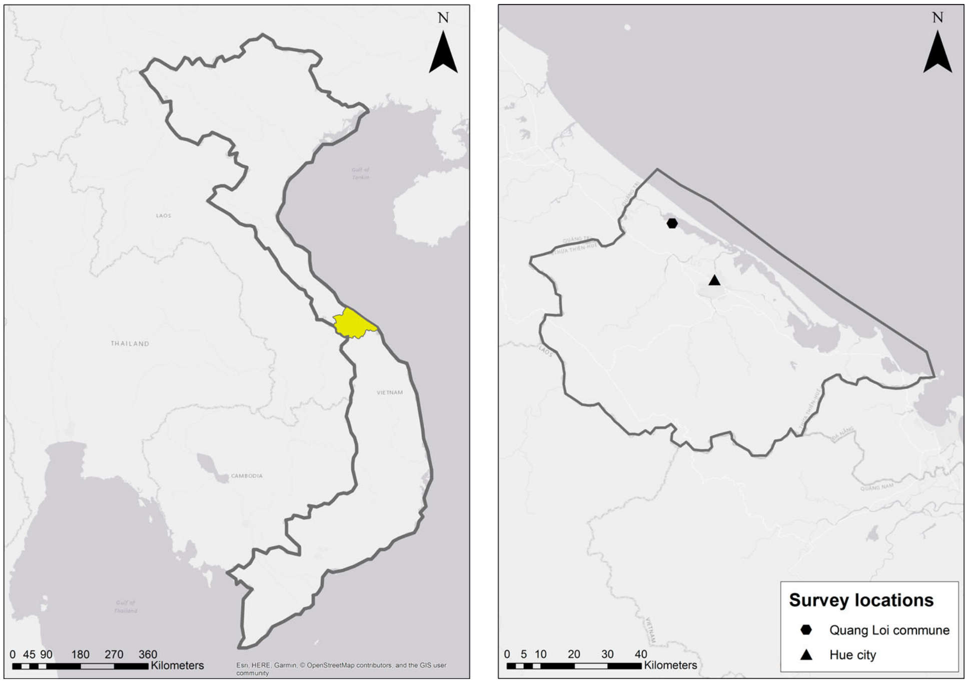

Figure 1. Location of Thua Thien Hue Province within Vietnam (left, yellow) and location of the survey sites within the province of Thua Thien Hue Province (right, study sites marked via solid shapes).

district of Hue City. Urban and coastal areas were selected as geographical units because they are, and will be, the hotspots of flood impacts (Birkmann, Welle, Solecki, Lwasa, & Garschagen, 2016; Hallegatte, Green, Nicholls, & Corfee-Morlot, 2013).

Our sample design is to reflect these two hotpots using a sample drawn from central Vietnam.

Due to the survey being required to achieve several objectives we employ a simple sampling approach to maximize the survey's suitability for all research objectives. In both study sites a full list of official residents/households was not available due to more unofficial construction taking place. Therefore, we were unable to pre-select households to interview consistently across both case study areas. In order to produce a consistent approach using maps of the areas, we firstly identified the area that most benefits from our planned EbA investments (a mangrove forest in Quang Loi and urban pond restoration in Hue City). Once this spatial extent was determined all households within the identified area of our case study areas where approached (at random) to ask for their participation in the survey until a sample of 505 survey respondents were collected in each survey area. In effect this approach was an 'nth household' approach as not all approached households agreed to take part in the survey. A potential limitation of this approach is that it may result in a sample that draws stronger benefits from EbA measures as compared to the average resident. This is less problematic for flood experiences due to the overall large scale of floods occurring in the area. A target number of 505 responses was selected as it was the maximum number of respondents that could be budgeted for this survey wave.

Additionally, before conducting the final survey wave a pretest and pilot survey was conducted in each case study location. In total these surveys contained 210 respondents, and were used to test and localize the survey. For example, these surveys were used to test the clarity and consistency of questions. This was because the surveys were originally developed in English and translated in Vietnamese. These respondents were excluded from the potential sample population (i.e. each respondent was only surveyed once).

These surveys were administered between June and September 2017 using Kobo Toolbox by the research team, local professionals, and students from Hue University of Sciences.

Under this approach quotas for female and male respondents were not pre-determined. This is because the survey conducted was a comprehensive survey consisting of eight sections covering a wide range of questions (e.g. dependence on ecosystem services, subjective well-being, a discrete choice experiment, flood experiences, among others) to meet a range of research objectives regarding ecosystem-based adaption to flooding (or climate change), not all of which are applicable for the current study, in areas surrounding potential investments in ecosystem-based adaptation. The survey employed in the coastal and urban areas are mostly identical. The questions regarding ecosystems differed across case study areas due to the presence of different ecosystems.

Within Hue city, the survey was conducted within the Citadel area, which in 2012 contained 65,000 (official) residents out of a total of 350,000 for the city as a whole. This implies that there are about 16,000 households, assuming there are 4 residents per household following official statistics. On the other hand, Quang Loi commune has about 7,600 residents, which corresponds to about 1900 households, assuming there are 4 residents per household following official statistics. The surveying of 505 respondents in each area corresponds to about 3% of households within the Citadel area of Hue city, and 26% of households in Quang Loi commune.

Finally, we focus on a sub-set of the overall population who could have been potentially affected by flooding within the last 15 years. This sub-set of respondents was chosen because this is a similar range of years as in Hudson et al. (2017) our main source of comparison, while being a wider range than studied in Sekulova and van den Bergh (2016). This resulted in a final sample of 747 respondents due to missing variables.

Given the sampling approach it was important to check the patterns within the collected data match the overall patterns within Tua Tien Hue. In terms of overall representativeness, we can only compare our sample to descriptive statistics for the province of Thua Tien Hue using data from the General Statistics Office of Vietnam.[1] We can compare our sample in terms of: Household size, income, and sex ratios. In terms of household size (about 4 people per household, with a standard deviation of 1.66) and income (mode per capita income of about 2.5 million VND per month and a median income of 1.9 million VND per month) we match the overall patterns within the province. However, the sample diverges in terms of sex ratios. Official statistics states that 51% of the province's population is female, while our sample is only 48% female (which is constant across both coastal and urban survey sites). Therefore, there is a slight oversampling of male respondents as compared to females. The General Statistics Office of Vietnam states that there is roughly an equal split of residents in rural (coastal) and urban areas in Thua Tien Hue. This matches our sampling approach finding an equal number of respondents in each case study area. The final split in the sample is 49% are located in the coastal area and 51% in the urban area, roughly matching the overall pattern in the province.

