A multidimensional framework for disaster recovery: Longitudinal qualitative evidence from Puerto Rican households

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ABSTRACT

Research on household disaster recovery has principally applied quantitative methods to explain, in a correlative way, the speeds at which households recover. Yet there are limited explanatory models of household recovery. This study adopts a qualitative, longitudinal methodology to develop a model of how and why household recovery pathways and speeds are heterogenous. Data was collected over five field visits to Puerto Rico during the first year after Hurricane Maria in 2017. Households mobilise their agency to leverage their assets and recovery priorities to mitigate and/or adapt to four major societal conditions (disaster support; public services; markets; employment and public financial assistance). These societal conditions and household characteristics act as enablers and barriers, which vary over time, and interact to shape households' capacity to recover. The paper also proposes a new definition of disaster recovery, which reflects households' pursuit of recovery needs that do not directly adapt to, reduce or avoid the impacts from disasters.

1. Introduction

Post-disaster recovery is a critical process in building resilience–the reduction of risk and a key component of sustainable development (Davis & Alexander, 2015). Yet recovery is often cited as the least understood phase of the disaster cycle (Chang, 2010, He, 2019). Much knowledge about recovery has been gained from detailed investigations of disaster-affected communities that *identify* important conditions for recovery and *measure* these–in a correlative manner (Horney et al., 2017). In particular, quantitative panel survey research has correlated conditions with the speed that households recover (Kurosaki, 2017) e.g. that households with fewer capital assets have greater difficulty recovering (Warr & Aung, 2019); and that recovery is heterogeneous across households (Tafti & Tomlinson, 2019). Therefore, research has moved beyond earlier uni-dimensional, and linear conceptualizations of recovery, and toward approaches that reflect variability, social inequality and diversity in recovery pathways.

However, theory development has been hampered by a failure to uncover how household characteristics interact with broader societal conditions to shape household recovery–in a mechanistic rather than correlative manner (Tierney & Oliver-Smith, 2012). Several social vulnerability theorists (for example, Peacock et al., 2012; Sadri et al., 2018) suggest that socially marginalised households are slower to recover from disasters. However, longitudinal data that *explain* how and why recovery unfolds, remain under scrutinised. Also, much recovery research focuses on community, city or regional level, largely overlooking the household level despite households being on the 'front line'. This article sets out to address these key gaps.

From analyzing longitudinal qualitative data, we develop a framework to explain how households recover from disasters, over time. We demonstrate how and why changes in societal conditions, located beyond the household, change in the aftermath of a disaster and how these enable or constrain household recovery patterns. We categorise these broader societal conditions as: disaster support; public services; markets; employment and public financial assistance. The research shows how households' capacity to recover is unequally impacted by changes in these societal conditions because household characteristics – capital assets, agency and recovery priorities – directly shape the extent to which

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households can mitigate and adapt to the adverse impacts of changing external conditions and perform recovery strategies.

2. Literature review

Households are composed of people who have and spend money collectively, including migrants who live overseas and who add to the 'collective pot' via remittances (Varley, 1994). Our study builds on foundational works that explore the correlative conditions that support household recovery, including those from disaster studies, development studies and sustainability research. Given the relatively small set of empirical knowledge and the scarcity of longitudinal data exploring disaster recovery, we draw from seminal research within development studies to understand current theories and frameworks of household recovery from disasters.

2.1. Household recovery

Manyena (2006) suggests that disaster recovery is a process of "bouncing back" to a pre-shock state. However, this is an inherently conservative approach because returning to a state of 'normalcy' is insufficient if pre-disaster conditions render people vulnerable to hazard impacts (Kelman et al., 2015). As such, there has been a shift to longer-term developmental perspectives aimed at building resilient societies after disasters (Sou, 2019). The UNDRR defines resilient recovery as,

> "The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and "build back better", to avoid or reduce future disaster risk." (UNDRR, n.d.)

Recovery can last years or even decades, and complete recovery is often impossible because of permanent impacts from disasters (Davis & Alexander, 2015). Short-term recovery of households begins immediately after initial impact (Twigg et al., 2017) and is typically characterised by the restoration of utility services, clearing debris, access to housing, and generally establishing conditions necessary for households to begin long-term recovery (Shaw, 2014). Long-term recovery typically includes physical repair and (re)construction of houses and the built environment, as well as re-establishing or improving levels and diversity of economic, human, social capitals and community cohesion, which can take many years (Cueto et al., 2017). Increasingly, research recognises the importance of recovering the culture of disaster-affected communities, and of harnessing this culture to support resilient recovery (Sou, 2019).

2.2. Household capacities and resources for recovery

Formative disaster research shows that disaster-affected populations are important agents that form the basis of recovery (Longhurst, 1994). However, household capabilities to recover from shocks do not take place in a vacuum (Twigg et al., 2017). Moser's (1998) seminal research on household recovery from economic shocks highlighted that households have a suite of capital assets to facilitate recovery. However, the quality, quantity and diversity of these assets is dependent on the social profile of household members (e.g. number of children and working adults, health and skills set of members) and the decisions and activities taken by actors beyond the household. Thus, household capacity to recover reflects Nussbaum and Sen's (1993) seminal work on poverty reduction and that recovery is shaped by actors and changes in societal conditions taking place on multiple levels. This approach acknowledges the heterogeneity and the multi-dimensional nature of recovery across households.

Economic income is central to facilitate household recovery strategies. Yet, disasters can temporarily or permanently interrupt routine income streams (e.g. livelihoods) (Gallagher & Hartley, 2017). Households may diversify income streams by mobilizing additional labour, depending on household members' opportunities and constraints, such as their education levels and need to balance employment with other responsibilities (Moser, 1998). For instance, women have been found to open home-based enterprises but the success of such enterprises depends (in part) on assets such as such as electricity, water, skills, and finances. Alam and Rahman (2017) suggest women are empowered through labour mobilization in the aftermath of a disaster. However, Bradshaw (2015) suggests this burdens women with additional responsibilities and men do not adjust by taking on more household tasks, nor do governments or local communities compensate by providing more childcare facilities post-disaster to offset the increased responsibilities of women. Other income diversifying strategies include: economic remittances from kin living overseas; using savings; selling assets; and securing loans (Davis & Alexander, 2015).

Human capital, understood as the skills, knowledge, nutrition and health of household members (Paudel & Ryu, 2018) supports recovery. Higher education levels are associated with higher income levels (Psacharopoulos & Patrinos, 2018). Yet, knowledge can also be mobilised to facilitate recovery activities, such as housing construction (Wamsler et al., 2012). Household members can engage in income earning activities and/or recovery activities (Krüger et al., 2015). The structure and cohesion of intra-household relations also contribute to household recovery. Households may expand, becoming composed of multiple extended households, to provide shelter or pool income and spending on everyday items, which can reduce per capita income and increase dependency ratios (Gignoux and Menéndez, 2016). However, restructuring households can increase intra-household conflict and tensions (Moser, 1998). Yet there remains minimal research about how and why changes in intra-household social relations happen after disaster (Tierney & Oliver-Smith, 2012).

