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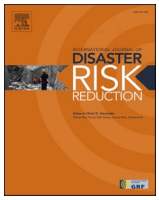

Leverages and obstacles facing post-cyclone recovery in Saint-Martin, Caribbean: Between the 'window of opportunity' and the 'systemic risk'?

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ABSTRACT

The 2017 hurricane season in the Caribbean Basin recorded 18 events (storms and hurricanes), including Category 5 hurricane Irma on which this article focuses. The aim of this study is to analyse the 'window of opportunity' of the post-Irma reconstruction in Saint Martin. Located 250 km north of Guadeloupe, Saint Martin is a small bi-national island composed of two entities: Sint Maarten in the south (state of the Kingdom of the Netherlands) and Saint-Martin in the north (French overseas 'Collectivité'). Our research focuses on the French region, and reconstructions and formalises various attributes, operations and sectors preceding and following the passage of the cyclone. This research highlights twelve key variables distributed within four interdependent spheres (political-administrative, economic and financial, socio-cultural and land-use planning) of Saint-Martin's vulnerabilities. This is represented and analysed schematically through an 'influence diagram' (ID). The research outlines the balancing or reinforcing effects of four major variables of the post-disaster period: state re-engagement, post-disaster price increases, intra-communal solidarity and updating risk prevention plans. It appears that disasters alone cannot be considered as a 'window of opportunity' given the weight of pre-existing structures and operating patterns. The case of Saint-Martin illustrates the inertia of a system in the face of a major event, despite strong decisions to implement disaster risk reduction and recovery.

1. Introduction

The post-disaster recovery process begins when the emergency phase of a hazard event is over and relief operations are no longer active. This includes rebuilding housing, permanently replacing damaged infrastructure and buildings, fully restoring all services and revitalising the economy [1–3]. One of the major challenges in this process is to meet both the immediate and long-term physical and psychosocial needs of the population [4]. Thus, post-disaster recovery is a complex and multi-faceted process which extends over decades [5,6].

Additionally, the post-disaster period must meet the injunction of rebuilding resilient territories and societies, based on the postulate that this period is a *'window of opportunity for change'* [7,8]. Damage and disorganisation in the aftermath of a disaster act as a magnification of the vulnerabilities of the affected territory[1] [9,10]. This can create an opportunity to 'take advantage' of the post-disaster period to rebuild differently [11–16]. Beyond creating *'an opportunity for reducing weather- and climate-related disaster risk'*, reconstruction and recovery also create *'an opportunity to* […] *build adaptive capacity'* [17]:10. These two major challenges were clearly expressed by D. Gibbs, the President of the 'Collectivité' (local authority) of Saint-Martin after Category 5 Hurricane Irma when he declared:

> *"Irma almost wiped us off the map but instead she put us at the centre of the world. We must become a model of resilience and adaptation to climate change"* (Territorial Council of Saint-Martin, 09.11.2017).

Seizing the opportunity of a disaster to rebuild differently refers to the concept of Build Back Better (BBB). This first appeared from the Yokohama World conference for Disaster Risk Reduction (DRR) in 1994 and was then reaffirmed in the Hyogo Framework for Action in 2005. Eventually, BBB was adopted as Priority Number 4 of the Sendai Framework for Action [18]. BBB is defined by the United Nations as the way of increasing resilience of nations and communities through *'integrating DRR measures into the restoration of physical infrastructure and*

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[1] The territory can be defined as a portion of geographical space that is appropriate and developed by human societies. It also 'coincides with the spatial extend of a government's jurisdiction' [110].

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societal systems, and into the revitalisation of livelihoods, economies, and the environment' [19].

However, the preventive role of reconstruction can be questioned due to the persistence of risks, the difficulties of disaster victims in recovering and the lasting deterioration of living conditions after a disaster [20–24]. The disaster does not 'wipe the slate clean' of the past, and reconstruction does not start from a blank page that is free of legacies on which everything could be rebuilt better. Conversely, post-disaster recovery build on existing politico-administrative, economic and socio-cultural structures [25–27]. Thus, many obstacles (political, regulatory, technical, organisational, social) constrain the capacity of post-disaster recovery to be a tipping point for the bifurcation in the trajectory of vulnerability of socio-territorial systems [28–30].

Focusing on the French part of Saint Martin Island (Saint-Martin herein), we question the 'window of opportunity for change' opened by the post-disaster period. This is through analysing the leverages and pitfalls for the implementation of a DRR process over the three years following Hurricane Irma. The island of Saint Martin, located in the Lesser Antilles, consists of two territorial entities separated since 1648 by the Mont des Accords Treaty: Saint-Martin (a French 'Collectivité d'Outre-mer') and Sint Maarten (one of the four constituent countries of the kingdom of the Netherlands, with the Netherlands, Aruba and Curacao – [31]), that both benefit from an administrative autonomy from their mainland (Fig. 1.). As a 'Collectivité', Saint-Martin is composed of a territorial assembly and an executive council led by a president that has communal, departmental and regional competencies (in the fields of taxation, road traffic and road transport, roadways, state law, access to work for foreigners, tourism, town planning, construction, housing and energy).

The development of Saint-Martin has been constrained by its mountainous topography, which explains the concentration of urbanisation and infrastructure in the coastal lowlands, including reclaimed areas (Fig. 1.). These coastal areas saw a sudden population growth in the 1980s, motivated by the tax exemption policies which generated a large influx of Caribbean labour force. This, combined with the development of a tourism mono-economy, led to the dense occupation in areas highly exposed to climate and sea-related hazards. From a social point of view, Saint-Martin is a cosmopolitan island (a multinational, multi-ethnic and multicultural population gathering more than a hundred nationalities), with communal lifestyles [32,33]. Almost half of the population (38,002 hab., World Bank,2019[2]) is under 30 years of age, 60% of whom are under 15 years. In 2018, the unemployment rate was 35.2% of the active population, one of the highest rates among French overseas territories [34]. Only Guyana (24%) and Mayotte (35%) have comparable employment figures [34].

In the night of 5–6 September 2017, the island of Saint-Martin was hit by Hurricane Irma, with severe material and human consequences. 11 were found dead and 2 missing [35,36]. With approximately 1.2 billion euros in damages, Irma was the most expensive event since the creation of the French Natural Disaster Compensation Scheme in 1982 [37].

The post-Irma recovery process in Saint-Martin is relevant for analysing the post-disaster 'window of opportunity' in three main respects:

i) Irma revealed an accumulation of structural, organisational, social and economic vulnerabilities;
ii) the magnitude of the damage and destruction (95% of buildings and infrastructure) paved the way to an exemplary and preventive physical reconstruction, and;
iii) both the restructuring of governance, notably through the renewed commitment of the State, and the allocation of financial resources for reconstruction were liable to support the reduction of organisational and structural vulnerability.

This article focuses on a holistic approach of the post-disaster period without neglecting crisis management, nor the long-term construction of root causes of vulnerabilities [38–41]. This study has three overall aims. The first is to interpret the key drivers of Saint-Martin's vulnerabilities on the eve of Hurricane Irma, building on and complementing their identification in a previous study by Duvat and colleagues [42]. The second is to analyse the variables that interact and influence each other to highlight the recovery processes that contribute to the strengthening or balancing pre-existing vulnerability patterns. The final concluding aim is to understand the extent to which induced changes in the vulnerability dimensions (social, structural, organisational, etc.) opens a 'window of opportunity' for Saint-Martin.