While it would be preferable to compare the representativeness of each sub-sample directly to its own population (e.g. urban respondents with the citadel area of Hue city) the level of publicly available information is limited (hence the selected variables). Therefore, the choice was made to compare the overall sample to the province as a whole. With this choice in mind, it may be possible that the sub-samples do not fully reflect all aspects of the populations from which they are drawn.

Overall the final sample appears to be representative of the overall population of Thua Tien Hue. However, it should also be acknowledged that when households were approached for an interview, whether the respondent was male or female is in effect chosen by the households themselves. Therefore, it is possible that in households where women faced greater impacts the household may have been more likely to select female respondents to answer the questionnaire.

2.2. Methods

2.2.1. Statistical analysis

The first methodological assumption made is that SWB values can be understood to be cardinal as opposed to ordinal in order to be in line with the previous literature (Hudson et al., 2017; Sekulova & van den Bergh, 2013; Sekulova & van den Bergh, 2016). However, it should be noted that both interpretations are equally robust regarding SWB (Ferrer-i-Carbonell & Frijters, 2004; Frey et al., 2009). The measurement of SWB and SWBDs in this case ask survey respondents to rate or describe their experiences on a fixed scale (Ferrer-i-Carbonell & Frijters, 2004; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004; Krueger & Schkade, 2008). A scale of 0 (low SWB) to 10 (high SWB) as an 11 point scale can increase the variation of responses as responses for overall SWB tended to be clustered around higher values (Hudson et al., 2017; van Praag & Ferrer-i-Carbonell, 2008).

The second methodological choice is to design the empirical model used to estimate the overall welfare impact of a flood. This study uses a similar approach to Hudson et al. (2017), to investigate the generalizability of both the methods and questions used in the Global South context. This cross-cultural comparison can aid in the further development of the studies linking SWB to disasters in order to gain a better understanding of the full range of disaster impacts.

The Hudson et al. (2017) approach is based on the mediation model framework presented in Heyes (2013) and the understanding of SWB and its connection to environmental problems as presented, originally, in van Praag, Frijters, and Ferrer-i-Carbonell (2003). In this framework proposed in van Praag et al. (2003) the potential influence of the flooding on SWB is decomposed overall SWB into 6 separate subjective well-being domains (SWBDs) each of which explain separate elements of overall well-being. The SWBDs are being satisfied with the following areas: their health, their home, their (living) environment, their free time and social life, their family life, and their finances (and work-life). These SWBDs selected are based on those successfully applied in previous studies as comprehensively covering many areas of life (Hudson et al., 2017; Socio-Economic Panel, S 2016; van Praag et al., 2003; van Praag & Ferrer-i-Carbonell, 2008). Moreover, these SWBDs summarize and aggregate many of the known factors correlating with overall SWB as summarized in Dolan, Peasgood, and White (2008). Therefore, these SWBDs are significant areas of life which explain overall SWB in addition to being linked with each other (van Praag et al., 2003). However, as flooding is potentially traumatic the flooding SWBD is tangentially related to all of the SWBDs as well as impacting SWB directly. Therefore, a flooding SWBD is constructed by including variables related to: flood experiences, adaptation and recovery potential, and flood risk worry. These variables generate the SWBD for a range of reasons. The first is that floods are negative life-events with a temporally changing impact. Secondly, flood risk worry is likely to lower SWB if flooding is an endemic risk. Finally, adaptation and recovery potential is included since potentially better prepared residents face a smaller flood burden.

Additionally, given the linkages between SWBDs a mediation style regression analysis is employed as the effects of flooding on overall welfare and through the separate SWBDs can be modelled, controlled for, and explored (Hudson et al., 2017; van Praag et al., 2003). The mediation style analysis could also be considered as taking a structural econometric approach, as the approach is guided by the theory of how the system of equations should be constructed (Reiss & Wolak, 2007), based on the previous (limited) available literature (Hudson et al., 2017; van Praag et al., 2003; van Praag & Ferrer-i-Carbonell, 2008).

The mediation style regression analysis is based on a seemingly-unrelated regression (SUR) analysis to model the overall and intervening relationships. Under this framework a set of equations are modelled for the direct effects of the flood risk sub-domain on overall SWB as well as indirect effects through the various SWBDs. A SUR model assumes that a set of regression equations can be modelled with correlated error terms (Wooldridge, 2012). This is appropriate as each set of equations are all related to each other as they are drawn from the same respondents. Therefore, a single shock to one SWBD can be transferred to the remaining SWBDs, which the SUR framework implies.

When designing SUR models, it is necessary to assess the potential for endogeneity to occur. Endogeneity problems manifest when there are important excluded variables. These excluded variables are problematic as they are correlated with both the explanatory and dependent variables. Excluded variables can cause inaccurate parameter estimates. Dolan et al. (2008) note several relationships that should be controlled for when modelling SWB. These variables are indirectly controlled for as they are key components of our SWBDs, resulting in endogeneity not representing a large concern overall (Hudson et al., 2017). For example Dolan et al. (2008) notes the importance of relative income which can be considered part of the financial SWBD when a respondent evaluates their satisfaction in this area. An additional example from Dolan et al. (2008) is the health status of the respondent which we include as a direct SWBD. Therefore, using the SWBDs as the main control variables aggregates many of the relevant socio-economic variables known to have a strong relationship with SWB.

In eq. (1), this set of equations is presented where the overall SWB for individual i is a function of the individual SWBD for individual i and SWBD j; the flood risk domain variables [$FR(.)_i$], which consists of the set of risk perception variables, flood impacts, and time elapsed since the last flood; and an error term (ϵ_i or $\varepsilon_{j,i}$), where $COV(\epsilon_i, \boldsymbol{\varepsilon}) \neq 0$; while α and θ values represent parameters that are to be estimated.

$$\text{eq} = \begin{cases} \text{SWB}_i = \alpha_0 + \sum_1^6 \alpha_j^1 \text{SWBD}_{i,j} + \text{FR}(.)_i \boldsymbol{\theta} + \epsilon_i \\ \text{SWBD}_{i,1} = \overline{\gamma_{0,1}} + \text{FR}(.)_i \overline{\boldsymbol{\theta}_1} + \varepsilon_{1,i} \\ \vdots \\ \text{SWBD}_{i,6} = \overline{\gamma_{0,6}} + \text{FR}(.)_i \overline{\boldsymbol{\theta}_6} + \varepsilon_{6,i} \end{cases} \quad (1)$$

Once eq. (1) has been estimated, the direct (α_j^1) and indirect ($\alpha_j^1 \overline{\theta_{x,j}}$) effects are combined to produce the total effect on SWB (Ψ_x) as shown in eq. (2).