A household's social capital is an intangible asset, which signifies the rules, norms, obligations, reciprocity, and trust embedded in social relations, structures, and institutional arrangements (Putnam, 1995). Households draw on horizontal networks with kin, friends, neighbouring households or community-based organisations to access emotional, informational, and material or financial social support (Lin et al., 2013), that facilitate recovery (Aldrich, 2012). Research–principally in rural areas–highlights that households collaborate to support their recovery and that, long-term, levels of social capital increase and are consolidated across households (Twigg et al., 2017). Households with adequate resources to recover are more likely to support neighbouring households via reciprocal arrangements to share food, water, cooking, childcare or borrowing money on a short-term basis to buy consumables (ibid). Yet, Simpson and Serafini (2019) show that inter-household social trust and cooperation increase soon after a disaster, but pre-disaster patterns of low social capital levels soon resume.

2.3. Recovery factors beyond the household

The decisions, perceptions and behaviours of household members are intimately shaped by broader societal conditions (Moser, 1998) and the actions of actors located beyond the household. However, research tends to explore the influence of singular factors on recovery e.g. financial aid, electricity, employment opportunities, whilst limited research synthesizes how multiple

broader societal conditions change post-disaster and how this shapes household recovery over time.

Relief aid and recovery are often viewed as temporally and conceptually distinct. However, relief aid and/or financial and technical assistance from non-governmental organisations (NGOs) or government actors constitute initial household recovery that can offset expenditure (Gignoux and Menéndez, 2016). Access to relief aid is not universal as distribution may happen in places or at times that are inaccessible to some households given the ages, disabilities, or work patterns of household members (Tatham & Houghton, 2011). Needs assessments and distribution of financial aid is often bureaucratic and unequipped to recognize locally and culturally specific living arrangements, which can result in recovery assistance being denied, or not meeting households' needs (Twigg et al., 2017). Schofield and Miranda Morel (2017) call for a more integrated and informed choice so households can choose between aid for housing support, new furniture or backing for a livelihood start-up for example. This transfers agency for recovery to affected households so residents make informed choice through the provision of appropriate technical support and information.

Government programs exert a powerful influence on all forms of recovery, but little is known about how different approaches influence household recovery (Curato, 2018). Research often shows a lack of government investment in household disaster recovery in low-income neighbourhoods in the global south. This leaves many households to recover in the absence of formal government support (Twigg et al., 2017). Official reconstruction policies and regulations also affect the speed of recovery trajectories and progress towards safer building (He, 2019). For instance, reconstruction grants often require compliance with building regulations and proof of home ownership. However, building regulation adherence can require finances that are beyond household resources, and many low-income households in the global south do not have formal legal proof of home ownership, despite having lived in the house for decades (Green, 2008).

Damage and closure of public services are typical outcomes of disasters (Mitchell & Lovell, 2015) and recovery research has tended to explore when services are recovered (Zorn & Shamseldin, 2015). Limited research investigates how such public assets shape household recovery, despite development studies highlighting how public services shape household development and poverty reduction. For example, access to electricity and water facilitates economically productive activities (e.g. home-based businesses (Moser, 1998), routine domestic duties (e.g. cooking, cleaning (Wutich, 2009)), and social activities (e.g. watching television (Blunt, 2005). The disruption to schooling can adversely impact children's education - hampering access to higher paid incomes later in life (Wamsler et al., 2012). Furthermore, recovery research is yet to uncover how disruption to waste management services impact on household recovery (Sakai et al., 2019).

Access to health services can maintain household members' engagement in recovery activities e.g. income generation and housing reconstruction (Mehwish et al., 2014). Yet, health services are often disrupted by disasters and affected population's health can deteriorate post disaster (Stough et al., 2016). For instance, the impacts of disasters, limited recovery options, and the bureaucracy of applying for aid has been correlated to depression and stress, which can drain households' economic resources (Bromet et al., 2017). Availability of transport systems and roads may also be adversely impacted by disasters, which can sever household's access to income earning activities and restrict relief aid distribution (Berariu et al., 2015). Yet again, the mechanisms for, and longer-term impacts on recovery are little explored.

Research suggests that disasters which require large-scale reconstruction may cause market swings that localise price hikes of commodities until supply overtakes demand (Sou & Webber, 2019). For instance, following the Nepalese earthquake in 2015, the availability of materials for house reconstruction was undermined by post-disaster market processes (Twigg et al, 2017). More work is needed to understand how and why market behaviours impact on household recovery, and the recovery pathways and decisions of households following disaster.

To summarize, the literature shows that households have multiple resources to facilitate recovery, but these are asymmetrical within and across households because of the heterogeneity of households' capital assets. Also, household recovery is intimately shaped by the decisions, behaviours and activities of actors beyond the household, as well as the governmental, economic, environmental and social contexts in which recovery takes place.

3. Methodology

Exploring how and why households take different recovery pathways and patterns benefits from a qualitative case study approach to exploit rich data. We analyse this in a single-sited case study to track phenomena within a real-life context over time (Yin, 2003) to explore similarities and differences that emerge within and between households that are responding to, and recovering from, the same set of societal changes in a post-disaster context.

3.1. The case site

Ingenio, a neighbourhood in Puerto Rico, was carefully selected as our case for four reasons Fig. 1. First, residents expected to continue to live in the neighbourhood, despite the disaster, enabling us to conduct a longitudinal study where data could be collected for the first year after Maria's impact, via multiple and repeated data collections from the same sample (Hedeker & Gibbons, 2006). We also required a location that residents were not leaving en masse, whether forcibly or voluntarily (nor seemed as if they would), which would compromise our longitudinal ambitions. Second, appreciating that disasters are more acutely felt in the global south, at the household level in areas of economic poverty and where government struggles to organise effective disaster management, we required an area with these characteristics. In this light, 66% of Ingenio's residents live below the poverty rate (US Census Bureau, 2018), and there was an absence of an effective disaster response to the hurricane. Third, access to Ingenio was made possible as one author is personally known to a local government official, who introduced them to a neighbourhood councillor. The councillor introduced them to heads of local households who were fully briefed on the project and given 48 h to reply if they would like to participate. Relatedly, we had access to external actors who could offer context (e.g. local and national government, nongovernmental organizations) to situate the experiences of Ingenio residents (Fig. 1).

3.2. Introducing the case

Puerto Rico is a Caribbean island, a territory of the United States (US) of America, and its citizens are US citizens. Puerto Rico's status as an unincorporated territory positions the island within state governance but not as far as to be encompassed within the 50 states themselves (Rivera, 2020). This means that citizens of Puerto Rico cannot vote in US elections for Congress or the Presidency, but they are subject to the US laws and regulations passed by these bodies (Ayala & Bernabe, 2009).

