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Recovery Capacity: To Build Back Better

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Abstract
The ambition to Build Back Better after a serious flood disaster is a complex challenge. A comprehensive, multi-disciplinary redevelopment planning process is required to reduce the flood risk and meanwhile create sustainable solutions that bring added value to society every day. General planning principles can be formulated on how to develop the physical conditions for flood resilience, while building a better place to live and work. Scoping and the charrette method are to be applied for pairing and integrating disciplinary results, to co-create Better plans in an interdisciplinary planning process. Two disaster recovery cases in Japan, after the 2011 Tohoku tsunami, and one case on Grand Bahama, after 2019 hurricane Dorian, were studied by multidisciplinary teams of students and staff to investigate in how far Building Back Better was, or is to be, realized. This was done by confronting the practice of the reconstruction process and the resulting plans with the guiding principles for the physical concepts and interdisciplinary planning approach. Practice shows that Building Back Better is suffering from a lack of integration of disciplinary solutions, guided by existing planning regulations and practices and driven by the need for flood safety and by the urgency of the reconstruction works.

Keywords
Recovery capacity, build back better, multi-disciplinary approach, spatial planning, guiding principles, flood risk reduction

Introduction

The need for disaster risk reduction and improved disaster management stands beyond doubt. Disaster response is often well-organized, as part of disaster preparedness. This phase of emergency relief accompanies the phase of recovery and reconstruction. Survivors want to build up their regular life again, but in a way that such a disaster 'can never happen again'. They want to Build Back Better and strengthen the protection level of their living environment. Rarely the reconstruction process is seen as an opportunity for fundamental changes in the social and economic development of a region.More often, the first step is to rebuild what was lost.

The UNDRR (The United Nations Office for Disaster Risk Reduction) identifies Prevention, Preparedness, Response and Recovery as key components of risk reduction, however, recovery is the final and often least developed part of this framework (UNISDR, 2005). That it why it was made one of the four priority areas of the Sendai Framework for Disaster Risk Reduction: Enhancing disaster preparedness [...] to «Build Back Better» in recovery, rehabilitation and reconstruction (UNISDR,2015).

This chapter will concentrate on the recovery from tsunami- and hurricane-hit areas. The recovery in Japan from the Tohoku Tsunami in 2011 and on the Bahamas from hurricane Dorian in 2019 were investigated by multi-disciplinary teams of students and staff from TU Delft, to see how they Build Back Better. In Japan the reconstruction was activities were ongoing when the cases were studied, while in the Bahamas, a few months after Dorian hit the islands, recovery planning was in its inception phase. The data on which this chapter is based is collected in close collaboration with Waseda -, Tokyo - and Tohoku University, University of the Bahamas, the local authorities and many others. The teams visited the sites; on-site workshops with the local stakeholders were very important for appropriate understanding of the cases. The students in the interdisciplinary project groups of Yuriage (Areso Rossi et al., 2018; Vafa, 2018; Möhring, 2018; Mustaqim, 2018; Dobbelsteen, 2018, van Dijk, 2018; Glasbergen, 2018) and Otsuchi (Roubos, 2019; Salet, 2019; Filipouskaya, 2019; Nederlof, 2019; Yasaku, 2019; Mujumdar, 2019; Rao, 2019; Broere et al., 2019; Van Klaveren et al., 2019; Van den Berg, Hendriks, & Boertje, 2019; Höller & van de Wiel, 2019; Li, Dik & van Unnik, 2019; Prida Guillén, 2019) used all information for making theses. The project of Grand Bahama is still ongoing. . Other experiences with the recovery process were collected in New Orleans after hurricane Katrina and in Houston/Galveston after hurricane Harvey.

Building Back Better (UNISDR, 2017) is a complex process, not only because of broken infrastructure but also due to a lack of a well-functioning organization. Reconstruction authorities have to deal with the trauma of survivors on the one hand, the requirements of investors, and regional, national and international authorities on the other. The only way to Build Back Better is to organize a comprehensive, multi-disciplinary planning and redevelopment process. This process will be highly situation- and site-specific. General planning principles can be formulated on how to develop the physical conditions for flood resilience, while building a better place to live and work. These principles will be formulated and used to reflect on cases in Japan and the Bahamas, to give general recommendations on how to Build Back Better.