2. From the 'window of opportunity' to the 'systemic risk': literature review on post-disaster reconstruction and recovery

2.1. The reconstruction process as a 'window of opportunity' to Build Back Better?

The *emergency period* – which brings together the clean-up, rescue and emergency resettlement activities – marks the beginning of the post-disaster period [11,43]. This is followed by a *restoration period*, during which damage is assessed, resources are allocated, and the affected population moves from emergency shelters to temporary re-housing facilities [44,45]. Following this, the *rehabilitation period* takes place. This primarily includes securing and restoring vital services and networks. Finally, the *reconstruction, recovery and development period* involve re-housing affected people on a long-term basis and implementing [re]development strategies [23,46–48]. Post-disaster reconstruction, therefore, implies meeting the challenge of matching immediate responses with longer-term planning. Facing this, governance – i.e. the actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemented – is frequently restructured [49–53]. Indeed, the post-disaster phase often suffers from the absence of a single policy and guidance framework, especially when compared to other phases of risk management (such as prevention or crisis management). Due to the intervention of multiple actors (stakeholders, network operators, funders, associations, first responders, etc.), it mobilises a multitude of tools and frameworks. The major challenge of post-disaster governance is therefore the coordination of these frameworks in action. This is in order to implement measures that meet immediate needs on the one hand, and to plan for less vulnerable and more resilient development on the other. Among the variables that contribute to post-disaster recovery as an opportunity for change toward adaptation are new knowledge [s], enhanced political will to reduce risks from future disasters, and the de-compartmentalisation of the governance modes [16,45,52,54,55].

As stated by Birkmann and colleagues [7]:638, *"Disasters can catalyse structural and irreversible change by creating new conditions and relationships with environmental, socio-economic and political structures, institutions and organisations"*. The development of BBB assumes that post-disaster recovery opens a 'window of opportunity for change' [16,24,56,57]. Preventive gains can be analysed at different scales, and the 'opportunity effect' generated in the post-disaster period does not necessarily apply to all scales and sectors in the same timeframe [58]. Thus, one of the pitfalls with the current design of the BBB injunction is that it implies there is a recipe to be followed to be/become resilient and develop in a sustainable way; as though this can be achieved through a list of good practices that can be implemented whatever the previous situation of the territory and the variety of individual situations that it gathers. However, as scholars have emphasised, 'a silver bullet' or 'single, miracle solution' does not exist [39]. The post-disaster recovery process is neither uniform nor homogeneous in time-space respects, and local

[2] https://data.worldbank.org/country/MF.

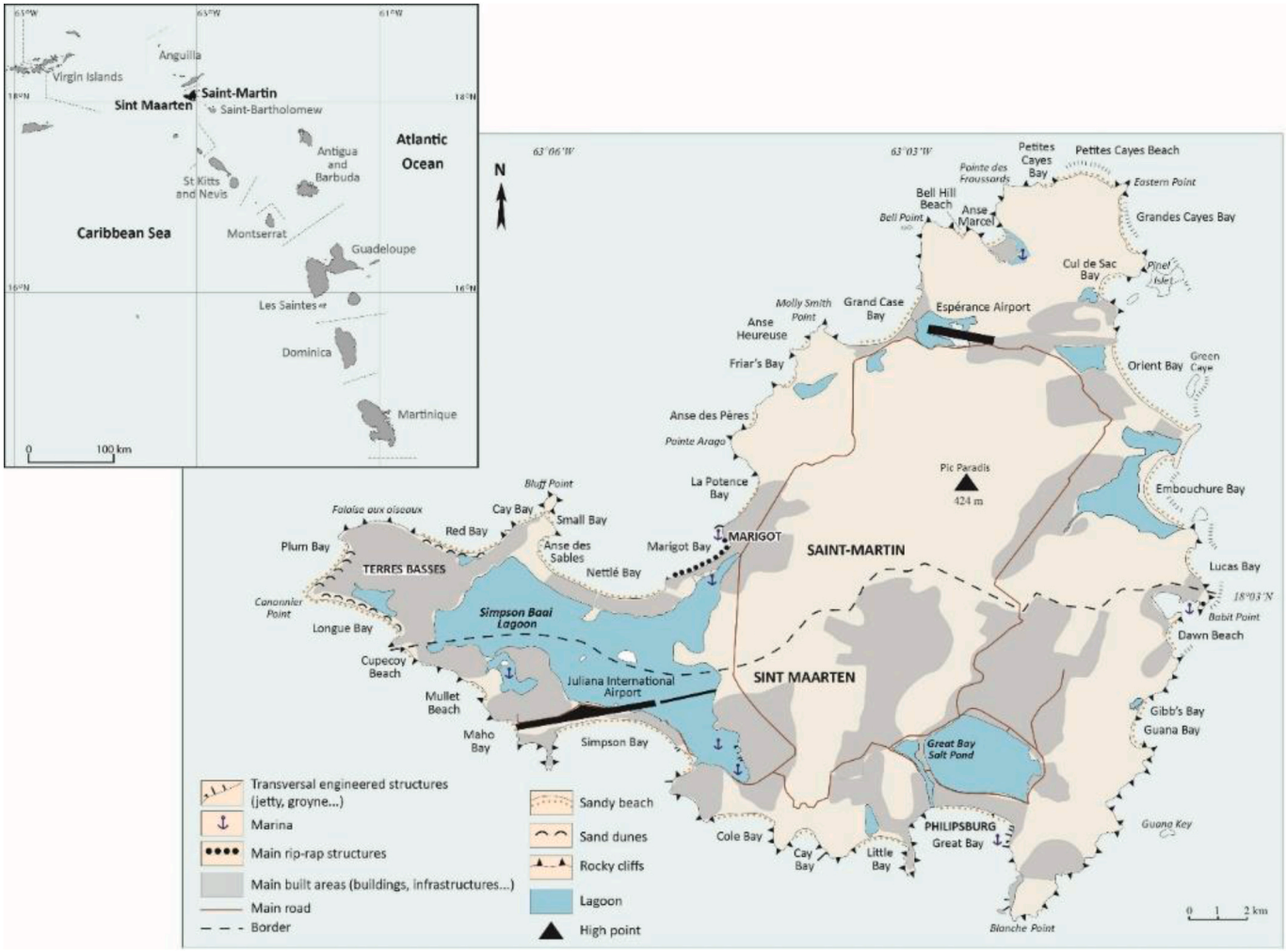

Fig. 1. Saint-Martin, a small bi-national Caribbean island with densely urbanised coastal areas.

variations in temporality can be observed from the individual scale to that of districts and social groups [48,59]. These variations find their origins in the severity of the damage, the location of the affected households, the chosen reconstruction strategy (for example identical or different, on site or by relocating), and in the structuring socio-economic factors which pre-exist and lead to disaster (economic means, access to resources, knowledge in key areas) [51]. They are also grounded in the 'root causes' of individual and collective vulnerability, and despite the collective efforts of public authorities supported by solidarity actions, emergency and crisis situations often drag on for the most precarious [5,40,60,61].