The national poverty and vulnerability of Puerto Rico is shaped by natural hazards such as droughts, floods and hurricanes. Since 1970, Puerto Rico has recorded 28 disasters – 6 in the past decade. In 2017, the island was hit by two major hurricanes (Irma on
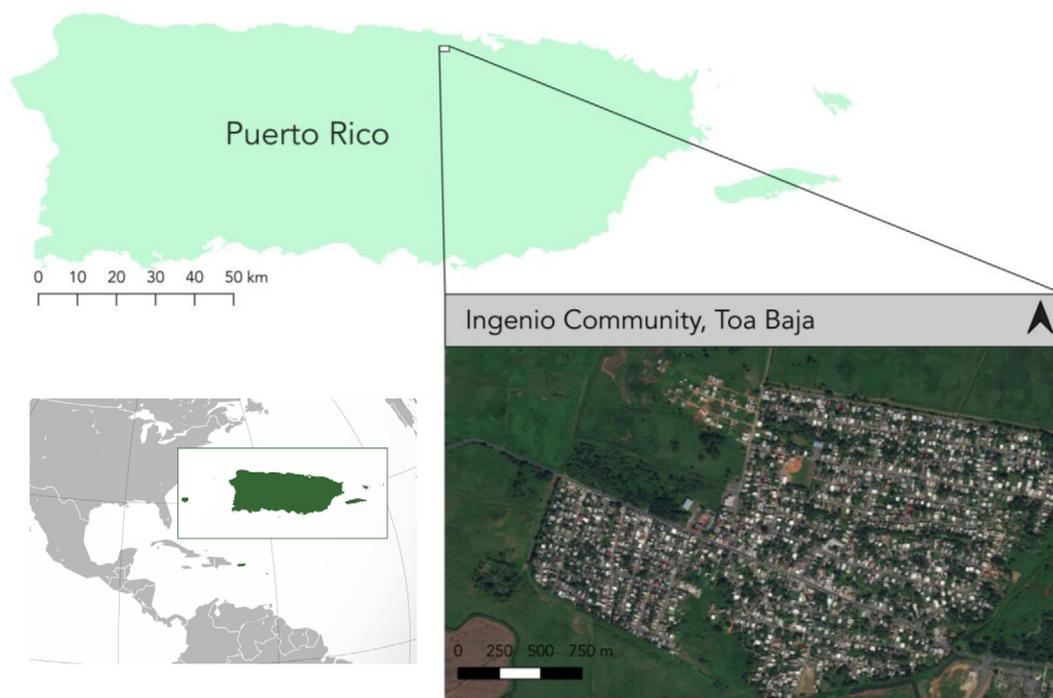
Source: Google 2021

Fig. 1. Ingenio community located in Puerto Rico Context.

September 7 and Maria on September 21). These, particularly Maria, caused devastation to infrastructure and economic activity. Damages from Hurricane Maria were an estimated USD $31.5 billion (FEMA, 2018). However, the effects of the storm are best understood as the compounded results of a long-standing colonial history (Bonilla and LeBrón, 2019)[1] and a long history of structural vulnerability and forced dependency created the widespread poverty, unemployment and decrepit infrastructure, which enabled Maria to have such devastating impacts (Bonilla, 2020). For example, Puerto Rico's weakened local government is subject to the whims of Washington and thus unable to chart political and economic policy centered around local needs. For instance, USA policies have deliberately weakened the manufacturing and agricultural sectors in Puerto Rico, which means Puerto Rico no longer produces sufficient levels of its own consumables and non-consumables reserves (Iglesias, 2018; Mares, 2019) – 85% is imported from the US (Garriga-López, 2020). All imported goods must arrive on ships from the US with US crews – a process agreed under the Jones Act, which limits international trade competition and punishes Puerto Rican consumers by making imported commodities costly, slow to arrive and limited in availability (Cortés, 2018).

San Juan is Puerto Rico's capital and, 13.5 km along the coastline is Ingenio, a neighbourhood of 5,354 persons across 1,529 households (US Census Bureau, 2018). Ingenio is a *peri*-urban, coastal community in Toa Baja municipality, which was heavily affected by Hurricane Maria (FEMA, 2018). Ingenio lies in a floodplain of La Plata River, an area surrounded by sugarcane farmland. Hurricane Maria (September 21, 2017) had just hit Ingenio, causing major structural and floodwater damage to all houses when it was selected as our case.

Briefly for context, local government response and recovery to the hurricane was difficult. For example, the Toa Baja municipal

government lacked human and financial resources but distributed water and food aid to Ingenio and incrementally re-instated public services including waste removal, electricity and water. The role of FEMA was to rapidly assess household needs of financial aid for recovery and reconstruction, providing funds to eligible cases. Eligibility involved an onsite assessment of the structural damage to houses by FEMA staff, a detailed application by the household, and proof of legal ownership of the property – following which a 2–6 month approval process begins. On US aid, US policy stipulates that only federally approved NGOs are permitted to provide disaster relief to its citizens in a federally declared disaster area and that federally-funded disaster relief goods must be sourced from US suppliers – both factors are problematic for a territory over 1000 miles from the mainland.

3.3. Data collection

We took a qualitative approach to understand residents' experiences, how recovery emerged, and the influence of external factors. Data collection in Ingenio began on 16th October 2017 (27 days after Hurricane Maria hit) and concluded on 13th September 2018 (almost one year after the hurricane). Data were collected through five visits to Ingenio that were equally spaced throughout the period (Table 1). We did not aim to take five snapshots of recovery indicators, as we wanted to understand how factors interweaved to shape household recovery. We followed the lives of a group of households (Marcus, 1995) that volunteered to participate in the research. In our sample, households differed by the physical damage sustained (partial or total collapse and/or flooding) and the social profile of households (e.g. number of household members; ages; gender ratio; income; number of dependents). We purposefully selected households with diverse social profiles-recognizing that our sample may not represent Ingenio, yet allowing us to explore how the composition of household members shape the

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[1] Recent work by Garriga-Lopez (2020) also demonstrates how US colonialism is compounding the impacts of Covid 19.

Table 1
Visit descriptions.

Time elapsed since Maria	Month 1	Month 3	Month 6	Month 9	Month 12
Date of data collection	16th–30th October 2017	14th–22nd December 2017	23rd–31st March 2018	6th–15th June 2018	3rd–13th September 2018
Visit duration	15 days	9 days	9 days	10 days	11 days
Number of households	20	16	13	12	12

Source: Authors.

Table 2
Household profiles. Key: [F]emale; [M]ale; [A]dult; [C]hild; [E]mployed; [P]ublic financial assistance; [H]ome-based business; [R]emittances.

Household	Number of household members	Household members (sex, age and pre-hurricane income sources)	Land title	Home ownership	Location in neighbourhood (measured by distance from the main road where relief aid was distributed)	Month interviewed (from Table 1) and reason for leaving study (if applicable)
1	6	FAPH; MAE; FC; FC; FC; MC	No	Yes	Moderate	1,3,6,9,12
2	5	FAPH; MAP; FAE; MAE; MC	Yes	Yes	Far	1,3,6,9,12
3	2	MAP	No	Yes	Close	1,3,6,9,12
4	3	FAPH; MAP	Yes	Yes	Close	1,3,6,9,12
5	1	MAPH	No	Yes	Far	1,3,6,9,12
6	1	FAE	Yes	Yes	Close	1,3,6,9,12
7	2	FAP; MAP	No	Yes	Moderate	1,3,6,9,12
8	2	FAE; MAE	Yes	Yes	Moderate	1,3,6,9,12
9	4	FAP; MAE; MC; MC	Yes	Yes	Far	1,3,6,9,12
10	3	FMPH; MMP; FC	No	No	Far	1,3,6,9,12
11	3	FAE; FAE; FC	Yes	Yes	Moderate	1,3,6,9,12
12	2	FAE; MC	No	Yes	Moderate	1,3,6,9,12
13	2	FAE; MAE	Yes	Yes	Close	1,3,6, then migrated
14	5	FAE; MAE; FC; MC; MC	Yes	No	Moderate	1,3, then migrated
15	3	FAPR; MAR;; FC	No	No	Close	1,3, then migrated
16	4	FAE; FC; MC; MC	Yes	No	Close	1,3, then opted to withdraw
17	1	FAP	Yes	Yes	Moderate	1, then passed away
18	4	FAPH; MAP; MC; MC	No	No	Moderate	1, then opted to withdraw
19	4	MAE; FMP; FC; FC	No	No	Far	1, then migrated
20	2	FAP; MAP	No	Yes	Far	1, then migrated

(Example from row 20: FAP = Female, Adult, supported by public financial assistance).
Source: Authors.

capital assets of a household and thereby recovery pathways (Table 2).