Guiding principles

Guiding principles for the (re)construction of a flood and climate resilient urban environment can be split in principles on the physical concepts and principles in the planning process.

Physical concepts

Safety first is a logical starting point for every reconstruction plan. The first question to ask is: Should we (re)build in these flood-endangered areas and, if so, how do we rebuild in a safe way? Space is to be made available for infrastructure needed to create safety, while extra protection is to be provided for critical infrastructural objects and networks as well as for the most vulnerable groups of the population.

A **risk approach** is necessary to Build Back Better. Risk is defined as the product of the probability of exposure[1] to a certain hazard and the damage sensitivity to this exposure. The **vulnerability** of our society includes a lack of capacity to adapt to newly emerging risks. Hazard reduction hence is a first, but often difficult way of reducing risk. Measures to reduce exposure also provide effective ways of reducing risk. Damage sensitivity can often be diminished by the smart design of critical infrastructure and buildings.

[1] For definitions of **Exposure, Hazard, Sensitivity** and **Vulnerability see** (IPCC 2007, 881 and 883) and (IPCC, 2014: Annex II: Glossary)

Only **four ways** to reduce the risk of flooding are available (Van de Ven et al., 2009). Namely the improvement of flood protection and drainage system. The second is to change the topography; digging a hole creates storage capacity and the excavated soil can be used to construct a mound for flood defense. The third way is to make the construction of buildings and infrastructure more water-robust. And the fourth way is to improve people's level of preparedness.

Four **capacities** are to be strengthened to reduce vulnerability (De Graaf et al., 2017). Threshold capacity is installed to protect against damage up to a certain level (e.g. levee, pump). If this is exceeded, coping capacity is needed to reduce the damage. Recovery capacity is required to minimize damage of the slow reconstruction process. Last but not least, adaptive capacity is needed to modify the system to unexpected changes in conditions that the site and society are exposed to.

The **three-point approach** (Fratini et al.,2012)to design is an important concept for Building Back Better. The first point in Figure 1 representsthe design of a protection facility, designed to provide protection for extreme conditions that occur only once per so many years, the so-called design return period. Point two represents a situation where this protection level is exceeded(ie.conditions are even more extreme and the protection system fails). This point emphasizes the need for a design aimed at minimizing the damage of that failing system by maximizing its coping and recovery capacity. The third point represents the every-day situation. Instead of being a hindrance, the facilities ought to provide added value and/or services to society every day. Multi-functional protection measures are essential.

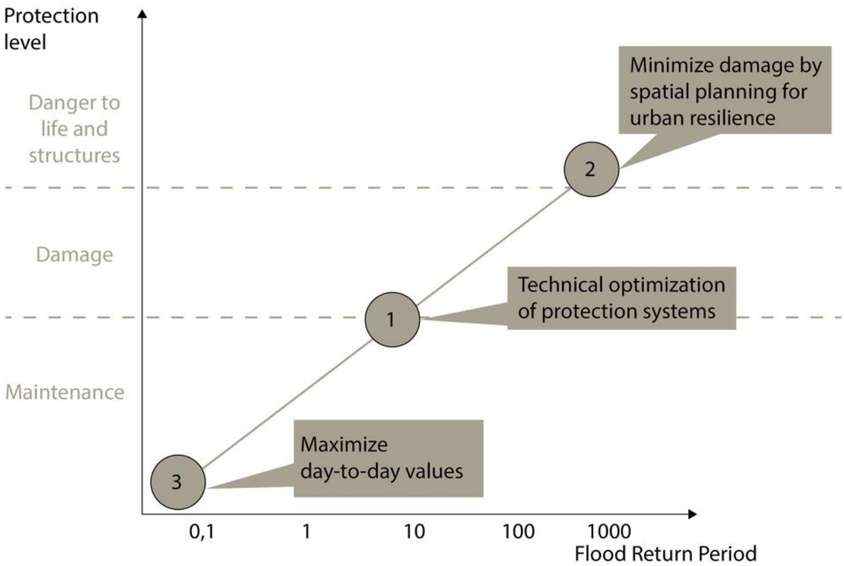

Figure 1. Three-point approach for flood risk management (modified after Fratini et al., 2012)

Hybrid solutions – i.e. a balanced combination of traditional grey solutions, smart and nature-based solutions - help create a more resilient urban environment. Hybridity is not only a technical issue, it also refers to the need for spatial and governance hybridity (Sugano and Lu, 2019). Spatial hybridity is about visibility, legibility and connectivity of blue-green elements in the urban landscape, while governance hybridity handles the balance between public, collective solutions versus solutions at the private, individual level.