2.2. The triptych 'resilience – vulnerabilities – capacities' to highlight the recovery-related 'systemic risk'

Resilience, vulnerabilities and capacities are core concepts used to understand the issues and failures of the 'window of opportunity' for BBB in post-disaster contexts. Indeed, recent research on post-disaster recovery process reveals a large number of technical, organisational and socio-politic obstacles in the implementation of 'resilient' and 'sustainable' recovery [30,62–65]. Those constraints are rooted in the combination of a lack of resources and the difficulty of mobilising them effectively to respond to the emergency, all the while not hindering future development [51]. These pitfalls point out that the term 'window of opportunity' downplays the complexity and diversity of societal processes at the root of vulnerabilities and recovery capacities. Indeed, vulnerability *'stresses the condition of a society which makes it possible for a hazard to become a disaster'* [39]:219, and thus encapsulates all the facets of a *'situation that influences [its] capacity to anticipate, cope with, resist and recover from the adverse effects of physical events'* [66]:11. In the face of major disasters, damage, disorganisation and reconstruction efforts involve all the socio-territorial patterns. Within the reconstruction process, the concept of capacities can often bridge the link between vulnerabilities and the pitfalls of implementing DRR strategy. Capacities refer to the combination of all strengths, attributes and resources, and their accessibility and availability that individuals and communities have and develop to manage and respond to a disaster [17,39]. By focusing on societal responses, the 'window of opportunity' approach also makes it possible to question 'maladaptation': actions and decisions (often labelled as adaptation) that do not help people to cope with change and may even worsen existing problems in the future, or may reduce the capacity to respond to future events and crisis [67,68].

By studying the effects of disasters over several decades, the social science has provided evidence of the strong influence and potential prevalence of long-term vulnerability drivers, which may challenge the capacity of the reconstruction process to increase resilience and reduce vulnerability in post-disaster periods [16,69]. These processes question both the disaster 'window of opportunity' effect and the system inertia over time, with the premise that reconstruction is fundamentally a 'socially-configured' process [61]. Using the term 'window of opportunity', once again, minimises the complexity of the *'definition of reconstruction goals, the identification of socially acceptable and feasible*

adjustments and mitigation measures' [70]:1. These choices need to be made within very compressed timeframes and with limited resources, as human and financial resources are often diverted from their main and routine tasks to support reconstruction efforts [71–73]. Furthermore, post-disaster action and decisions can sometimes amplify feedback loops that showcase how disasters may be responsible, or contribute to significantly to, macro-level poverty traps [58,74,75]. Therefore, while reconstruction can be seen as an opportunity for adaptation, it can also have the characteristics of a 'systemic risk', this is to say that it is likely to destabilise the system, as a whole, by spreading maladaptation through a domino effect [51].

Post-disaster reconstruction is characterised by this double dynamic of willingness to restore and preserve what previously existed in order to provide reassuring continuity on the one hand, and on the other hand, the need to adapt to prevent the root causes of vulnerabilities from being recreated or reinforced. *'For disaster-affected communities and individuals, there may be no swift and easy way back to the pre-disaster state. Nor is the pre-disaster state, the vulnerable normal, necessarily an aspiration, given that this state includes the vulnerability that caused the disaster in the first place'* [4]:647. Indeed, it takes time to reconcile the resilience of disaster-affected people to restore their daily lives and livelihoods, while also planning for longer-term reconstruction efforts to align with national and international development objectives. Time which is often lacking in post-disaster situations [4,76]. Thus, the recovery period can increase the vulnerability of all or part of a system through the disorganisation of mobilising resources, the inadequate regulatory framework for post-disaster management, the tense social and political climate [26,61,77].

3. Material and methods

3.1. Qualitative survey methods

The data used for this article draws from existing literature (scientific and grey, including reconstruction plans, Binational treaties, Court of Auditors' reports and minutes of public meetings) and local press review (Soualiga Post and St Martin's Week), and is combined with field surveys conducted in October and November of 2017 and 2018. In terms of research ethics, the post-disaster reconstruction follow-up raises questions, as 'gold rush attitudes' have been reported in various disaster areas, and the Caribbean basin is no exception [78,79]. As the first field mission was carried out one and a half months after Hurricane Irma, the authors have taken particular care in preparing it by acquiring knowledge about the territory through existing literature, and conducting preparatory interviews with key stakeholders aiming to explain our research and establish a local network. We guaranteed anonymity and confidentiality (particularly for elements related to ongoing legal proceedings) to the respondents. Finally, we implemented a flexible strategy by adapting the format of the interviews (individual or collective), their duration (between 30 min and 2h30), the place (home, place of work, public place, café, etc.) as well as the time of the appointments in order to constrain our respondents' agendas as little as possible.

During fieldwork, two of the authors carried out 58 semi-structured individual interviews[3] (Table 1.) and two non-participating observations at meetings of the Territorial Council. The results obtained were analysed qualitatively and aimed to represent the views of the actors in charge of reconstruction. The preparatory work for the field missions in this compact geographical area, combined with the small number of actors in charge of reconstruction, allowed us to clearly identify the resource persons and the main actors at the national and local levels. Regarding communication flows, non-participant observations were supplemented by a description and identification of the channels and methods of communication between actors during individual interviews. Finally, the results of this research were validated on the one hand through expert opinion, and on the other hand through exchanges with resource persons. Furthermore, we were inspired by work in Social Network Analysis [80,81], but our approach remained focused on influence diagrams approach in order to keep the emphasis on interactions between variables. The analysis of the interplay of actors and governance being invited to explain these interactions rather than to analyse them *per se*.

To cover the various territorial scales from local to national, the authors interviewed local and national risk management stakeholders, NGOs, local associations, journalists, insurers, teachers, security officers and citizens' representatives. Shown in Table 1., the themes covered by the interviews included the preparedness and the alert, the management of the crisis and the phases of restoration, rehabilitation, reconstruction and recovery (X stands for topic addressed, and 0 stands for not addressed). These last few phases were still underway during the time of interviewing. As a result, it is not yet clear if and how the changes initiated in the post-disaster period will have lasting impacts and how far-reaching consequences will manifest.

For each of the phases covered by the survey protocol, we collected the narrative of key facts and moments, and asked respondents to identify vulnerabilities as well as resources and capacities experienced. The interviews were transcribed in a 'smooth' way (i.e. without including speech pauses and language tics) and the verbatims were synthesised in an analysis matrix. This analysis matrix included the themes of this research (i.e. phases of the disaster, causes of vulnerability, and resources and capacities) and highlighted a list of variables which characterises the post-Irma reconstruction context of Saint-Martin. Then, by correlating the findings from the existing literature on Saint-Martin's vulnerability with the variables resulting from our interviews, the authors extracted 12 major variables which characterise the situation of Saint-Martin on the eve of Hurricane Irma. The analysis of these variables highlighted four spheres that encompass them: political and administrative, economic and financial, socio-cultural, and land-use planning (Fig. 2 and 3.). Within each sphere, the variables were ranked from 1 to 3, starting from the broadest territorial scale (1) to the finest (3).

3.2. Building influence diagrams (IDs)

Analysing the post-disaster 'window of opportunity' with influence diagrams (IDs) may be a useful way to identify conceptual and theoretical frameworks to formalise key drivers and processes operating over the post-disaster recovery period [67,75,82,83]. Formalising adaptations after an event is a methodological challenge because: i) adaptation is a dynamic process, ii) adaptation measures change situations and, iii) these evolutions generate the need for new forms of adaptation in return [67]. Furthermore, change is driven by interconnected variables produced by various types of actors (from institutions to citizens and their groups of interests) who continually modify local conditions and context [81]. The notion of *feedback* becomes important: the action of a system in return for changing one of its parameters [76,84]. When the feedbacks between the different variables lead to an amplification of the disturbance, the feedback loop is positive, also known as a reinforcing loop [76,85]. Conversely, when the feedbacks lead to a decrease of the disturbance, it also modifies the balance of the system, in the direction of homeostasis: the feedback loop is then negative, known as a balancing loop [76,85].