$$\Psi_x = \alpha_x + \sum_{j=1}^{j=6} \alpha_j^1 \overline{\theta_{x,j}} \quad (2)$$

We also further developed the study of the temporal aspects of SWB recovery from experiencing a flood. The temporal dimension is captured via a threshold model. In a threshold model, the estimated parameters can be understood following eq. (3). In eq. (3), the new terms are as follows: *E(.)* is the expectations operator and *T* represents the specific time variables which take values of 1 or 0.

$$\Delta = \begin{cases} E(\text{SWB}|T_{t<1} = 0,\, T_{t<5} = 0,\, T_{t<10} = 0,\, T_{t>10} = 0) = \alpha_0 \\ E(\text{SWB}|T_{t<1} = 1,\, T_{t<5} = 0,\, T_{t<10} = 0,\, T_{t>10} = 0) = \alpha_0 + \Psi_1 \\ E(\text{SWB}|T_{t<1} = 1,\, T_{t<5} = 1,\, T_{t<10} = 0,\, T_{t>10} = 0) = \alpha_0 + \Psi_1 + \Psi_2 \\ E(\text{SWB}|T_{t<1} = 1,\, T_{t<5} = 1,\, T_{t<10} = 1,\, T_{t>10} = 0) = \alpha_0 + \Psi_1 + \Psi_2 + \Psi_3 \\ E(\text{SWB}|T_{t<1} = 1,\, T_{t<5} = 1,\, T_{t<10} = 1,\, T_{t>10} = 1) = \alpha_0 + \Psi_1 + \Psi_2 + \Psi_3 + \Psi_4 \end{cases} \quad (3)$$

Therefore, each coefficient represents the change in SWB due to moving to a later time period as compared to the previous period. For instance, the estimated value of Ψ_1 can be understood as the loss in welfare due to experiencing a flood, while Ψ_2 represents the change in SWB due to the flood event going from being within the last year to being within the last 2–5 years. It is expected that the values shrink as the effects diminish over time.

A limitation of this methodological approach could be perceived to be the absence of link between the hydrological intensity (e.g. via return periods), as it could be expected that more objectively intense flood events generate larger well-being impacts. However, this limitation is mitigated in two ways. The first by using the *range of flood impacts experienced* as a proxy measurement of the intensity of previous flood experiences. The second is the focus of this paper on subjectively perceived impacts which lessons the need for objective flood impacts. This choice to focus on subjective impacts is also driven by potential measurement error in the recording of a flood's hydrological nature for example. Further research and systematic data recording can help to further establish the connection between objective flood indicators, and how this can be integrated into flood risk modelling (Table 1).

2.2.2. Temporal Conversion of flood impacts on SWB into monetary values

There are several studies using SWB to value the negative or positive welfare impacts of a range of tangible and intangible experiences such as terrorism, marriage, and social connections (Blanchflower & Oswald, 2004; Frey et al., 2009; Lucas, 2007; Powdthavee & van den Bergh, 2011). This valuation is done by finding an equivalent value of money that *compensates* for the change in SWB. This is achieved by linking the total effect on SWB to the relationship between income and SWB. Understanding this relationship provides a monetary or compensating value (CV), which equates SWB before and after a change in one of the variables (Clark & Oswald, 2002) compensating an individual's welfare loss.

Through this monetization process, we can gain a better understanding of the full range of flood impacts that would not otherwise be captured if purely physical impacts where focused upon. Moreover, this can be shown through a value that is commonly understood by a range of stakeholders. For example, flood risk management activities are often guided by monetary cost-benefits studies (Mechler et al., 2014), which require tangible monetary values.

Table 1. Summary of variables included in this study.

Variable name	Variable description	Variable descriptive statistics
Overall SWB	A variable indicating the respondents overall SWB reported on a scale of 0–10, where higher values report a higher level of SWB.	Mean = 7 Min = 1 Max = 10
Subjective well-being domains		
Satisfied with the health SWBD	A dummy variable taking a value of 1 if the respondent is satisfied with the health SWBD, and 0 otherwise.	Mean = 0.67
Satisfied with the home SWBD	A dummy variable taking a value of 1 if the respondent is satisfied with the home SWBD, and 0 otherwise.	Mean = 0.82
Satisfied with the environment SWBD	A dummy variable taking a value of 1 if the respondent is satisfied with the environment SWBD, and 0 otherwise.	Mean = 0.85
Satisfied with the financial SWBD	A dummy variable taking a value of 1 if the respondent is satisfied with the financial SWBD and 0 otherwise.	Mean = 0.34
Satisfied with the free time and social life SWBD	A dummy variable taking a value of 1 if the respondent is satisfied with the free time and social life SWBD, and 0 otherwise.	Mean = 0.69
Satisfied with the family SWBD	A dummy variable taking a value of 1 if the respondent is satisfied with the family SWBD, and 0 otherwise.	Mean = 0.82
Flood risk domain		
Range of flood impacts experienced	A variable taking values between 0 and 3, where higher values indicate that the respondent has suffered a wider range of flood impacts. The range of potential impacts are property damage, physical injury, and psychological harm	Mean = 0.88 Min = 0 Max = 3
The respondent worries about flooding	A dummy variable taking a value of 1 if the respondent worries about flooding, and 0 otherwise.	Mean = 0.61
Importance and quality of the local ecosystem based adaptation mechanism	A continuous variable taking values between 0 and 10. The value of the index is produced by taking the average of the self-stated importance of the various aspects of the ecosystem-based adaption mechanism, the current quality of the ecosystem measure, and the potential improvement.	Mean = 6.2 Min = 1.75 Max = 9.83
There is nothing that can be done to prevent, or limit the damage, that floods cause	A dummy variable taking a value of 1 if the respondent agreed with the statement and 0 otherwise.	Mean = 0.46
Experienced a flood within the last year	A dummy variable taking the value of 1 if the respondent has been flooded before, and 0 otherwise	Mean = 0.9
Experienced a flood within the last five years	A dummy variable taking the value of 1 if the respondent has been flooded before and has occurred within 5 years, and 0 otherwise	Mean = 0.68
Experienced a flood within the last 10 years	A dummy variable taking the value of 1 if the respondent has been flooded before, and it has occurred within 10 years, and 0 otherwise	Mean = 0.43
Experienced a flood over 10 years ago	A dummy variable taking the value of 1 if the respondent has been flooded before and it has occurred over 10 years ago, and 0 otherwise	Mean = 0.26