In depth interviews with household heads gathered insights from expert 'insiders' (King et al., 2018). In total, 73 household interviews were conducted – one with the same household head during each visit. The respondent was interviewed alone in a relaxed environment in their home. Interviews were semi-structured and focused on the impact of the hurricane and recovery strategies, and explored other issues happening in the weeks since they had been last interviewed (Flick, 2009). The semi-structure nature of the interviews meant that questions were informative, rather than restrictive, allowing us to follow up on any unexpected data. See the annex for a list of the informative questions used during each of the five visits. Household interviews were triangulated with other data gathered through multiple methods including interviews with Toa Baja municipal government officials, national government officials, and NGOs as well as extensive direct observation and visual methods (i.e. photography and videos). Other data included observed changes in the neighbourhood (e.g. routines, social interactions, changes in the built environment and physical artifacts) and having informal spontaneous conversations on general matters (including recovery) – what Barbour (2014, p156) calls "incidental ethnographic encounters". Furthermore, we consulted information, policies and data on recovery from municipal and national government, as well as census data.

3.4. Data analysis

Our inductive approach to analysis took three stages to identify patterns in the data (Babbie, 2004). First, we analysed the

interview and visual data to identify themes contained therein – we did not use a pre-existing classification. This involved an open coding process (Corbin & Strauss, 2008) in which we segmented the data into related concepts that emerged from those data, called 'minor themes' (Braun & Clarke, 2013). Examples are 'lack of electricity', 'lack of usable water'. Second, we analysed the data from a single visit to understand the pattern of minor themes for the visit. Clustering these minor themes into related groups led to the identification of higher-level codes which we called 'major themes' (e.g. the examples above were clustered into a major theme called 'public services) – again, themes emerged from the data. Major themes, detailed by minor themes, were used to understand the content of each visit and showed differences and contradictions across households. The major themes identified four societal conditions (disaster support; public services; markets; employment and public financial assistance) that led to our theoretical model. Triangulation of data of different types, from different times and from multiple sources increased our confidence in the presence of these four societal conditions and their impact on household recovery (Aaltio & Heilmann, 2010). The open coding process ensured all data was themed.

Finally, to analyse for longitudinal relationships we used the four societal conditions to understand how household recovery emerged across the five visits. This identified how minor themes changed or disappeared (e.g. potable water disappeared as a concern once water was consistently available from Month 3) and how contradictions emerged within households across the five visits. This process led to discovering stages of household recovery over time, which, from having multiple households to triangulate across, increased the reliability of results.

4. Findings

Our findings are structured by the four major societal conditions (disaster support; public services; markets; employment and public financial assistance) because households' capacity to recover is unequally impacted by broader changes in these four societal conditions. That is, households mobilise their agency to leverage their agency, assets and recovery priorities to mitigate and adapt to the four major societal conditions. This interaction between household characteristics and changing societal conditions determines households' capacity to engage in recovery activities. Fig. 2 visualizes the changes in the four major societal conditions following hurricane Maria. Below, all quotes are from interviewees.

4.1. Disaster support

DiD Disaster support includes financial, material and technical assistance, which are given in response to the impacts of the hurricane. Actors are located beyond the household and include municipal government, national government, federal government, NGOs, neighbourhood, and kin.

Interviews indicate that the least support to households was from municipal government, signaling a lack of capacity and preparedness to cope with the impacts. From national government, the collapse of the system to distribute regular state public financial assistance payments e.g. pensions and disability support, meant eligible households did not receive payments until Month 3. Meanwhile, federal support for household recovery centred on FEMA's needs assessment – designed to provide urgent financial support but its application was shaped by three problems. First, FEMA's focus on structural damage to houses resulted in households with minimal structural damage being disproportionately rejected for support despite experiencing significant loss of contents, aesthetic damage, disruption to income, or psycho-social impacts. Second, federal bureaucracy was ill equipped to accommodate local socio-cultural living arrangements. For instance, eligibility for funding relies on *proving home ownership.* Yet houses often belong to a relative who live elsewhere, is estranged, has died, or lacks necessary documentation, which has been observed across many disaster contexts (Paxson & Rouse, 2008). Without a title deed one interviewee found it *"really hard"* to get FEMA funding and, for another interviewee, *"my dad made a sworn declaration that I have always lived here…and with all that we went [to FEMA]"* and, for another woman, *"everything is under my father-in-law's name, not ours"* so they were ineligible. Third, the release of funds was not rapid as 28% of case households waited 2–3 months after Maria for FEMA's financial assistance; 22% waited 4–6 months; and 50% were rejected. FEMA has published the total amount distributed to households i.e. US$1.5 billion, but as of yet has not published acceptance rates for disaster assistance applications made by households (FEMA, 2020).

Households responded in two ways, driven by their economic status. Households dependent on public financial assistance as their main income (50% of case households) often delayed reconstruction while waiting for FEMA's assistance, so lived in precarious housing which compromised their well-being and wider recovery. For example, one interviewee reported *"The roof we are only going to do it when we get the money from FEMA"* which determined their pace of recovery. Households with multiple sources, or higher levels of income often began reconstruction prior to FEMA's assistance, demonstrating how higher levels of economic income bolsters household agency. One household head observed that households recovered more quickly if they *"received monetary assistance, for example from FEMA, or … had some type of insurance"*.

As such, long waiting times to process applications determined recovery rates, and the limited financial support households were offered was heavily subsidized with household finances to reconstruct houses.

Very few *"saved enough money [to] recover ourselves better"* - that is, most households were not economically able to reduce the physical vulnerability of their house to pre-Maria levels or better. Overall, household members were *"angry"* as they perceived government support should have been quicker and equally distributed[2] across those affected. Instead, government support was absent until later in the recovery process and was uneven and dependent on the ability of households to comply with rigid national systems, leaving households frustrated with processes where inspectors *"lose paperwork"*. NGOs, neighbours and kin addressed the gaps left by government, providing emotional, informational, material and financial social support (Lin et al., 2013).

During the initial six weeks, NGOs were heavily present in Ingenio including international NGOs (e.g. Red Cross), local Puerto Rican organisations and US missionary groups; however public information about the origins and amounts of NGO aid are not publicly available. Households accessed relief aid unevenly and interviewees from the municipal government used the term *"insufficient"* to indicate that there was not enough relief aid distributed to Ingenio, resulting in some households receiving very limited aid, despite requiring greater support. Interviews with household members corroborate this as household access to relief aid was unequal across Ingenio, as further discussed in 4.1.