Formalising the window for change in post-disaster recovery is complex *'since the interacting forces behind the opening a window of opportunity and the possible exploitation, constitute a huge complexity when it comes to actors, driving forces, economic forces, what opened the window, why and when was it closed etcetera'* [16]:2. Thus, we started by

[3] An interview code is used to identify each actor interviewed; it includes a number, an abbreviation of the respondent's function and the location of the interview (in italics). The location *'island'* refers to interviews conducted in several locations with various representatives of local associations or press.

Table 1
Interviews conducted, and periods covered with each type of actor consulted.

Interview code	Stakeholder *(nb of interview.s)*	Scale	Responsibilities	Prevention and crisis	Post-disaster
Int.1_pref_*PtP*	Prefecture *(5)*	National	Environment, Control of legality, Housing, Finances	X	X
Int.2_prefloc_*marigot*	Local State services *(1)*	Local	Environment, Control of legality, Housing, Finances	X	X
Int.3_irm_*marigot*	Interdepartmental Recovery Mission *(4)*	National	Post-disaster recovery	0	X
Int.4_com_*marigot*	'Collectivité' risk service *(2)*	Local	Risk management and politic	X	X
Int.5_cesc_*marigot*	'Collectivité' Economic, Social and Cultural Council *(1)*	Local	Socio-cultural and economic management and politic	X	X
Int.6_gend_*concordia*	National police force *(1)*	National	Security	X	0
Int.7_port_*galisbay*	Public port authority *(1)*	Local	Harbour management	X	X
Int.8_ednat_*marigot*	National Education *(3)*	National	Education	X	X
Int.9_lpo_*marigot*	Vocational school *(4)*	Local	Education	0	X
Int.10_syndic_*savane*	Secondary School Teachers' Union *(1)*	Local	Education	X	X
Int.11_deal_*marigot*	Department of the Environment, Planning and Housing *(1)*	Local	Environment, Control of legality, Housing, Land-use	0	X
Int.12_sgrepres_*sandyground*	Sandy Ground district representative *(1)*	Local	Politic	X	X
Int.13_sem_*marigot*	SEMSAMAR (semi-public company of Saint-Martin) *(1)*	Local	Housing	0	X
Int.14_frig_*galisbay*	Logistic service *(1)*	Local	Logistic	X	X
Int.15_crf_*concordia*	French Red Cross *(3)*	National	Solidarity and individual support	X	X
Int.16_fdf_*hopeestate*	Fondation de France *(1)*	National	Solidarity	0	X
Int.17_compbat_*sandyground*	National NGO Compagnons bâtisseurs *(1)*	National	Solidarity and individual support	0	X
Int.18_secpop_*paris*	National NGO Secours Populaire *(1)*	National	Solidarity and individual support	0	X
Int.19_locasso_*island*	Local NGOs *(11)*	Local	Solidarity and individual support	X	X
Int.20_rotary_*marigot*	Rotary Club *(2)*	Local	Solidarity and individual support	X	X
Int.21_locpress_*island*	Local press – Soualiga post and St Martin's Week *(6)*	Local	Information	X	X
Int.22_frceinfo_*marigot*	National press – France Info *(1)*	National	Information	X	X
Int.23_ruidn_*paris*	Emergency radio for the northern islands – radio France *(1)*	National	Information	X	0
Int.24_insu_*lamentin*	Insurance *(1)*	Local	Post-disaster compensation	0	X

representing the main drivers that made Saint-Martin vulnerable to Irma (Fig. 2.). Following, we explain how they can be balanced or reinforced by post-disaster decisions and actions (Fig. 3.). Systems operate according to three *modus operandi,* that can be understood through process analysis: production, reproduction and transformation of spatial structures [86,87]. Appearances, disappearances, and changes of state are bifurcations in the spatial-temporal processes that may be largely due to the intervention of small-scale fluctuations around critical thresholds [88,89]. Here, we are analysing Saint-Martin from the pre-hurricane situation to until approximately three years later, using the pre-hurricane situation as a baseline.

A primary criticism of IDs is that they often do not allow the representation of *'the smoothed nature of the caused effect over time'* [82]. Producing before and after IDs aims at avoiding the production of 'static thinking' by working on the dynamics and drivers of post-event adaptation. Basically, it is the lack of consideration for the temporal dimension of phenomena which is criticised [82,90]. By including the behavioural pictogram (the purple triangles in Fig. 2 and 3.) we have reintroduced the temporal dimension of the evolution of the variable's behaviour over time [82]. Given the lack of temporal hindsight on the reconstruction actions underway at the time of the study, we did not assign a behavioural pictogram to the post-disaster variables as it is impossible to predict whether these variables will be punctual to persistent, extended to the whole territory to very geographically or socially specific. Nevertheless, together these adjustments make it possible to better describe and understand processes driving change. We, however, acknowledge that it is impossible to identify and describe all of the causal links, balancing and reinforcing loops that make up systems. In line with Lin and Chien [91]:6, we argue that *'it is better to capture the important feedback loops in a system than to pursue unnecessary complexity or detailed definition'*. Following this principle, we chose three drivers per sphere and deliberately restricted the number of arrows and loops (thus reducing the number of influence and feedback relations). These choices were made by crossing the variables obtained from the interviews with previous studies: only the links and feedbacks cited by both a majority of respondents (and validated by resource persons), and the literature were retained to produce the results presented below.

4. The four spheres involved in social production of disasters in Saint-Martin

Saint-Martin's vulnerability to climate and sea-related hazards has emerged from the combination of past political and economic legacies, the growing exposure of coastal human assets, and the socio-cultural specificities of this territory [42,92]. Fig. 2 summarises the main variables involved in Saint-Martin's vulnerability and their interrelations. The sub-administration (I.2) of the territory associated with the tax exemption system (II.2), has led to a lack of coherence in land-use planning and more specifically, a dense urbanisation of coastal hazard-prone areas (IV.1). As a result, advocacy groups (III.3) formed to represent and defend divergent or even opposing interests, which take land pressure as a common foundation. Before the September 2017 disaster, only three variables were stable: weak cross-border cooperation (I.1), high external dependency (II.3) and social fragmentation (III.1). Both sub-administration and the tourism mono-economy (encouraged by the tax exemption system) contributed to their persistence over the past three decades, and therefore to their structuring role in the system. The nine other variables all showed a growth trend before the disaster insofar as they maintained reinforcing loops with each other.