The CV is calculated via the ratio of the marginal total effect of the variable (Ψ_x) to the marginal effect of income on SWB. This is shown in eq. (4), assuming a logarithmic relationship between SWB and income (Hudson et al., 2017; Sekulova & van den Bergh, 2016). A logarithmic relationship is assumed, following previous studies, due to the law of diminishing marginal utility, which implies that an additional dollar is worth less to an individual with an income of 10,000 USD than to one with 1,000 USD (Mas-Colell, 1995). Therefore, the relationship between income and SWB is assumed to follow a semi-elasticity relationship. This implies that the CV is approximately equal to the percentage change in income required to offset the change in welfare.

$$CV_x = \frac{\partial \ln(\text{Income})}{\partial \text{SWB}x} = \frac{\Psi_x}{\lambda_{\text{income}}} \text{ Income} \tag{4}$$

The value λ_{income} cannot be reliably estimated from within the sample due to the use of the SWBDs to control for the potential endogeneity of results as much as possible meaning that the influence of income on SWB was controlled for. Moreover, the relationship between income and SWB is complex, and therefore specifically-designed studies are needed to establish a reliable correlation between income and SWB. Therefore, we extract this value from wider literature on this topic. Hudson et al. (2017) used a meta-analysis of studies from across Europe to report a value of 0.21 for the correlation between SWB and income. However this value is not necessarily directly applicable to Vietnam. However, to the best of our knowledge there is not a suitable base of studies regarding Vietnam. A further relevant study is Reyes-García et al. (2016), while they do not focus specifically on Vietnam they do produce results for Asia indicating a correlation of 0.44 across their range of estimates. Moreover, we present a value of 0.3 to complement these values, based on our judgment. This produces a range of values until further research can produce a robust value for the linkage between SWB and income in Vietnam (Figure 2).

3. Results

3.1. Estimation results

Table 2 shows the results of the mediation style analysis regarding the estimated total effects for each parameter for the various sub-samples. The results for the male sub-sample are displayed in Model 1, the female sub-sample in Model 2, and the combined sample in Model 3.

The total effects of the SWBDs on the overall SWB are displayed in Panel A of Table 2. The SWBDs act in the expected directions (i.e. a positive relationship) and are for the most part highly statistically significant. The only exception is the variable associated with a respondent's satisfaction with their

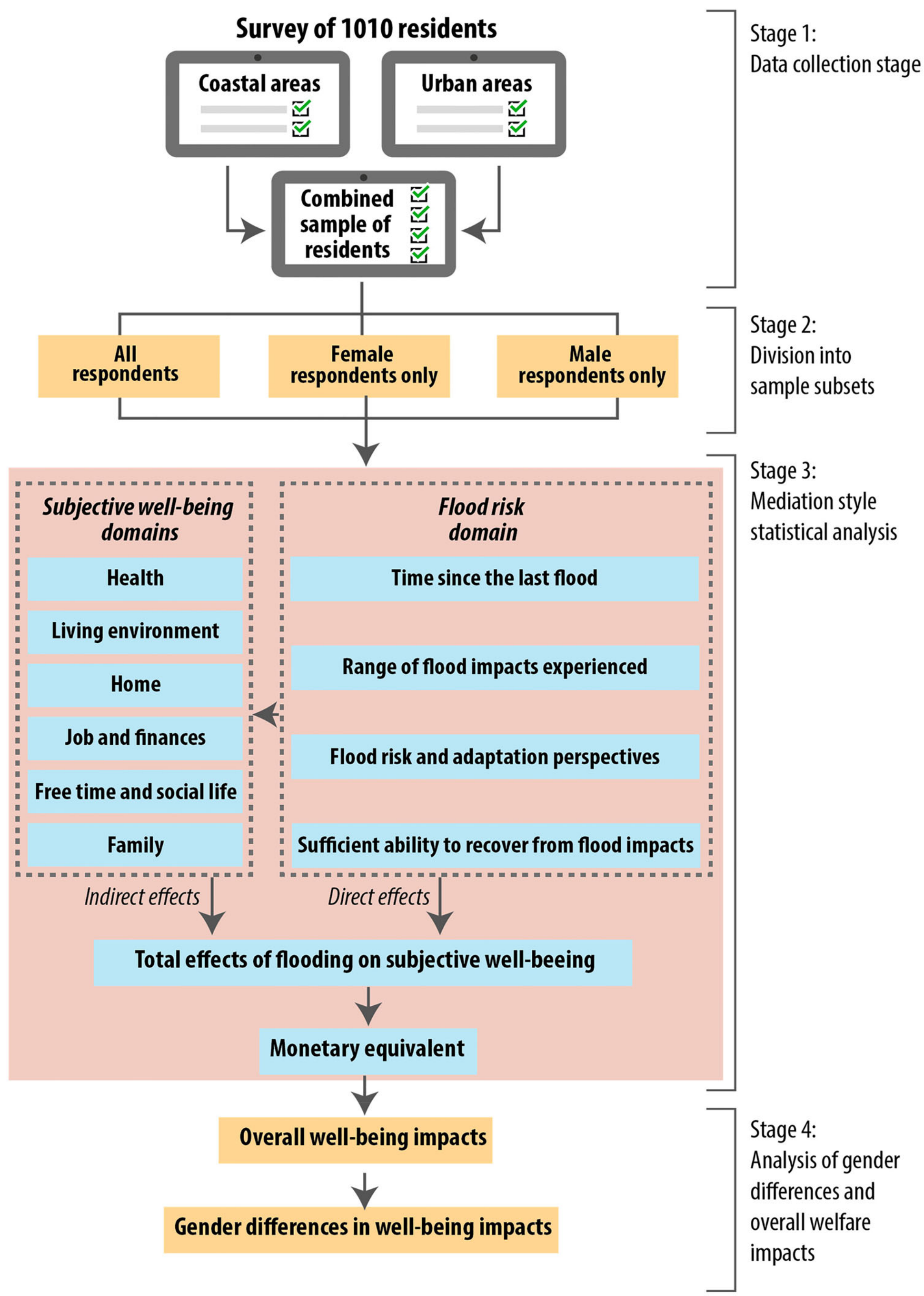

Figure 2. Flowchart describing the research methodology.

living environment. This could be due to the inclusion of other SWBDs that capture overlapping elements the SWBDs.

Panel B of Table 2 indicates the flood risk domain effects on overall SWB. The overall impacts act in the directions expected. There is a large initial drop in SWB in the immediate aftermath of a flood with a later recovery in SWB, while the absolute size of later coefficients is smaller. This result is expected, given that the longer the period is since the flood occurred, the smaller the impact on current SWB is expected to be. This is due to a degree of automatic welfare recovery taking place.