Hybridity is also relevant in socio-economic reconstruction, balancing reconstruction of homes and economic activity. Lasting employment is a prerequisite for successful recovery of the area.

Interdisciplinary planning approach

Comprehensive planning of the reconstruction requires an interdisciplinary approach. Many involved disciplines in urban development need to connect their part of the problem. This can be done with **scoping** (Hooimeijer et al., 2018) , carried out according to the **charrette method** (Lennertz and Lutzenhiser, 2014).

The **charrette method** suggests a series of steps where disciplines are twinned in sub-group discussions and the size of each sub-group is gradually increased until the final session, whenone large group discussion is held with all disciplines (Figure 2).

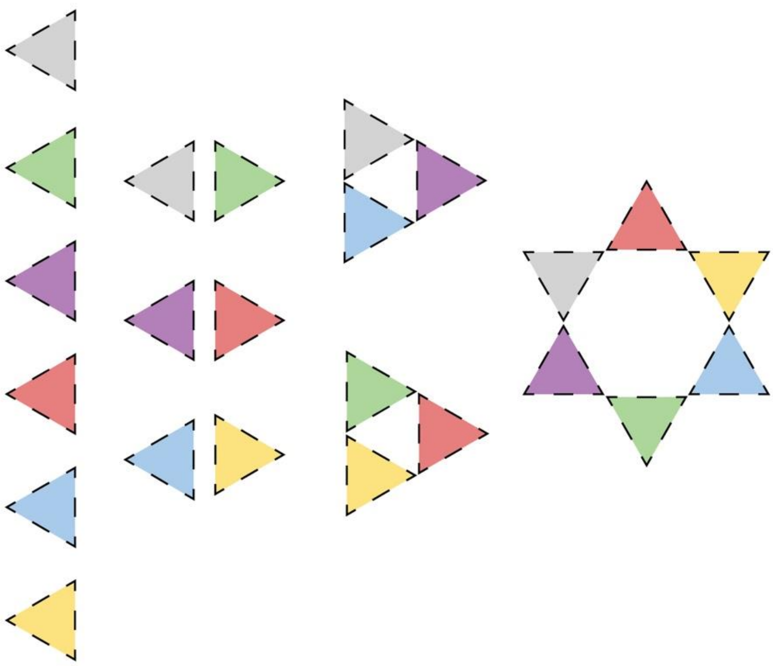

Figure 2: Schematic representation of the charette approach.

The first stage of the process consisted of the **scoping** method. This is the monodisciplinary analysis in which concepts and/or measure sets are selected and evaluated. What is important is that the different disciplines use comparable values to be able to explain and merge their chosen concepts with ones from other disciplinary perspective. In the projects peresented in this chapter the '4P approach' by Duijvestein and Van Dorst (2006) was used.

The next step consists of pairing up disciplines to discuss their scope and merge them. The value system is critical in the communication in order to organise in-depth discussions. The last two steps are discussing in a group of three and finaly, again, with all the diciplines present. Each step creates new combined scopes with integrated measure sets or concepts. This co-creative approach can be applied at different spatial scales, to confront large scale planning ideas with small scale, much more detailed plans to test the feasibility of the ideas.

This approach creates a 'professionals plan' in which all possible measures from the different disciplines are brought together in synergy. The most desired variants can then be presented to local residents in co-creative sessions, so they can participate in the propositions to tune them towards local needs.

Balancing the role of local residents, representatives and politicians in the planning process with the power of external experts from different disciplines and representatives for regional and national governments and funding agencies is a delicate task. Seizing the opportunity, brought by the disaster, to Build Back Better is understood differently by the various parties. Often, a Redevelopment Authority is created to organize the recovery process; they have the hard role of directing the reconstruction process in order to make a future-proof plan without compromising the interests of other involved parties.