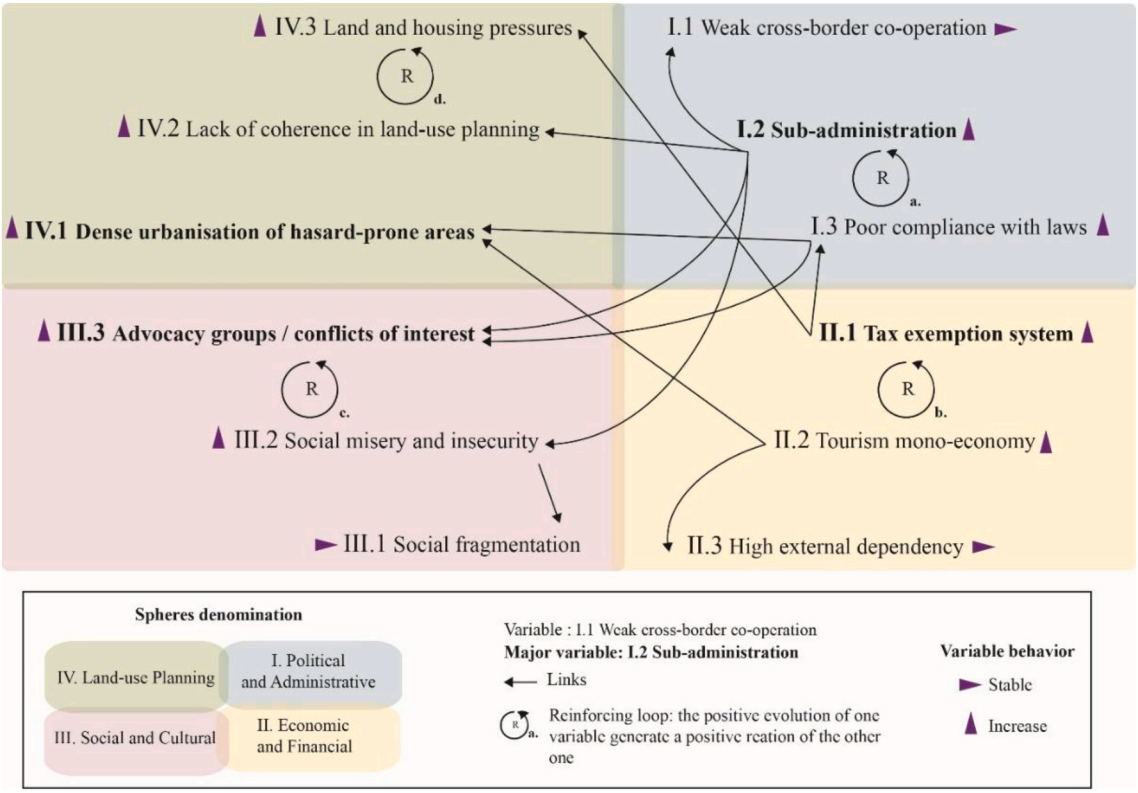

Fig. 2. Influence diagram of the pre-Irma situation on Saint-Martin.

4.1. The influence of the politico-administrative sphere (I) on socio-cultural assets (III)

The sub-administration of the territory (I.2) – officially recognised by the French Republic after Irma [35] – is the main variable in the political-administrative sphere, as it generates most causal links and feedback effects. The term sub-administration brings together the COM's weak capacity to administer its territory and the State's disengagement from this overseas territory, both of which suffers and benefits from a situation of 'double insularity' [32].

As a bi-national island, Saint-Martin could have benefited from additional means and resources by cooperating with Sint Maarten [92]. *Trans*-border institutional cooperation had been the subject of a treaty in March 2015, including mutual assistance in the event of mass demonstrations, major events or disasters (Police Cooperation Treaty between France and the Netherlands, 2015). This Treaty also deals with law enforcement, illegal trafficking, illegal immigration and crime. Despite this Treaty, administrative relations between the two parts of the island remained limited. This weak cooperation (I.1) is the responsibility of both the French and Dutch administrations (the consequences in terms of sub-administration can also be seen on Sint Maarten – [54]). This resulted in a lack of coherence in risk management policies and strategies, whether related to natural, economic or social hazards, and has contributed to the widening of the gap over the decades between the most affluent and the least affluent social categories [31,42,92].

In addition, a third variable intervenes in this political and administrative sphere: the poor compliance with laws (I.3). This variable reinforces sub-administration, since all legislative means are not mobilised by the stakeholders, particularly in terms of risk management and internal security (policing). Sub-administration results in a lack of inclusion of climate and sea-related risks in land-use planning (IV.2) (which is nevertheless consistent with a short-term tourism development objective), and in the non-application of French planning standards (notably the Coastal Law, which imposes setback guidelines in the coastal zone – [42]). Sub-administration also generates and maintains – or at least fails to curb – social misery and insecurity[4] (III.2), whether perceived or experienced, while also encouraging the development of advocacy groups (III.3).

These variables are part of the social and cultural sphere (III) which relates to the quality of life and lifestyles. The latter are communal and spatial patterns that reflect the lack of social diversity and the social fragmentation (III.1) prevailing in Saint-Martin. Indeed, the neighbourhoods are very heterogeneous among themselves, with the social, cultural and economic characteristics being homogeneous within the neighbourhoods. There are significant income disparities between them, which generate jealousies and feelings of injustice in the face of multi-speed development and reconstruction (Int.5_cesc_*marigot*). In addition, the geographical position of the island and the 'regulatory vagueness' make it a crossroads for drug and arms trafficking in particular. In this context, insecurity is one of the drivers shaping the local social climate (Int.19_locasso_*island,* Int.21_locpress_*island*). Directly linked to the sub-administration and poor compliance with law (i.e. circumvention of the law or non-compliance with it, fictitious jobs in the 'Collectivité', etc. [93]), the authorities are mistrusted by the population, paving the way for the development and consolidation of advocacy groups. The presence of these groups generates positive feedback on

[4] The term insecurity is here understood in a broad sense, i.e. it encompasses crimes and incivilities as well as precariousness and marginalisation.

social misery and insecurity insofar as some of these advocacy groups are sometimes involved in illegal trafficking (arms, drugs, even organs) [33]. Sub-administration enables and feeds the widening of the gap between the most precarious and the most well-off, thus generating the fragmentation of Saint-Martin's society: *'There is here the problem of the different groups in this very diverse society marked by an unmixed multiculturalism'* (Int.3_irm_*marigot*).

4.2. The economic and financial (II) strategy and their consequences on land-use planning (IV)

The major variable in the economic and financial sphere (II) is determined by the tax exemption system (II.2), which is marked in particular by the succession of tax exemption laws (Pons:1986–2000, Paul: 2001–2002, Girardin: 2003–2017, Pinel Outre-mer: 2014–2016). These laws have mainly boosted the construction of housing for residential and tourist purposes, thus encouraging the development of a tourism mono-economy (II.2) that is very vulnerable to coastal risks (drop in 40% of visitor after Hurricane Luis in 1995, Int.2_prefloc_*marigot*). The poor diversification of income sources and livelihoods has led to a strong external dependency (II.3), both for imports (food and building materials in particular) and for income (mostly generated by tourism).

The tax exemption system in place in the French West Indies and Saint-Martin, – despite its beneficial impacts (i.e. investment attractiveness and tax cuts) – has also had many perverse effects. This includes the low quality of construction (acceptance of constructions that do not comply with construction standards and French regulations, Int.3_irm_*marigot*), the lack of involvement of owners and the overdevelopment of the tourist sector, for example. As highlighted by one of the interviewees:

> *'In Saint-Martin, tax exemption has caused the number of co-properties to explode and in some cases the owners don't even know they have a flat there'* (Int.24_insu_lamentin).