A relevant finding is that ecosystem-based adaptation measures and the various co-benefits they provide have a significant positive impact on SWB of both men and women. These benefits could offset the SWB loss from flooding if the local ecosystems are repaired or are further developed after a flood event.

3.2. Methods Conversion into monetary values

The survey sample has a mean (median) annual household income of roughly 4000 (3400) USD. The average working individual has income of around 1600 USD for the overall and male sub-sample, while the female sub-sample value is around 1400 USD.

In order to estimate the total CV, these values for the total effect are estimated across genders using the appropriate total effect value and income level. For example, the results for

Table 2. The estimated total effects of the subjective well-being domains on overall subjective well-being.

Independent variable Overall subjective well-being	(1) All observations	(2) Male observations only	(3) Female observations only
Panel A: Total effects of the subjective well-being domain			
Satisfied with the health SWBD	0.38*** (0.13)	0.42** (0.17)	0.36* (0.22)
Satisfied with the environment SWBD	0.18 (0.17)	0.18 (0.22)	0.13 (0.27)
Satisfied with the home SWBD	0.98*** (0.16)	0.96*** (0.22)	1.08*** (0.25)
Satisfied with the financial SWBD	0.56*** (0.13)	0.47*** (0.17)	0.68*** (0.19)
Satisfied with the free time and social life SWBD	0.55*** (0.14)	0.54*** (0.19)	0.51** (0.22)
Satisfied with the family SWBD	0.49*** (0.17)	0.52** (0.23)	0.46 (0.29)
Panel B: Total effects of the flood risk domain			
Experienced a flood within the last year	−0.58*** (0.22)	−0.58* (0.3)	−0.62* (0.35)
Experienced a flood within the last five years	0.45*** (0.16)	0.46** (0.12)	0.44* (0.24)
Experienced a flood within the last 10 years	−0.19 (0.15)	−0.2 (0.20)	−0.19 (0.23)
Experienced a flood over 10 years ago	−0.04 (0.19)	−0.08 (0.26)	−0.04 (0.31)
There is nothing that can be done to prevent, or limit the damage, that floods cause	−0.05** (0.02)	−0.03 (0.03)	−0.07* (0.04)
Importance and quality of the local ecosystem services	0.31*** (0.04)	0.28*** (0.06)	0.32*** (0.06)
There is sufficient help available to recover from flooding	0.1*** (0.03)	0.05 (0.04)	0.17*** (0.05)
The respondent worries about future flood impacts and occurrences	0.03 (0.03)	0.02 (0.04)	0.05 (0.05)
Range of flood impacts experienced	−0.25*** (0.1)	−0.19 (0.14)	−0.33** (0.14)
Observations	747	397	350

Note: Standard errors (shown in parentheses) are calculated via bootstrapping with 2000 replications.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ represent statistical significance.

Model 1 are combined with the income for the entire sample; while Model 2 results are combined with the income for the male sub-sample.

The CVs are presented in Table 3 to indicate the total welfare impact of the variables. The values generated by the SWB approach are generally in line with the long-run compensation needed to offset welfare losses from major life events, such as deaths of a family member or other traumatic experiences (Hudson et al., 2017). Positive values indicate an overall increase in welfare, while negative values indicate a reduction in welfare. Our findings show that the initial drop in SWB immediately after a flood event is equivalent to a value between 1,900 and 4,400 USD using individual income, a substantial welfare impact. While a recovery of SWB occurs over time, we find that even for 5 years after the flood, the welfare impact could equal a loss that is the equivalent of 480–1,000 USD, given a degree of uncertainty in the precise value, across genders. The overall welfare losses are larger for women after this period of time by about 160–320 USD (which corresponds to 11% to 23% of the average female income) as compared to the value for males. This indicates a gender-gap in overall SWB recovery. This is further supported by our findings that the range of experienced flood impacts also has a larger effect on the SWB of women as compared to men.

3.3. Sensitivity

A version of the model was also estimated with probability weights to correct for the urban/coastal divide which slightly deviated from the overall pattern within Thua Tien Hue, this is shown in Appendix 1 table A1 columns 1 and 2. In doing so we find the main consequences being driven from female sub-sample whereby the temporal pattern for the flood experiences remains similar, though the coefficient for Experienced a flood over 10 years ago takes a value of 0.03 and the value for Experienced a flood within 10 years grows to −0.22. The strongest difference occurs for the importance of ecosystems, help, and the range of flood experiences suffered. The point estimate for these values shrinks by about 30% on average. However, the qualitative implication of this change in point estimates is that having access to sufficient help in the wake of flooding is still more important to women than men, while the impact of the range of flood experiences on SWB is now only 25% for women as compared to men. The interpretation of these impacts remains constant. The most noticeable difference regards the importance of EbA is that it now appears to be more important for men as compared to women. This may because we now increase the importance of individuals living in urban areas where the tangible benefits of EbA may be lower.

Additionally, we explore the potential for standard errors to be clustered around specific groups. The unit of clustering considered is the coastal/urban divide. The pattern of significance only displays one significant change in the results presented in Table 2, which is that, the variable '*Experienced a flood within the last 10 years*' becomes statistically significant at (least) the 10% level across the estimated regressions. This is likely due to the importance of the 2009 flood, as noted in Section 4.2.1. This change is slight and doesn't impact the findings outside what has been discussed.

An additional source of sensitivity originates from our focus on gender differences. Our sampling approach did not explicitly set out to capture a predetermined quota of male and female respondents. This limited the sophistication of the analysis that could be conducted, in order to maintain a sufficient degree of statistical power to identify effects. However, due to the focus on generating a random sample of the residents in the two case study areas some systematic biases have been avoided (as can be indicated by the overall representativeness of the sample of the overall province).

4. Discussion

This section presents the implications of Table 3. However, it should be noted when understanding the estimated CVs that there is a degree of uncertainty in the precise value for the correlation between income and SWB, and the parameter estimate itself. This uncertainty therefore can produce overlapping confidence intervals for the various estimates. This uncertainty

Table 3. The potential range of the monetary equivalent for the subjective well-being impacts in USD.