Cases

Japan

On March 11, 2011, Japan experienced a magnitude nine earthquake (Figure 2) that caused an enormous tsunami felt across the Pacific Ocean. Waves with heights of up to 40 metres destroyed most of the eastern coastline in the Tohoku region; 560 square kilometres of land were inundated. Over 15,000 people died and more than 2,500 people are still missing. The displaced population is estimated at around half a million and the damage at around US$ 200 billion (Oskin, 2017).

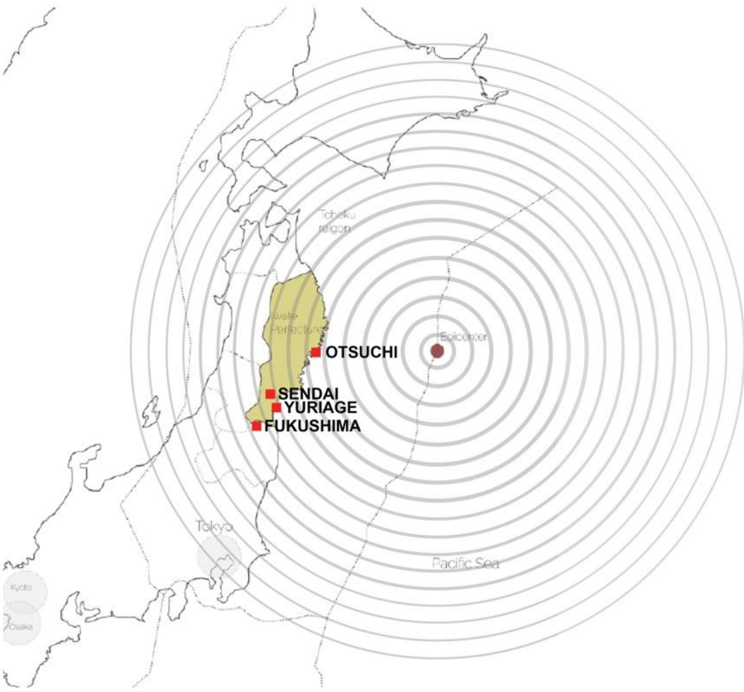

Figure 3: Seismic intensity per region (redrawn from Geology Page, 2014).

The region is subject to a tsunami return period of about 40 years (Esteban, Takagi, & Shibayama, 2015). This area was already in socio-economic decline due to a shrinking fishing industry, internal migration to other Japanese cities and demographic change.

The tsunami destroyed most coastal villages, including Yuriage and Ötsuchi. Yuriage is a coastal village, part of Natori, on the Sendai plain in Miyagi prefecture. Almost one thousand residents of Natori lost their lives and around 80% of the houses washed away (Murakami, et al., 2012).

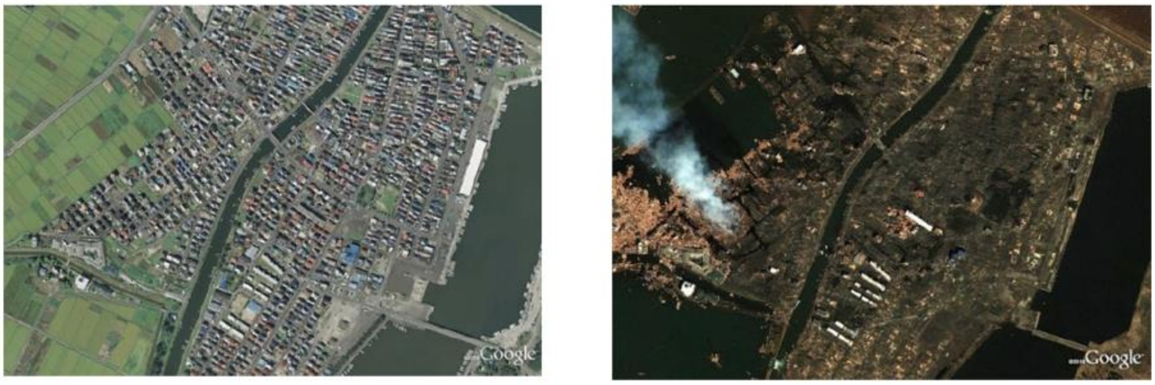

Figure 4. Distruction of Yuriage 2008, left and 2011 right after the Great Tohoku tsunami 2011 (Google Earth)

Ötsuchi is a coastal village of about 10.000 inhabitants in Iwate Prefecture, located between steep mountain slopes. The disaster took the lives of 1281 people (Nakai, 2013), while a built-up area of 216 ha was destroyed. Machikata, the central district, was severely damaged. Figure 5 shows aerial photos of this district before and after the tsunami.