Initial aid (i.e. water and hot meals) allowed households to maintain basic conditions and human capital (i.e. nutrition and health of its members) to engage in recovery and income earning activities. This reduced household expenditure at a time when income via livelihoods and public financial assistance streams were disrupted. Households that had consistent access to relief aid had bolstered mental well-being as they felt supported by external actors. However, household members experienced frustration and adverse impacts on mental health when they did not have consistent and reliable access to aid. For example, NGOs would confirm the location of aid distribution only two hours beforehand, so it was common that households missed this information and/or were unable to collect aid because they were not present in the neighborhood or did not arrange for kin or neighbours to collect aid in their absence. One interviewee felt that when aid arrived NGOs *"only informed one area of the community … they did not move to other parts of the communities"* and another noted that the aid distribution *"did not pass through our street because this is a dead-end street"*. Being overlooked by aid distributors particularly happened to households living in houses that were isolated/on the outskirts of the neighbourhood; those with members working jobs in the daytime; those providing constant care to dependents and who could not leave the house easily; and those with low levels of social capital so could not rely on their networks to gather aid for them.

We also found that aid provision did not develop beyond these basic needs to meet the diverse and changing needs of households throughout recovery. For example, soon after Maria, households needed specific basic supplies (e.g. diapers, baby food, medicines) and this developed over time to include cleaning supplies (e.g. mops, buckets), and then to heavier duty cleaning support (e.g. pressure washers) – none of which were provided, hindering recovery and frustrating people. By Month 3, NGOs had scaled back

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[2] Here, household members understood equal distribution as the process in which all affected households receive aid, and that this is proportional to the need in the household e.g. a single person household receiving aid for one person and a six person household receiving aid for six people.
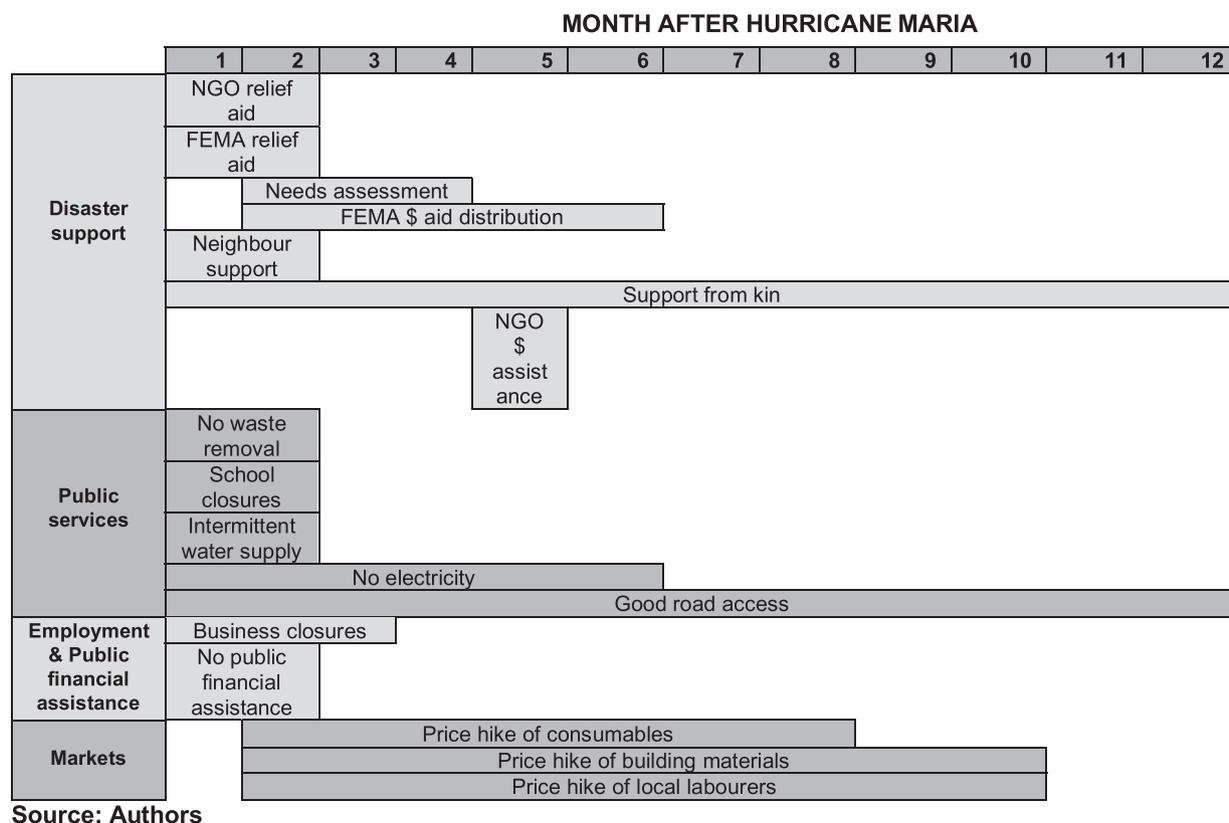
MONTH AFTER HURRICANE MARIA

	1	2	3	4	5	6	7	8	9	10	11	12
Disaster support	NGO relief aid											
	FEMA relief aid											
		Needs assessment										
		FEMA $ aid distribution										
	Neighbour support											
			Support from kin									
				NGO $ assistance								
Public services	No waste removal											
	School closures											
	Intermittent water supply											
		No electricity										
		Good road access										
Employment & Public financial assistance	Business closures											
	No public financial assistance											
Markets		Price hike of consumables										
		Price hike of building materials										
		Price hike of local labourers										

Source: Authors

Fig. 2. Changing societal conditions, following hurricane Maria.

distribution and only 24% of households were receiving water and food aid; and no ongoing relief was being distributed by Month 6.

Neighbours and community groups (e.g. churches) were initially cited as a source of help. In month 1, 42% of households received support from neighbours mostly with clearing debris and cleaning. By Month 3, this neighbourhood self-organisation and reciprocity was unequally distributed. The nature of pre-Maria social relations between households shaped the ongoing support that neighbours would provide to each other. For example, neighbours who had no initial nor ongoing recovery support from neighbours expressed that they had limited relations and interactions with neighbours prior to the hurricane. Whereas households who suggested they had consistent and good relations with neighbours said they received initial and ongoing support from neighbouring households. For example, one interviewee was given free "*tin sheets*" and plumbing "*pipes*" to repair roofing from neighbours who worked in factories. However, this support from neighbours was not as key to long-term recovery as that from kin.

Relationships based on kin were more consistent, reliable and diverse throughout data collection. Kin played a critical and varied role in short-term recovery (e.g. cleaning, collecting aid, sheltering for 90% of households in Month 1), medium-term (e.g. financing reconstruction, donating items, sheltering for 75% of households by Month 6) and longer-term (e.g. sheltering for 30% of households by Month 12). Overseas family members supported with economic remittances. Temporary shelter was critical to recovery and transformed household's structure and profile as household sizes increased to accommodate kin living in Ingenio (Gignoux and Menéndez, 2016). Thus, households could pool resources (e.g. space, income, and childcare duties) and save financially whilst remaining in their neighbourhood, close to livelihoods, social networks, and public services such as schools. Initially, interviewees agreed that practically "*we help each other and [say] 'family, I need*

this', 'I need that' … *the relationship is good*" and emotionally "*I try to show that everything is going to be alright*". Nevertheless, over time temporary sheltering strained kinship relations as overcrowding and limited privacy became problematic, resulting in more arguments within some households.

4.2. Public services

The major disruption to public services such as waste removal, water, electricity, sanitation, and education affected households and their ability to recover in different ways and at different times. Some public services were slower to recover, which required households to develop recovery strategies to mitigate the effect of disrupted services. The restoration of public services occurred unevenly across Puerto Rico and there is no public information that tracks and traces when, where and which public service was restored. Similar to *disaster support*, household characteristics again shaped to what extent households could mitigate and adapt to the adverse impacts of public service disruption.