Variables	Sample sub-set	Monetary equivalent (% of annual income)			Monetary equivalent (in $)		
		Correlation between income and SWB					
		0.44	0.3	0.21	0.44	0.3	0.21
Experienced a flood within the last year	All respondents	−132	−193	−276	−2100	−3100	−4400
	Only male respondents	−132	−193	−276	−2100	−3100	−440
	Only female respondents	−141	−207	−295	−1900	−2800	−4000
Experienced a flood within the last five years	All respondents	−30	−43	−62	−480	−720	−1000
	Only male respondents	−27	−40	−57	−420	−640	−880
	Only female respondents	−41	−60	−86	−580	−840	−1200
Range of flood impacts experienced	All respondents	−57	−83	−119	−910	−1400	−1900
	Only male respondents	*−43*	*−63*	*−90*	*−720*	*−1000*	*−1500*
	Only female respondents	−75	−110	−157	−1100	−1500	−2200
There is nothing that can be done to prevent, or limit the damage, that floods cause.	All respondents	−11	−17	−24	−190	−280	−400
	Only male respondents	*−7*	*−10*	*−14*	*−120*	*−160*	*−240*
	Only female respondents	−16	−23	−33	−210	−320	−440
Importance and quality of the local ecosystem based adaptation mechanism	All respondents	70	103	148	1100	1600	2300
	Only male respondents	64	93	133	1000	1500	2100
	Only female respondents	73	107	152	960	1400	2000
There is sufficient help available to recover from flooding	All respondents	23	33	48	370	520	760
	Only male respondents	*11*	*17*	*24*	*190*	*280*	*400*
	Only female respondents	39	57	81	530	760	1100

Notes: All values are in US dollars; the values in italics are qualitative values for otherwise statistically insignificant variables. Negative values correspond to a welfare loss, while positive values correspond to a welfare increase.

is especially prominent for the sub-sample estimates due to their smaller sample sizes. For this reason, rather than focusing solely on the potential statistical significance of estimated values, we also present a qualitative comparison of estimated values, since focusing on p-values is not always sufficient for understanding results (Altman & Krzywinski, 2017; Wasserstein & Lazar, 2016).[2] Thus, both a qualitative and quantitative analysis is required in order to provide future research focuses. However, the results for the overall model are the most robust due to its large sample size. The two sub-sample models should be treated with more caution but can provide a useful starting point for future research in this emerging research field.

4.1. Gender differences in the SWB impacts of the flood risk domain

4.1.1. Temporal differences in well-being recovery

In comparing the results of Table 2 qualitatively, we can highlight potential gender differences in the welfare impacts of the flood risk domain on overall SWB.

The threshold parameters in Panel B of Table 2 highlight how welfare recovers after experiencing a flood as compared to those who have never experienced a flood. These results imply that for both men and women, the experience of being flooded is associated with a loss in well-being of about 0.5 SWB levels. Overall, it appears that there is a degree of recovery, as it can be seen that between 2 and 5 years after the flood, the loss in welfare has recovered by 77% (i.e. the ratio of the monetized compensation associated with being flooded within the last 2–5 years to that of being flooded within the last year). After this time, the loss in welfare remains static as the two remaining parameters imply limited changes in welfare. This can be seen with the variable *experienced a flood over 10 years ago* as the estimate is close to 0. However, the variable *experienced a flood within the last 10 years* is quite negative, although it is considered insignificant at the normal levels. This is likely because of a cluster of respondents reporting their worst flood experience in 2009. The long-term impacts of experiencing the 2009 flood event is believed to be captured through the *range of flood impacts experienced* variable instead. However, including these parameters in these estimate of recovery has lowered the degree of recovery to 35%, which still indicates a lower level of long-run SWB; it should be noted that the estimate is less than or equal to 0 at the 5% significance level. When taken together, these results imply that while there is a welfare recovery, there remains a significant loss in long-run welfare. In a qualitative sense, the long-run CV is 62% of annual income.

By comparing Model 2 and Model 3 qualitatively, an additional nuance is added. Female respondents appear to suffer a slightly larger initial loss in welfare when compared to the male only sub-sample. However, both male and female respondents have similar parameter estimates in terms of their recovery. This results in an overall slower recovery from flooding, as it was found that around 2–5 years after the flood, male respondents were associated with a recovery of about 80% while female respondents were associated with a recovery of about 70%. Overall, this indicates a stronger impact on women as compared to men over the long-term due to a less complete long-run recovery. This is in part explained by the tasks completed by men and women after a disaster, and these tasks are found to be gendered and longer lasting for women (CSRD, 2015). Women are traditionally responsible for the sick, elderly, and children during and after a flood and for securing local livelihoods, which are often directly affected by floods. This poses a high flood-related work burden on women. However, further findings with a larger sample of men and women will be required to further explore and refine this finding in additional contexts. In a qualitative sense, the long-run SWB impact is associated with a CV that is between 27% and 57% of the respondent's annual income for males and 60% to 86% for females.

The lower recovery status of women as compared to men could be also partially caused by a tendency in the respondents to respond in line with societal norms and beliefs (Hebert et al., 1997). Since recovering reflects strength and an ability to take care of one's own problems – which are typical masculine stereotypes – men might overrate their recovery (Sigmon et al., 2005). This impact should be limited due to our indirect connection of SWB recovery and the flood risk domain.

4.1.2. Flood risk perceptions and impacts

The flood impacts index captures the respondents overall flood impacts that they have experienced across their lives and for members of their households. This variable is negative for both female and male respondents. However, the parameter is nearly 70% larger (in absolute size) for female respondents, indicating a greater subjective impact for them than for male respondents. This matches the finding regarding the initial impact of flooding on SWB; moreover, it highlights the potential long-lasting impacts of experiencing floods.

Out of the direct flood risk perception variables, the one with the strongest impact is that the respondent feels they are incapable of limiting or preventing the damage that floods can inflict. However, this is only the case for female respondents. This can be taken to imply a lower sense of autonomy over future flood risk adaptation. Moreover, the English wording of this variable is very similar to how self-efficacy has been operationalized in previous studies, such as the study by Babcicky and Seebauer (2017) when reverse coded. Self-efficacy forms a key element of the protection motivation theory, which is a commonly presented theory of flood risk adaptation (Bubeck, Botzen, & Aerts, 2012). Self-efficacy can be defined as an individual's subjective perception of their ability to limit negative impacts. Therefore, it is possible that a lower perceived self-efficacy is not only associated with a lower probability of undertaking protective action (Bubeck et al., 2012) but also a lower level of SWB.

Additionally, male and female respondents benefit from increasing both the quality and importance of the relevant ecosystem-based adaptation measure in their respective communities. This occurs because these measures are capable of reducing some flood impacts and bringing a range of more inclusive benefits. For example, mangroves could provide greater fish stocks and tourism providing income, while urban waterways can lower pluvial flood risk and provide additional recreational activities. In terms of gender impacts, this is particularly important for the women in our sample, who tended to rely more on the benefits provided by the ecosystem measures as compared to the male respondents.