Source: https://archive.town.otsuchi.iwate.jp Source: https://archive.town.otsuchi.iwate.jp

Figure 5 Distruction of Ötsuchi town by the 2011 tsunami

The Government of Japan issued guidelines for the reconstruction shortly after the disaster, emphasizing the need for a comprehensive approach while giving the municipalities a leading role in the reconstruction process (Tanaka et al. 2012).

<u>Yuriage – reconstruction measures</u>

Three categories of tsunami defense measures are constructed in Yuriage(Figure 6):

1. Physical defenses: a coastal levee, coastal forests, and elevated roads.
2. Relocation: Moving residents to raised inland areas .
3. Evacuation: Vertical evacuation facilities and evacuation routes.

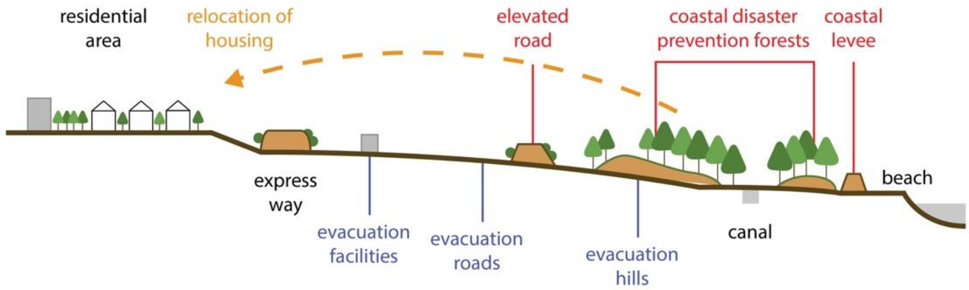

Figure 6: Proposed measures for tsunami defense in Yuriage.

The former centre was raised by 4-6 metres of sand to create a “Level 1” flood-safe place to live. New housing blocks were built there and on top of the highest blocks, evacuation shelters were realized. Industrial premises were planned on the lower grounds, between the coastal defence line and the raised residential area - “Level 2”. Verical evacuation facilities will also be created in the industrial zone, as well as elevated roads for horizontal evacuation (TUD, 2018).

Ötsuchi - Planning process

During the reconstruction planning of Ötsuchi-town, a bottom-up approach was applied (Nakai, 2013). The residents had to take responsibility for initialising the reconstruction process, as the top layer of local government had sadly lost their lives (Takezawa & Barton, 2016). Their plannning activities were supported by external consultants (Fukushima, 2017. Advisors for Machikata district were academics in the field of spatial planning. They, however, were also forced to manage civil engineering design issues, due to shortage of professional civil engineers, while fast redevelopment was necessary, as many people were relocated.

Ötsuchi - Reconstruction measures

The reconstruction plan is the outcome of an interdiciplinary planning process between residents and expert-advisers. The plan includes the following measures, as shown in Figure 7 (Broere et al., 2019; TUD, 2020):

- Construction of a 14m height seawall and floodgates;
- Raising a 31 ha residential area by 2.2m, for Level 1 protection (‘Reclamation area’)
- Creating a retention area with Level 2 protection for energy dissipation.

The result is a multi-level safety approach, as proposed by Iwate Prefecture (2011): Retreating from the danger by relocating to higher grounds and raising residential areas, while dissipating the tsunami’s energy.