Household recovery often began on the day the floodwater receded. Households cleared damaged items and debris into the streets for municipal waste collection. During the first five weeks, solid waste removal services were severely affected and streets became lined with damaged household items and garbage. Vermin were attracted as the municipality "*came to collect the trash only once*" during the initial three months. Interviewees expressed fear ("*centipedes kill us, rats pose a threat to kill us*") and disgust at the "*unsanitary*", "*unhygienic*" and "*ugly*" conditions and the physical and aesthetic deterioration of neighbourhoods. This unequally burdened household members by adversely influencing emotional well-being. Over the same period, recovery was further impeded by the unpredictable supply of piped water limited to 3–4 days a week. This restricted cleaning activities to when water was avail-

able, and required households to store water for later use. It also restricted personal hygiene to the extent where local government "*made a [publicly available] laundry in the stadium*".

During those initial two months, schools were closed which disrupted the pattern of daily life for children and mothers in particular. Children were prevented from playing in unhygienic streets, so spent long periods at their damaged home, which increased the time and labour intensity of childcare for parents trying to rebuild their home environment. Interestingly, 15% of case households migrated to the United States by Month two, and interviews revealed that the principal 'push' factor was parents' concern that their children would miss education. Another 15% wanted to migrate but had insufficient resources. By Month three, schools had re-opened and no more case households migrated during the research period.

Hurricane Maria resulted in the longest electricity blackout of any State or territory of the USA in its history, and the second longest in the world, according to a study made by Rhodium group (2018). Within Ingenio, electricity supply was the utility disrupted for the longest duration – until Month six. When considering electricity, gender is a critical differentiating factor, as homemaking practices in Puerto Rico position women as mothers, and as primarily responsible for the domestic sphere. This results in women taking primary responsibility for the day-to-day running of home and creating a 'home-like' environment via tasks including cooking, cleaning, washing, shopping and caring for children, which rely on electricity. After the initial six weeks, when NGOs scaled back their aid, the absence of electricity hit harder due to the absence of the hot meals NGOs provided. Many households adapted by cooking with small, inefficient and awkward camping stoves. Some households adapted by purchasing generators (35% of case households) or cabling to kin's generator when living next door (15% of case households) to assist with everyday living such as lighting and powering washing machines and refrigerators. However, generators created stress from the "*unbearable noise*" and breathing problems particularly for stay-at-home household members – principally women. Friction between kin was created around the use and financing of generators (10% of case households) resulting in cabling being cut off when relations deteriorated. Generators were seldom used to power televisions but, the few hours that they were, rapidly brought a temporary sense of "*normality*", comfort and homeliness, which residents had "*lost*" since Hurricane Maria. Six months after the Hurricane, electricity was restored to neighborhoods which gave a "*morale boost*", but households incurred the cost of an electrician to rewire the house if their disposable income was sufficient. Human capital could circumvent these costs and hasten reconnection and recovery if household members had the skills to rewire the house.

4.3. Employment and public financial assistance

During the initial weeks after Maria, severe disruption to labour markets, the reduced productivity of home-based enterprises, and the lack of regular state public financial assistance, cascaded disruptions to households' sources of income meaning many households could not access their regular income streams through to Month 3. One interviewee "*used to work at a Chemist but I have not gone back to work as it is still closed*". Below we show how this shaped recovery as households modified income generating activities and consumption patterns to create more disposable income to facilitate recovery. Again, household characteristics (capital assets, agency and recovery priorities) and relations significantly shaped how broader processes of employment opportunities and public financial assistance provision influenced recovery.

In response to changes in access to employment and public financial assistance, households developed recovery strategies to diversify income and reduce costs. Throughout the initial four months, household recovery strategies included seeking financial aid from friends and kin, typically those living overseas. This involved monthly remittances of US$100–200, informal loans, and gifts which were critical for households rejected by FEMA assistance, and those relying on public financial assistance payments or home-based enterprises. For example, one interviewee received "*luggage for my belongings and US$700*" from a friend; another received "*furniture*" and, in addition to federal assistance, in Month 5 all Ingenio households received financial aid of US $1500 from the Jennifer Lopez Foundation (JLF).

Household recovery strategies included diversifying income. Pre-Maria, 44% of case households had diverse income from multiple, formally employed members. Continuing these employments enabled them to recover the structural and material status of their house more rapidly–typically within five months of the Hurricane. Interviewees tended to "*try to make money without leaving the community*", which disproportionately affected women, who would (re-)establish businesses–but most required public services (e.g. electricity) so became unproductive. Additionally, securing paid local employment depended on their education level and relevant experience–neither of which are criteria for home-based enterprise. Pre-Maria, 30% of case households used their house as an income-generating asset by renting out a bedroom. The lack of public services in the aftermath of Maria disrupted these arrangements but this resumed once electricity was restored. Overall, 42% of case households diversified their income through female-led, home-based enterprise and renting out rooms. Prior to Maria this number stood at 30%, which illustrates how re-establishing or beginning to use the house as an economically productive asset is prevalent in recovery.

To reduce costs, households modified consumption patterns such as reducing expenditure on consumables to absorb the loss of income, for example, by "*staying in more*". Relief aid also allowed households to kerb expenditure. However, households that were marginalized from aid spent more on consumables than others. Second, households restructured through kin-related households temporarily living together to pool resources (e.g. economic capital and childcare) and share living costs (e.g. food and bottled gas) (Gignoux and Menéndez, 2016). Although solutions, these cost reduction strategies added pressures to household members already under stress from economic difficulties, leading to strained intra-household relationships, exacerbated by a lack of privacy and household members efforts to ensure equal contribution to household income and duties (e.g. cooking and cleaning).

Savings was spent in a range of ways, initially on housing reconstruction and, later, on household items and comforts. The timing of this varied for each household, typically according to when economic capital was accumulated. For example, low-income and public financial assistance dependent households were often unable to save quickly which delayed their physical recovery until they receive notice of their FEMA application. Consequently, their FEMA and JLF money was spent on reconstruction. Households with higher and more stable income, saved quicker which allowed them to reconstruct before they received notice of their FEMA application, typically by Month 5. Consequently, their FEMA and JLF money was spent on enhancing aesthetic qualities in their house and purchasing household items, appliances and furniture.

4.4. Markets

While public information on the market values of consumables, non-consumables, materials and labour were not publicly available, our research shows how the market price of consumables, non-consumables, building materials and labourers fluctuated in disaster recovery contexts. These market dynamics unequally

determined household access to supplies and labour for recovery. Local price rises significantly affected lower income households and those relying on public financial assistance.

On average, everyday food items rose by 35% between Month 2–8, gas canisters doubled in price until Month 6 when electricity became widely available, and gasoline prices for generators rose 23% between Months 2 and 8 after Maria. Households were unable to buy some everyday products due to price increases and one interviewee spoke for many by saying *"we need money now ... we live with my husband's public financial assistance check but, with the increase in food prices, it is not enough"*. Some households improvised items such as diapers and baby food. As stated above, households modified consumption patterns to accommodate market prices and pooled resources to access essential consumables.