Despite the succession of tax exemption laws that were supposed to resolve the shortcomings of the previous ones [35], this financial strategy has *"led to excessive investment in certain sectors and created instability in the economic fabric without correcting the inequalities of the territory"* (Int.1_pref_*PtP*).

Concerning land and housing pressure (IV.3), the population has more than quadrupled between 1982 and 2000, although this has been in slight decline over the last fifteen years [42]. The immigration generated by the need for labour caused by the tourist boom generated a rapid and sharp increase in population densities in only twenty years (Int.1_pref_*PtP*):

> *'With the tax exemption laws, buildings were constructed to excess and labour force had to be brought in from the neighbouring islands* via *Sint Maarten. After this construction phase there were not many job opportunities for them but they stayed'* (Int.5_cesc_*marigot*).

Regarding the pressure on housing, long-term renting suffers from competition from seasonal housing, which rapidly became much more profitable for owners (Int.11_deal_*marigot*). Land tensions and housing pressures associated with the lack of coherence in land-use planning are two mutually reinforcing variables; this is to the extent that land-use planning arrangements fail to counteract the perverse effects of successive tax exemption laws. The other consequence of this mono-economy is the very dense urbanisation of the coast (IV.1) where inhabitants, critical infrastructures and networks as well as tourist complexes are massed [42]. This model is also evident in Sint Maarten, where this situation is accentuated by a lack of updated, monitored and enforced building code [31]. All of these area and sectors differ in terms of activity, comfort and cost but which are all on the niche of the 'all-inclusive small paradise standing in water'. They are very vulnerable because they are both highly exposed and poorly maintained, which reduces their capacity to withstand shocks, on the one hand, and their ability to quickly recover their functionality after shocks on the other.

This dense urbanisation of the territory has proceeded in spite of French land-use laws [42]. With regard to the reduction of vulnerability, the local authorities (the prefects) are mandated for the design of risk maps, the '*Plans de Prévention des Risques'* (risk prevention plans, or PPR) which are equivalent to a public utility easement [72]. This means that no construction can be authorised in areas with the greatest risk levels, or only under certain constraints. Saint-Martin's PPR dates from February 2011 and was revised after Hurricane Irma in 2017 (Int.1_pref_*PtP,* Int.4_com_*marigot*). The State wishing to restrict reconstruction on the seafront has initiated an early approval procedure, which has not yet been completed due to conflicts between the 'Collectivité' and the population on one side, and State services on the other.

5. Balancing and reinforcing effects of post-IRMA decisions and actions on existing vulnerabilities

Fig. 3 responds to Fig. 2 by including the main drivers resulting from the decisions taken in the aftermath of Hurricane Irma. The renewed engagement of the French State in the administration and development strategy of Saint-Martin has had a balancing effect (balancing loop 'a.') on all the variables of the political-administrative sphere. This counteracted pre-existing trends in the social and cultural sphere (III), and in land-use planning (IV). The post-disaster price increase accentuated the already high external dependency, especially for imports (reinforcing loop 'b.'), and for the most precarious, dependency on external aid, in particular to rebuild their homes.

Given the path of Irma and the very active hurricane season, this heavy external dependency has contributed to extended reconstruction delays, especially for those who had neither the financial resources nor the social network to import materials by any other means than traditional suppliers. Indeed, while the social fragmentation of the territory reflects a multi-speed development and high socio-economic inequalities, it also implies local and community variations in the reconstruction process, particularly in terms of the temporality and duration of the crisis and emergency phases, which can last for a long time for the most precarious people, in connection with the strong reliance on external aid [24,45,61,94]. Under these circumstances, intra-community solidarity strongly developed and generated both a balancing effect on social misery and insecurity (balancing loop 'b.') and a reinforcing effect on social fragmentation (reinforcing loop 'c.'), which became more pronounced in the aftermath of the disaster. The post-disaster social climate in Saint-Martin was highly tense and the willingness of the national public authorities to implement the PPR by anticipation has stirred up additional latent conflicts. Nevertheless, the update of the PPR has had a balancing effect on the low level of compliance with law in terms of land-use planning in disaster prone areas (balancing loop 'c.').

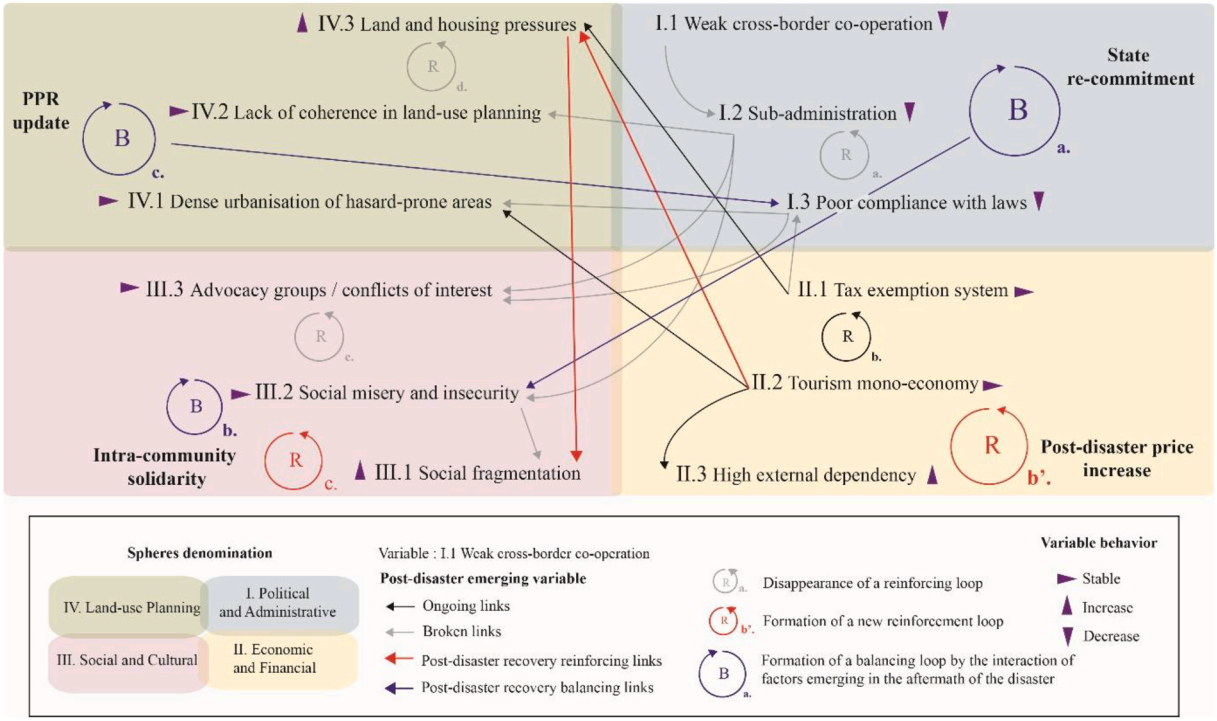

Fig. 3. Influence diagram of the post-Irma situation on Saint-Martin.