4.1.3. Recovery assistance and adaptation

A key component of the post-flood recovery process is the respondent's access to sufficient help in recovering after a flood. The results for the whole sample indicate the expected positive correlation; in that those who believe they have greater access to recovery help tend to have a higher level of SWB. However, this masks the gender difference in the impact on overall SWB. This is because when estimated for the male only sub-sample, it is a statistically insignificant variable, while for the female only sub-sample the estimate is highly statistically significant. Moreover, the female parameter estimate is around 3 times larger than the male parameter estimate. Therefore, it appears that having suitable and equitable support networks in place before a flood occurs may have a larger benefit on the well-being of women as compared to men.

4.1.4. The cyclical nature of flooding

The qualitative and quantitative results produced by comparing the three models in Table 2 highlight the presence of an incomplete SWB recovery for both genders. It is seen that after the variable indicating a gap of 2–5 years compared to the last flood, none of the remaining two threshold variables indicate a change in welfare. This result indicates a possible incomplete recovery in welfare as compared to before the flood. This is potentially problematic in flood-prone regions across the world as if floods happen relatively frequently, this produces in a downward spiral of SWB.

However, a downward spiral in SWB would only be in the case where all the well-being factors in Table 2 are held constant across floods. It is possible to close the long-run gap in well-being left by an incomplete recovery of the residents in flood-prone areas is by developing suitable recovery networks, and engendering a sense of autonomy over their flood risk adaptation decisions can close the well-being gap left behind by flooding. Additionally, developing and improving local ecosystems both promote adaptation to flood risk and improve the ecosystem services provided so that the well-being of the community is improved.

These findings show that sustained and long-run mechanisms should be placed in flood-prone communities that the recovery process of those affected can be supported, thereby increasing flood resilience. The mechanisms in place need to be sustained as the benefits of such activities will likely be important for increasing well-being in the several years after a major flood has occurred. The reason for this can be explained using qualitative information from local residents; this information shows that long-term mechanisms aimed at promoting flood recovery were more successful in promoting flood resilience than short-term mechanisms (Bubeck et al., 2018).

4.2. Cross-cultural comparison

Previous studies on the effect of floods on SWB are limited to industrialized countries. Comparing our results from Vietnam with the existing literature thus allows us to provide a first indication of whether findings can be transferred across very different risk, socio-economic, and cultural contexts. Hudson et al. (2017) provided the initial source of comparison for the current study. They looked at a set of respondents in France across three regions which differed in terms of flood risk and experiences. However, compared to Thua Thien Hue province, flooding in these areas occurs rather infrequently. Additionally, Hudson et al. (2017) did not examine the potential gender differences in overall SWB impacts but only SWB impacts overall. Hence, the most applicable source of comparison to Hudson et al. (2017) is Model 3 in Table 2 of this current paper.

Hudson et al. (2017) found that the immediate impacts of a flood were associated with a SWB loss of 1.25 and falling to 0.51 one year after the flood. When looking at the overall sample results presented in the current study, we find an immediate drop in SWB of a 0.58-SWB level when a flood is experienced, which falls by 77% within 2–5 years afterwards (i.e. the ratio of the monetized compensation associated with being flooded within the last 2–5 year to that of being flooded within the last year for the overall sample results). Therefore, these flood impacts may be long-lasting. Compared to the study by Hudson et al. (2017) with French respondents, we find an initial impact that is 53% smaller and falls by roughly 77% rather than 60%. This difference can correspond to the fact that the residents of Thua Thien Hue province in Vietnam are more often flooded than the French respondents, and hence there is a greater degree of adaptation to the overall SWB impacts of flooding. Additionally, Hudson et al. (2017) also found that that suitable flood risk adaptation can off-set the negative well-being impacts from the flood risk domain, which is in line with the finding in Vietnam regarding ecosystem-based adaptation measures.

An additional comparison is Sekulova and van den Bergh (2016), who examined the welfare impacts of flooding on respondents in Bulgaria using a series of linear regressions. In their work, Sekulova and van den Bergh (2016) used a similar scale to measure SWB. However, their scale is measured from 1 (*low*) to 10 (*high*). Sekulova and van den Bergh (2016) found a welfare drop of 0.9 from experiencing a flood, which is larger than the value found in the current study and smaller than that which was found in Hudson et al. (2017). However, flooding in Bulgaria is more common than the areas of France studied.[3] Additionally, Sekulova and van den Bergh (2016) found that respondents who suffered heavy or severe flood impacts suffered a loss in SWB of between 0.93 and 1.53 SWB levels. In the current study, the individuals experiencing the full range of flood impacts suffered a SWB loss of 0.75 SWB levels, which lies just below the values estimated in Sekulova and van den Bergh (2016). Additionally, they find CV values that are ∼100% of annual income for experiencing floods which is of a similar magnitude to our study. These differences are not surprising because we noted the lower SWB impacts in Bulgaria as compared to France, as well as lower estimates regarding Vietnam.

While we can only actively compare the well-being findings of this paper to two European countries, due to the scarce literature on the topic, the comparison shows a relatively high level of agreement despite the very different study/survey contexts in the pattern that is produced. From a comparison of the results of Sekulova and van den Bergh (2016), Hudson et al. (2017) and the current paper, an emergent pattern appears to be that the more frequent a flood event can be expected, it is possible that the intangible impacts of the flood will be smaller, resulting in a greater focus on the tangible impacts as the main driver of overall flood losses. This is because the results from Vietnam have the smallest SWB impacts, while France has the largest (i.e. growing with the flood frequency). Therefore, it appears that the SWB approach can be used across the globe, as in each of the tree cases the welfare losses are large with a constant pattern based on expected flood occurrence.

4.3. Implications for flood risk and climate change adaptation

The results of this paper demonstrate that the intangible impact of floods can be substantial and long-lasting, which means that the overall SWB impacts of floods need to be better addressed in recovery efforts, such as by providing psychological assistance. Currently recovery efforts often focus on the reconstruction of tangible flood losses. For instance, the intangible impacts estimated by Vu and Ranzi (2017), as noted in the introduction, could be associated with an additional monetary risk of US$10,000. This corresponds to 15.5 times the average annual household income. This value excludes the intangible impacts of the monetary estimates provided by Vu and Ranzi. Unfortunately due to our focus on subjective impacts we were unable to disentangle how much of the subjective impact was due to a tangible monetary loss.

The overall SWB impact of a flood is substantial across cultural contexts, further supports the call for better accounting in flood risk assessments. These assessments should inform disaster-risk management and climate change adaptation strategies so that more inclusive and appropriate strategies can be produced due to the gender-gap in flood resilience.