Recovery lagged for many households due to limited availability of supplies, and when supplies became available. Households paid premium prices due to import costs and the price hikes from overwhelming demand so many were unable to recover different features of the house, such as doors, roofs and windows, until affordable products were available. On construction equipment, households had to *"buy tools, the ladders, [everything]"* and could not *"borrow tools because everyone is in the same situation"*. On building materials, for example windows, doors and tin for roofs, the supply was subject to long waiting times because of increased demand (e.g. *"3 months for non-standard products"*). To source such products interviewees exploited social capital, for example, one household head got *"a donation for the roof ... the windows ... but now I am 'knocking on other doors' to get help with the walls and the flooring"*. For many households building supplies were made more costly by requiring expensive labourers who also exploited market opportunities and *"increased in price after Hurricane Maria"*. To avoid this, households often drew on the human capital of household members to conduct the work themselves, or rely on social relations (kin and friends) for help. This supported the physical recovery of houses throughout the 12 months and saved significant labour costs. Households with limited human capital, social relations, or the means to pay labourers, struggled in rebuilding.

Most case households perceived that federal government should have predicted that demand for consumables and building materials would outstrip supply and have planned for this and subsidized transportation costs. Also, they blamed federal government that Latin American countries had ships waiting to deliver cheaper supplies quicker but were prevented because all imported goods had to arrive on US ships. The lack of materials meant that many small businesses and other employers temporarily closed between Months 2–4, which compounded the effect of price rises on unpaid staff.

5. A framework for recovery

We now discuss how low-income households, located in Ingenio (Puerto Rico), recovered from a disaster over time, and why societal conditions act as enablers in determining household recovery pathways and speed. These questions are crucial in a broader research context, which has largely used quantitative methods to explore what enables household recovery without explaining *how* household recovery unfolds (see Chang, 2010; Finch et al., 2010; He, 2019; Horney et al., 2017; Kurosaki, 2017). Furthermore, theory development has been hampered by a failure to contextualize recovery within broader societal change that happens post-disaster, and in ways that synthesise how household and societal conditions shape recovery over time (Tierney & Oliver-Smith, 2012).

This discussion argues for reframing how we conceptualise household recovery. That is, households do not equally seek to recover their house, sense of homeliness and aesthetics, economic security, health, social relations and wellbeing. The particularities of these are heterogeneous across households and the speed at which households recover is unequal because recovery timeframes are determined by the two-way relationship between household enablers (5.1) and societal enablers (5.2). As such, it is not advisable to construct a universal model explaining how households recover in the "short", "medium" and "long-term" time periods. Instead, below we identify how enablers support household recovery.

5.1. Household enablers for household recovery

Households mobilise their agency to recover. Mainstream approaches to household recovery overwhelmingly focus on the physical restoration of housing, public services, and the broader built environment (Twigg et al., 2017). Other research identifies the restoration of economic, human and social capitals as well as psycho-social wellbeing as important (Cueto et al., 2017; Aldrich, 2012). Our research supports these findings, yet we also show why household members restore and value other elements that are typically overlooked in recovery research and policy, which chimes with Sen's notion of development as increasing people's freedoms to live the lives they value (Sen 2001). For instance, household members – particularly women – were concerned with recovering daily household routines and activities such as cooking, cleaning, and relaxing watching television, and restoring the aesthetic appearance of the house. These activities allowed households to recover agency to control domestic spaces, which was largely undermined by uncertain external societal conditions, particularly public service provision. Routine household activities also enable households to recover a sense of homeliness, comfort and familiarity, supporting research on the restoration of intangibles such as home as overlooked, yet important, elements of recovery (Sou & Webber, 2019).

Our data shows how the agency of household occupants is gendered in the short, medium and long-term after a disaster. For women in particular, their agency to recover income-generating activities was often obstructed long-term, and their gendered domestic duties became more time and labour intensive in the medium and short-term due to the disruption of public services (Enarson et al., 2018). Previous research on women in post-disaster contexts suggests that through an increased involvement in the maintenance and recovery of households, women become empowered (Alam & Rahman, 2017). Like Bradshaw (2015), our research suggests that gender inequalities are temporarily exacerbated in post-disaster settings as women's home-making activities become more time and labour intensive and they experience a loss of economic power within the household. Our understanding of women's empowerment reflects a process that addresses the embedded structural gender inequalities that pre-date a disaster – which is not apparent in Puerto Rico.

We found why households may restructure and expand to support recovery activities, for example, to provide shelter for those affected, to benefit from economies of scale on buying everyday items, and to share domestic and rebuilding duties (Gignoux and Menéndez, 2016). However, as Moser (1998) pointed out, this can increase conflict and tensions between household members. Our research demonstrates how (in some cases) extending households led to secondary impacts such as lack of privacy and strained intra-household relationships that undermined recovery. Further research on intra-household relations and it impacts household recovery is needed (Tierney & Oliver-Smith, 2012).

Access to information enhances household recovery by enabling household members to make informed decisions (Aerts et al., 2018). However, information poverty can undermine households'

ability to engage in particular recovery activities. For example, relief aid is helps to maintain basic conditions, reduce expenditure and bolster mental wellbeing. However, households may not access aid because they do not receive information about the times and locations of distribution. As such, unreliable and inconsistent information can stagnate and undermine recovery activities. How households respond to particular information is dependent on household's capital assets.

Household agency enables aspects of recovery, such as the distribution of disaster relief aid. Our research shows that aid provision requires an integrated approach where households are enabled to inform relevant organisations about needs, which mirrors work by Schofield and Miranda Morel (2017). Our research shows why the role of inter-household social capital is not as much of an enabler for recovery as suggested by other research (e.g. Aldrich, 2012; Twigg et al., 2017). Our research explains how social capital may evolve and enable differently across households. This aligns with Simpson and Serafini (2019) who show that inter-household social trust and cooperation increase soon after a disaster, but pre-disaster patterns of low social capitals levels soon resume. Further research is needed.

5.2. Societal enablers for household recovery

Household recovery also progresses with four major societal enablers (Disaster support; public services; markets; employment and public financial assistance). We empirically and theoretically demonstrate how these four societal enablers-that are largely beyond household's control-unfold and affect household recovery during the first year after a disaster. These exogenous conditions interact with particular household characteristics (capital assets, agency and recovery priorities), and unequally hinder and enable household recovery. Therefore, understanding context is critical for understanding how households recover.

The impact of these exogenous conditions on household recovery is mediated by the agency of households to mitigate and adapt to changing external conditions. Here, household agency is dependent on household capital assets and capacities, which are heterogeneous. In this way, our analysis demonstrates how the relationship between the household and broader societal conditions changes and informs each other through interconnected activity (Slack & Williams, 2000). This shows how households are not passive bystanders in their recovery, but regain and mobilise agency to influence recovery (Longhurst, 1994). Our research provides much-needed understanding of how household recovery temporally unfolds. Understanding how our four major societal enablers 'behave' *over time* following a disaster can facilitate understanding of household recovery in ways that can design and facilitate effective recovery programmes. Temporally, our research also shows how different household capital assets – largely determined by the social profile of household members - are mobilized at different times to mitigate and adapt to changing conditions within disaster support; public services; markets; employment and public financial assistance - our four societal enablers.