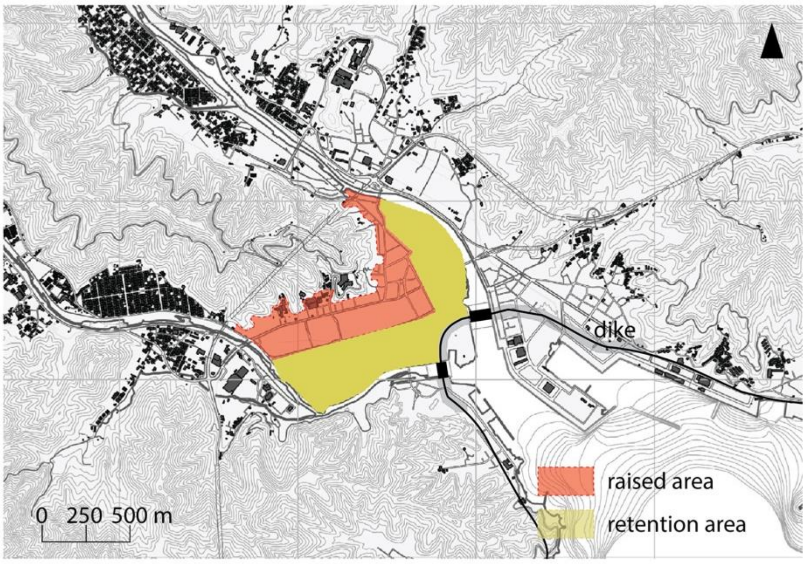

Figure 7. Reclamation plan for Ötsuchi's central district

Bahamas

On September 1, 2019, Hurricane Dorian made landfall on the Abaco Islands with a Category 5. On September 2 it hit the island of Grand Bahama with the same force and remained there for another day, finally pulling away from the island on September 3. The windspeeds, up to 295 km/h, also impacted a storm tide of 6.1 to 7.6 m, covering a large part of Grand Bahama with sea water. Dorian also dropped an estimated 0.91 m of rain over the Bahamas.

The total damage in the Bahamas amounted to US$3.4 billion, there were at least 70 deaths in the country, 10 of which were on Grand Bahama, and another 282 people were missing.

The island Grand Bahama, with 75.000 residents, suffered from multiple aspects: A king tide, stormsurges and waves led to coastal flooding which then caused salt water intrusion into their drinking water aquifer. At least 60% of Grand Bahama was left submerged once Dorian had passed over the island. Extreme rain led to pluvial flooding and extreme windspeeds and tornado's damaged buildings, infrastructure, trees and forests. There was an island-wide power outage, and an oil refinery was damaged. About 300 homes were destroyed or severely damaged. Floodwaters and sewage contaminated Rand Memorial Hospital and destroyed supermarkets. The income dip, population decrease and post traumatic stress are substantial societal problems as secondary effects of the hurricane.

Figure 8: Image of the effects of Dorian on the UB Campus on Grand Bahama island. (Hooimeijer)

Grand Bahama can be divided in three zones, namely east, west and the town of Freeport. Freeport is a 560 km2 free trade zone on Grand Bahama Island. The Grand Bahama Port Authority (GBPA) operates the free trade zone, under special powers conferred by the government under the Hawksbill Creek Agreement, which was recently extended until August 3, 2054. GBPA and the national authorities are currently developing plans for the recovery of the island. The University of the Bahamas (UB) and TU Delft started assisting in this recovery process with an interdisciplinary design project. Some of the results are summarized in the next parapraphs.

<u>Reconstruction measures</u>

The main vision for the reconstruction of Grand Bahama is to Build Back Better. This is done by taking an interdisciplinary approach and connecting engineering to spatial planning and design.

The proposed strategy reduces the risk by taking into account exposure and vulnerability of the general risk approach. The main point of the strategy is to create a resilient urban environment in which vital infrastructure like the airport remains operational.This is done by making a collective protection zone of the economic and social city center of Freeport, a zone that also offers shelter. Individual protection and evacuation shelters will be given to residents, buildings and facilities in the less densely built areas east and west of the city.

The strategy has three intervention layers: hydraulic engineering, zoning & critical infrastructure and resilient water supply. The hydraulic engineering layer proposes strategic dikes that connect natural heights in the town Freeport.This creates a zone that is safe from storm surges by a *collective* protection system and an ‘outerdike’ area that requires *individual* protection systems. Based on this new topography the zoning & critical infrastructure layer proposes interventions per zone. The new safe zone in Freeport (comparable to the traditional mound “terp” and Dutch polders) will be the centre for critical infrastructure and offers shelter for people from outside this protected zone. Road infrastructure on the island will be improved to give better access to this centre. In the ‘outerdike’east and west districts, individual protection needs to be scaled up by building regulations and by creating strategic evacuation centers. The layer of resilient water supply focusses on groundwater resource protection, large scale rainwater harvesting, the implementation of separate household and drinking water infrastructure, water purification and wastewater treatment facilities.