5.1. State re-commitment as an approach to change previous administrative and economic trends

The governance of risks and, more broadly, of socio-territorial systems, evolves systematically after major events (as developed in 2.1). Indeed, we observe an interdepartmental restructuration that generates a tendency to recentralise executive power [51]. Whether in Japan (Hanshin-Awaji Reconstruction Committee, in 1995 – [53,95]) or in New Zealand (Canterbury Earthquake Recovery Authority, from 2011 to 2016 – [52,96–98]), for example, national committee and minister were created to manage the reconstruction effort. Following Irma, the State re-commitment has had a balancing effect on the pre-existing vulnerability drivers of the politico-administrative sphere. A milestone action is the appointment of an interdepartmental delegate for reconstruction that is responsible for coordinating the action of State services (on September 14th, 2017). *'This symbol underpinned the State's message of strong support for the two devastated islands [of Saint-Martin and Saint-Bartholomew]'* [99]. The State re-commitment also took the form of the signature of a two-part cooperation Memorandum between the State and the 'Collectivité', in November 2017. The first part deals with cooperation in reconstruction process, and the second one covers the State's commitment to support the 'Collectivité's' budget as part of national solidarity.[5]

Further to this, the financial support is also substantial, insofar:

> *"the overall budget reaches 53 million euros to finance reconstruction and to fund 17 million euros of exceptional social aid paid to disaster victims. In addition, the European Union Solidarity Fund (EUSF), whose mission is to help territories cope with major natural disasters, has paid out a sum of 46 million euros, of which only part (28 million) has been spent to date due to the administrative delays accumulated by the community"* [100].

In September 2019, 6 million euros were programmed via the economic Memorandum signed between the State and the 'Collectivité' to rehabilitate damaged housing, 74% of which had been rebuilt by that date for both Saint-Martin and Saint-Bartholomew (Int.3_irm_*marigot*). By June 2019, 82% of the insured damage had been compensated for Saint-Martin (Int.24_insu_*lamentin*).

In addition, a territorial delegation of the Directorate for the Environment, Land-use planning and Housing (*Direction de l'Environnement, de l'Aménagement et du Logement* – DEAL) and of the Directorate for Employment Consumption and Labour were created in Saint-Martin. This made it possible to act directly on compliance with law on labour and land-use planning. One of the DEAL's missions is to examine the Barnier fund's[6] files and advise local authorities [72]. The Senate report [99], corroborated by our interviews (Int.4_com_*marigot,* Int.11_deal_*marigot,* Int.2_prefloc_*marigot*), highlights the difficulties of the 'Collectivité' to compile the Barnier fund's compensation claim files, both the preparation of the file and the use of the funds. Those difficulties are linked to the lack of skills within the 'Collectivité', as stated in the report of the territorial audit chamber [92]: *"recruitment of poorly qualified agents [who] remain unproductive for the public service"* (p. 5), and which presents *"irregularities in statutory matters and remuneration"* (p. 6). In order to enable the 'Collectivité' to claim the aid, three agents of the French Agency for Development were mobilised (Int.2_prefloc_*marigot*). Thus, while the State and the 'Collectivité' have shown a willingness to implement an exemplary reconstruction in terms of resilience (confers the Memorandum), the weight of pre-existing structures and functioning modes – that is, the inertia of the system – has severely limited the capacity of public actors at all scales to exploit the post-Irma as an opportunity for DRR.

These different forms of state re-commitment have helped to reduce

[5] The principle of national solidarity reflects the State's commitment to social and economic life and dates back to the economic crisis of 1930 and the post-World War II period. It is closely associated with the concept of the welfare state, and has led to the creation of several health and social protection institutions based on a system of compulsory insurance organised by the state (e.g. social security and unemployment insurance).

[6] In the event of major climatic events, the Barnier fund intervenes to compensate for damage not covered by home insurance [72].

the social misery of the most disadvantaged, at least temporarily (Int.5_cesc_*marigot,* Int.19_locasso_*island,* Int.20_rotary_*marigot*). Human supports to law enforcement agencies have contributed to curbing incivilities and trafficking. Between August and December 2016 and 2017, all forms of violence against the population fell by 7%, (Int.6_gend_*concordia*) due to an above average number of agents in Saint-Martin and Saint-Bartholomew (600 agents until November 2017) compared to usual (120) (Int.6_gend_*concordia*). Locally, the State re-commitment is experienced as a conflicting necessity, as witnessed by this statement of the president of the 'Collectivité':

> *"Our relations with the State must be, and are, cordial and constructive, but we will not allow ourselves to be dictated the terms of development in our island"* (territorial council of November 2017).

The post-disaster governance in Sint Maarten took the form of a National Recovery Program Bureau whose role is to coordinate managers and manage the reconstruction plan [101], and was also characterised by the Kingdom of the Netherlands re-commitment. Indeed, the Netherlands has released funds from the national budget (550 million euros) to support reconstruction, with the condition that the local authorities implement *'an anti-corruption watchdog and temporarily (hand) over border controls'* [31,54,101]. This was a prerequisite for rethinking cross-border cooperation, as evidenced by this excerpt from the report of the Interdepartmental Delegate for Reconstruction: *'the French state can no longer afford to act as a 'social buffer' for the populations living and working in Sint Maarten'* [35].

Given the extent of the reconstruction efforts in all sectors, cooperation was first rethought in the post-crisis period (which is marked by the Goteborg summit on December 1, 2017). This is largely in terms of reciprocal support to claim for European funding, even if the two entities do not have the same status, as Saint-Martin is an outermost region and Sint Maarten an overseas country and territory. The pooling of structural facilities in the fields of waste management, sanitation and water supply, as well as electricity and telecommunication networks was another objective of cross-border cooperation. In the area of waste management, for example, the Goteborg Declaration provided for the joint removal and treatment of shipwrecks stranded in the Simpson Bay lagoon. This operation has benefited from European co-financing under the 2014–2020 territorial cooperation projects.

Cross-border co-operation is also a major issue regarding tourism, and the current COVID-19 situation is a clear demonstration of Saint-Martin's dependence on Sint Maarten. The huge disparity in terms of health provision between the Dutch and French sides of the island led the delegated prefecture to close the border in the summer of 2020. Tourism professionals and the 'Collectivité' reacted strongly, arguing that this decision deprived Saint-Martin of its essential source of income. This is evidenced in a column in the local press by the hoteliers' club:

> *"Three years after Hurricane Irma and the significant sacrifices and investments made to revive life on our island, 8 months after the serious events linked to the early application of the PPR and its significant negative consequences both in human and economic terms, two months after the total containment and the brutal shutdown of our society,* […] *if it is not, now, announced that the French part will reopen on November 1st, 2020 at the latest, there will be no next season!" (Soualiga Post, 05.08.2020).*

This testimony is particularly interesting because it highlights the interlocking nature of the crises [24,102,103] – hurricane-related disaster, conflicts around the PPR, sanitary crisis and border closure – and thus, the interdependence of the political, economic, social and spatial planning spheres.

5.2. The preservation of existing trends in land-use planning, rooted in the continuity of the economic and financial strategy

Regarding the economic and financial sphere (II), the post-disaster price increase generated a reinforcing effect on all the variables of the sphere. Indeed, rising prices for building material, rents and necessities are a constant feature of reconstruction processes [45,104,105], and Saint-Martin is no exception:

> *"You can't find the companies to do the work, or it's too expensive. Prices are soaring and the insurance companies refuse to pay between 5 and 10 times more than before"* (Int.19_locasso_*island*).