These changing conditions in society are observable in post-disaster contexts across the world so are useful for researchers and policy professionals working on disasters. We do not argue that the intricacies of household characteristics are irrelevant. Instead, the analytical focus on households and their related resources reflect only one side of the puzzle, so research must also scrutinise and synthesise broader societal conditions and how changes in those enable, hinder and stagnate household recovery. Thus, we call for additional detailed, empirical, policy-relevant and culturally sensitive research to uncover how societal conditions change post-disaster, and how they combine to support household recovery. Although we presented some findings chrono-

logically, we do not suggest that the timeline of changes in societal conditions in Puerto Rico are universal. For instance, the distribution of relief aid may take place at different times, or public services may be restored earlier than in Ingenio. Nevertheless, the influence of societal changes on household recovery is generalisable.

6. Conclusion

We present a qualitative, longitudinal analysis of associations between household recovery, driven by exogenous societal enablers, and household agency in the aftermath of a disaster. In summary, our paper develops understanding of recovery, underpinned by social vulnerability theory – extending beyond treating heterogeneous recovery patterns as principally symptomatic of household capital assets (Kurosaki, 2017). However, overly focusing on the capabilities of households as the analytical explanation for recovery moves responsibility for risk towards affected populations and their capacities, whilst the broader conditions among disaster support; public services; markets; employment and public financial assistance, which we find shape household capacity to recover, are left unexplored. This neoliberalises disaster risk reduction and recovery policy by shifting responsibility away from the state and onto households (Felli & Castree, 2012). Yet, in highlighting the importance of household access to societal enablers such as public services, public financial assistance and employment opportunities to enable recovery, our model chimes with Nussbaum and Sen's (1993) notion that promoting access to opportunities are central to social development and that recovery is both heterogenous across households and multi-dimensional (see Fig. 3).

Our findings show why, first, household members are not solely and centrally concerned with physical restoration of the house as they also seek to recover other needs and concerns, such as homeliness, comfort and daily household activities. These aspects are overlooked in mainstream definitions and programmes of recovery because their function is not to directly adapt to, reduce or avoid the impacts of hazards. Therefore, successful disaster recovery ought to be more than rebuilding resilience to reduce disaster risk - it should also seek to deliver ambitious, transformational change to address fragilities and inequalities laid bare by the disaster – so-called 'renewal' (Shaw et al., 2020). Renewal gives opportunities through major strategic initiatives to tackle the underlying issues that create unequal vulnerabilities and compromise resilience. Therefore, we suggest that the definition of disaster recovery be expanded to reflect the opportunities to renew our society for better lives,

> "*The sustainable restoration or improvement of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, which reduces future disaster risk and tackles underlying causes of risk through transformational renewal initiatives*" *(Authors definition)*

Renewal, and the addition to UNDRR's definition, puts emphasis on recovery being relatively short-term and transactional but offering the opportunity of major societal transformation. This will require co-production of renewal with disaster-affected people to ensure transformation integrates local needs that may fall outside dominant conceptualizations of recovery and resilience (Shaw et al., 2020). This steps towards a normative recovery agenda that recovers and improves the lives of disaster-affected people, and in ways that are locally appropriate. It is also important to ensure the sustainability of recovery, renewal and resilience policies more broadly (Sou, 2019).
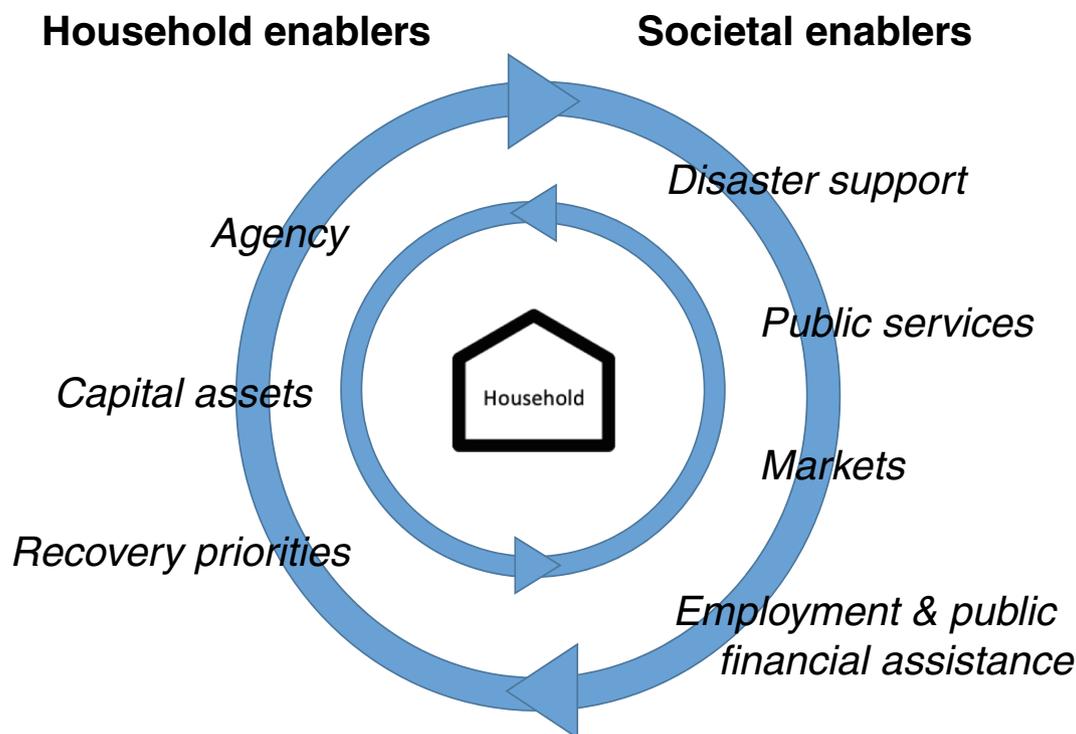
Household enablers   Societal enablers

Fig. 3. The relationship between household enablers and societal enablers, which shape household recovery over time.

Second, households pursue similar recovery ends e.g. enhanced income levels, wellbeing, aesthetics, housing, health. However, the quality and quantity of these recovery ends differ. Third, households mobilise their agency to leverage their assets and recovery priorities to mitigate and adapt to the four major societal conditions (Disaster support; public services; markets; employment and public financial assistance). This interaction between household characteristics and changing societal conditions determines households' capacity to engage in recovery activities. Thus, recovery pathways and speeds are highly heterogeneous across households. Fourth, household agency to recover is enabled by reliable and consistent information. Where dependable information is unavailable, households may engage in risk averse activities that they perceive will reduce disaster impacts. Fifth, household recovery is a highly gendered experience for household members, as women are likely to experience more adverse disaster impacts than men in the short, medium and long-term (Enarson et al., 2018). Finally, restructuring and extending households can mitigate impacts and facilitate recovery; however, intra-household relations may deteriorate and undermine recovery strategies.

Our analysis has focused on a single case, however, it yields implications beyond Puerto Rico and future research should further explore our findings. Specifically, a next step is to systematically investigate the differential effects of changing societal conditions on household recovery in other post-disaster contexts beyond Puerto Rico. Moreover, it is initially critical to understand household recovery over time through a qualitative methodology as this will give needed insight into how and in what ways households experience recovery.

7. Annex: Informative questions used during each interview

a. How is your family experiencing the impacts of the hurricane?
b. Has your family engaged in any activities to recover from the hurricane?

c. What support have you received and who was this from?
d. Is your family facing any challenges to recover?
e. What does your family require to recover?
f. What are your recovery priorities?
g. How are the relations between family members?
h. How is the family's morale and attitudes towards recovery?
i. How will you know when your family has recovered?

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