Therefore, the first policy implication is that safety nets should be put in place with a focus on meeting the needs and requirements of women in the communities at risk of flooding. A tangible policy example can be seen through increasing the active collaboration of women's advocacy and support groups with those who actively manage natural disaster risks. For instance, in Vietnam attempts can be made by actively involving local women's Unions in the decision making and particular aspects of flood risk management to create a more gender inclusive disaster-risk management process, as also called for by the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015) and the Sustainable Development Goals 5 (UN, 2018). Therefore, community adaptation strategies should be further developed.

A second policy implication is that for both men and women the local ecosystem-based adaptation measures can play a role in limiting the long-term welfare impacts of experiencing a flood. Therefore, a greater role for ecosystem-based adaptation measures can be promoted as a risk management tool that can increase overall resilience due to the various ecosystem services provided. Given that these measures provide co-benefits which are important for the livelihood of women (Hagedoorn et al., 2018), the measures can be considered a promising means for strengthening the role of women in disaster-risk reduction and climate change adaptation. Moreover, this policy implication can be combined with wider findings, as a way of offsetting welfare losses from their flood experiences.

5. Conclusion

The research presented in this paper follows on the research recommendations made in many recent studies to acquire a better understanding of the full range of flood impacts so that more suitable policy and recovery instruments can be developed. Therefore, this paper developed the following objectives: (a) to investigate the potential differences between the SWB impacts of flooding on men and woman; (b) to conduct an analysis of the SWB impacts of flooding in a non-European cultural context in order to further establish the degree to which previous findings and methods can be generalized across the globe by using a very different flooding context.

Overall, we find there is a roughly equal drop in SWB due to experiencing a flood between men and women, which is more strongly seen when the SWB loss is monetized. Additionally, we note that women are associated with a slower recovery as compared to men – namely 13% lower SWB 5 years after a flood as compared to men. This is in part explained by the tasks completed by men and women after a disaster, which are gendered and last longer for women. This gap is most strongly displayed in the monetized welfare impacts, where the CV for women who have experienced a flood over 5 years ago is 36% larger. Overall, this finding can be taken to indicate that women are more heavily affected by floods than men are.

Additionally, we find that creating a sense of autonomy over adaptation projects – and the extent of such projects – can offset the long-run welfare losses due to flooding. Finally, when the results of this study are compared to previous studies conducted in Europe, we values for the loss in welfare that fall in line with the pattern of previous studies. Therefore, these SWB impacts and approaches may be fairly generalizable across the world.

The results of this paper demonstrate that the intangible impact of floods can be substantial and long-lasting, which means that the overall SWB impacts of floods need to be better addressed in recovery and risk management efforts, such as by providing psychological assistance. Currently recovery efforts often focus on the reconstruction of tangible flood losses. Our results support the call to better account for intangible impacts in flood risk assessments. The assessments that inform disaster-risk management and climate change adaptation strategies can be made more inclusive and socially appropriate strategies can be produced to address the overall gender-gap in flood resilience.

In this paper we provided an initial comparison of the impact of flood on SWB across very different contexts (i.e. hazard profile, culture, and socio-economics). More studies are needed to confirm our initial findings – especially studies in other developing countries and emerging economies where the majority of flood-affected people live – so that results seem comparable. An example of future research can be more systematically comparing the different experiences in rural and urban areas. Moreover, a greater understanding of the link between SWB and income is needed, especially in Asia.

Notes

1. Link: https://bit.ly/2AZJz0f.
2. In particular the American Statistical Association statements 3, 5, and 6 are especially relevant.
3. As a proxy measured via flood protection infrastructure estimates as reported in Scussolini et al. (2016).

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The authors acknowledge funding received from the Global Resilience Partnership (GRP) through the Water Window project's ResilNam Coastal and ResilNam Urban as funded by the Z Zurich Foundation. The funder had no direct input on the research conducted or the ability to publish the paper.

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Appendix

Table A1. The estimated total effects of the subjective well-being domains on overall subjective well-being under probability weighting and clustered standard errors.

Independent variable	The use of probability weights		(3) The use of clustered standard errors	
Overall subjective well-being	Male observations only	Female observations only	Male observations only	Female observations only
Panel A: Total effects of the subjective well-being domain				
Satisfied with the health SWBD	0.42** (0.17)	0.36** (0.15)	0.42*** (0.04)	0.36** (0.15)
Satisfied with the environment SWBD	0.18 (0.22)	0.13*** (0.04)	0.18 (0.21)	0.13*** (0.04)
Satisfied with the home SWBD	0.96*** (0.22)	1.08*** (0.32)	0.96*** (0.2)	1.08*** (0.32)
Satisfied with the financial SWBD	0.47*** (0.17)	0.68*** (0.07)	0.47*** (0.003)	0.68*** (0.07)
Satisfied with the free time and social life SWBD	0.54*** (0.19)	0.51*** (0.18)	0.54*** (0.04)	0.51*** (0.18)
Satisfied with the family SWBD	0.52** (0.23)	0.46** (0.2)	0.52*** (0.16)	0.46** (0.2)
Panel B: Total effects of the flood risk domain				
Experienced a flood within the last year	−0.58* (0.3)	−0.62* (0.35)	−0.58*** (0.17)	−0.62** (0.26)
Experienced a flood within the last five years	0.46** (0.12)	0.44* (0.24)	0.46** (0.19)	0.44*** (0.10)
Experienced a flood within the last 10 years	−0.2 (0.20)	−0.22 (0.23)	−0.2** (0.09)	−0.19*** (0.07)
Experienced a flood over 10 years ago	−0.07 (0.26)	0.03 (0.31)	−0.08 (0.36)	−0.04 (0.23)
There is nothing that can be done to prevent, or limit the damage, that floods cause	−0.03 (0.03)	−0.07* (0.04)	−0.03*** (0.01)	−0.07*** (0.003)
Importance and quality of the local ecosystem services	0.28*** (0.06)	0.22*** (0.06)	0.28*** (0.08)	0.32*** (0.09)
There is sufficient help available to recover from flooding	0.04 (0.04)	0.12** (0.05)	0.05 (0.04)	0.17*** (0.04)
The respondent worries about future flood impacts and occurrences	0.02 (0.04)	0.05 (0.05)	0.02 (0.03)	0.05 (0.04)
Range of flood impacts experienced	−0.19 (0.14)	−0.24* (0.14)	−0.19 (0.20)	−0.33** (0.13)
Observations	397	350	397	350

Note: Standard errors (shown in parentheses) are calculated via bootstrapping with 2000 replications.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$ represent statistical significance.