This increase in prices, combined with the strong external dependency, the *'lack of skilled labour and companies able to carry out the work on site'* (Int.17_compbat_*sandyground*), and the choice to pursue a tourism-focused development strategy, has increased land and housing pressure. Based on the same argument of tourism and economic concurrence with Sint Maarten, the State and the 'Collectivité' strategies differ; the State wants to develop green and luxury tourism (Int.3_irm_*marigot*), while the 'Collectivité' wishes to develop a mass tourism based on a design similar to Sint Maarten (Int.5_cesc_*marigot*).

Financial resources for reconstruction are derived from national and local development budget reserves and finances. These funds are mobilised in the post-crisis emergency to meet the immediate needs of disaster victims and must therefore be released and disbursed as quickly as possible [45,73,106]. Reconstruction funding can be classified into two categories: those that can be mobilised only after the disaster, which in most cases are intended to respond to the emergency, and those that can be mobilised preventively but are conditional on the development of a specific action programme [58,72,107]. These measures include budget reallocation, domestic and external credit, tax increases, and private donor assistance. The latter has been substantially solicited in the case of Saint-Martin, by reaffirming the strategy of tax exemption in the post-disaster period by the Girardin 2018 and 2020 laws, which aim to achieve private investment in the industrial and social housing sectors. These sectors are considered as priorities for the development of French overseas territories. The Pinel 2020 law completes these measures by providing tax exemption for investments in new or rehabilitated housing in French overseas territories. This economic and financial strategy has therefore been reaffirmed and strengthened, reproducing and accentuating pre-Irma trends.

Within the sphere dedicated to land-use planning (IV), the land and housing pressure variable is the only one to maintain an increasing trend. This is the consequence of the severe damage to the housing stock, the priority given to infrastructure and the tourism sector, as well as the need for accommodation for construction workers. The two other variables underwent a stabilisation of their evolution trend as a result of the balancing loop generated by the PPR update. Even though the PPR updating procedure has not yet been successful because of the conflicts it has generated, the updating of the regulatory zoning allows State services to compel and/or regulate the reconstruction of certain risk-prone areas. Indeed, the PPR has been vehemently criticised by the 'Collectivité', as the first information meetings have been conducted in French; this was naturally deemed unacceptable as the people of Saint-Martin claim Creole English as their 'official language'. Further, the zoning has also been strongly criticised. The main grievances addressed to the Administrative Court against the early implementation of the PPR are the failure to *'consider the exceptional nature of this cyclone and the probability that a new cyclone will be of comparable strength'* and the unreliability of the data extrapolated to obtain the regulatory zoning [108].

These tensions have increased the existing social fragmentation by catalysing it around conflicting interests based on land-use planning. This division of society according to mainly socio-economic criteria (religious background, socio-professional category and associated

income) was the mark of a multi-speed development before the disaster, and generates a non-uniform reconstruction in the post-disaster period. Indeed, local variations in temporalities are observed between districts, social groups and individuals [45,48,75,104]. They are rooted both in these pre-existing conditions, and also in the strategic choices of geographical and/or sectoral prioritisation that are necessarily made in the programming of recovery aid distribution [40,45,74]. Faced with housing difficulties, it is here again the intra-community networks which take the lead in compensating for the shortcomings of public action. Whether they are based on ethnic or economic criteria, the members within the same group belong to the same socio-economic spheres, thus promoting self-reliance (*'entre-soi'*). On the other hand, the intra-community solidarity that has developed in the aftermath of Irma generates a balancing effect on social misery and insecurity. This is through mutual aid mechanisms and the mobilisation of the various networks that make up the social capital of these community groups. Thus, the weight of pre-existing structures – reinforced by the continuation of past strategies and the reactivation of latent conflicts over land-use planning skills – have restricted the 'window of opportunity' of post-disaster. Despite agreement on the general objective of reducing the vulnerabilities and building resilience of Saint-Martin, the State and the local authority are divided on the concrete ways to achieve this. The consensus is long and complex to find, leading to the illustration of the power of the system's inertia in the face of change, which is nevertheless desired by all categories of actors present in the territory.

6. Conclusion

The consequences of Hurricane Irma on the territory and society of Saint-Martin have highlighted the accumulation of long-term structural, organisational and socio-economic vulnerabilities that magnified the impacts of the hurricane. This pinpointing of vulnerabilities associated with the damage and destruction, together with the resources deployed locally, have resulted in the commitment for more resilient reconstruction. Through influence diagrams, this research highlighted: i) the processes at work in the construction of vulnerabilities, and ii) the phenomena of balancing and reinforcement generated by post-disaster actions and decisions. Following disasters, a preventive 'window of opportunity' can result, as can a rift for lasting destabilisation of the system. Beyond opposing two visions, that of the bifurcation of trajectory towards greater resilience against the continuity of the structuring parameters of society in place prior to the disaster, our results draw a more nuanced portrait. Indeed, by interrogating this duality at different scales, sectorial variations and nuances appear.

The restructuring of post-disaster governance (Interdepartmental Recovery Mission and State re-commitment) has led to a time and efficiency gain by the direct exchange between the concerning ministries. This circumvents many traditional time-consuming channels of communication and administration. This ability to respond quickly and in a coordinated manner has made it possible to limit the number and duration of extreme precarious situations. In addition, the re-engagement of the State and the resources deployed, have generated greater respect for the laws and standards in force, thus fostering greater social and economic equity. For all these reasons, the case of Saint-Martin illustrates the capacity of national and local authorities to seize this opportunity for change towards increased collective resilience regarding national solidarity and law sector.

However, the reactivation of latent conflicts crystallised around land-use planning adds nuance to this conclusion. Indeed, the failure of consultation around the PPR, as well as the lack of consensus on the economic development strategy, lead to the persistence of pre-existing structures and testify to the power of the system's inertia in the face of changes in trajectories. This results in a deterioration of the social climate that was already tense before the disaster. Against a tense backdrop of social jealousy, local variations in the length of the reconstruction process exacerbated the divisions within Saint Martin's society. This deterioration is also more broadly seen in struggles between the State and the 'Collectivité' concerning the environmental competence that local authorities want to obtain in order to have the stranglehold on land-use planning.

The case of Saint-Martin demonstrates that theoretically the post-disaster period can be a 'window of opportunity'. Indeed, vulnerabilities related to sub-administration and poor compliance with law have been considerably reduced, mainly due to the State's re-commitment. However, in practice, pre-existing trends and modes of operation – which are reflected in the social climate and conflicts of interest in particular – strongly constrain the willingness and capacity to implement DRR recovery strategies. The use of diachronic influence diagrams to formalise the interactions and feedbacks between the structuring variables of vulnerabilities and major post-disaster decisions has highlighted the complexity of these dynamic processes. In addition, this highlights the need to consider the imbrications of geographical, social and administrative scales in order to analyse the duality inherent in the post-disaster period, between the 'window of opportunity' and the vicious circle of systemic risk. The portrait drawn in this research focuses on the three years since Irma's disaster and does not allow the authors to conclude on the deep and lasting consequences of the evolutions generated by the post-disaster on Saint-Martin's vulnerability drivers. Although the inflections on several key variables have been detected and interpreted, longer-term assessment of the recovery process is necessary at this point to characterise the impacts of the Saint-Martin recovery model on its adaptation pathway to future risks. From a public action point of view, these results plead for the creation of national action frameworks declined at regional and local levels in order to manage post-disaster reconstruction in a more coordinated and efficient way (as it is more the case for crisis management or prevention).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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