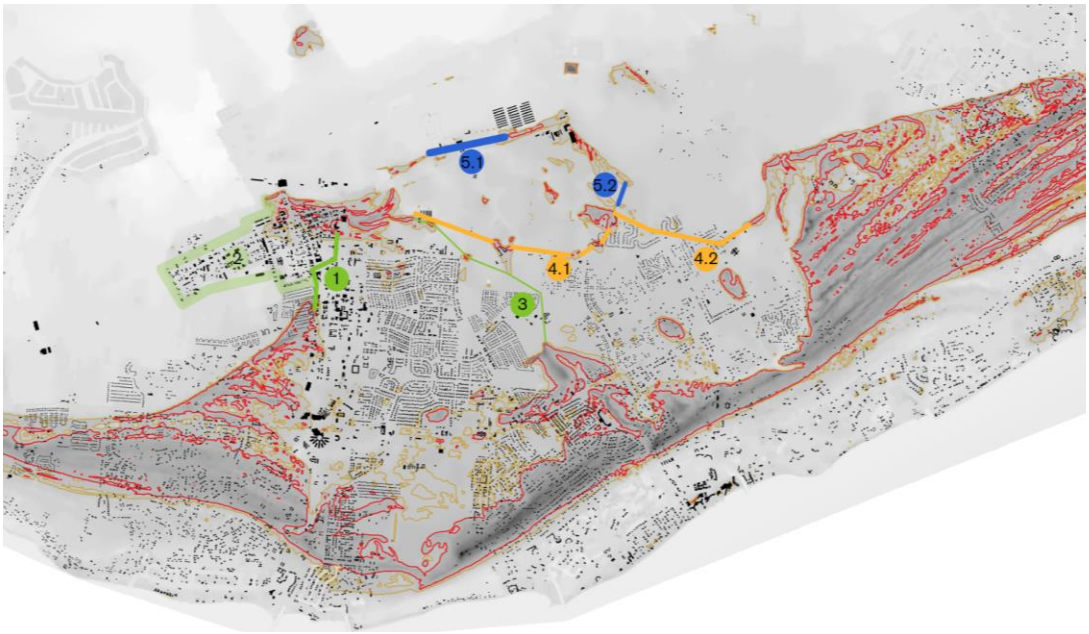

Figure 9 The building of strategic dikes (no 1 and 3) to create a safe core in Freeport.

This vision and strategy is developed in more detailed plans for three locations: the airport, the UB North Outside Campus and the UB town campus. Both the new airport building and the UB North Outside Campus are made out of ensemble of smaller building that are more resistent to the hard winds of the hurricane. They are made flood proof by lifting them on mounds. The UB In Town Campus is an historcal building that also is made flood proof by placing program on the first floor. The ground floor is flexibly used. All three buildings are designed as an evacuation point.

Analysis

It is interesting to reflect on both cases from the perspective of the principles for Building Back Better. It is important to realize that both cases are incomparable in their phase of recovery. The tsunami hit Tohoku in 2011 and reconstruction activities are well underway, while the hurricane Dorian hit Grand Bahamas in fall 2019 and the recovery process has just started. Hence, in the case of Japan, the study was done ‘in hindsight’ while in the case of the Bahamas, the situation could be studied in an exploratory way. In Table 1, an overview is given of key elements, both in the current situation and in the way the principles can be seen in the results of the study project.

Table 1. Guiding principles and interdisciplinarity in the recovery cases in Japan and the Bahamas; current situation and approach in multidisciplinary study project

Physical concepts and interdisciplinary planning approach		**Interdisciplinary approach**	**Japan**	**Bahamas**
Safety first	**current situation**	Mono-.functional separation of safety and spatial planning	Level 1 and Level 2 protection compulsory; realized by a levee, raising the land, strict zoning plan and better infrastructure	Protection strategy is based on evacuation
	study project	Integration of flood safety and water management in spatial planning	Students followed Level 1 and 2 instructions but balanced the interventions with other spatial program like natural area	Students proposed to make a safe haven in Freeport, plus amendments to buildings and better infrastructure both inside and outside this protected area.
Risk approach	**current situation**	Risk approach independent of spatial planning, No related spatial planning practice	Hazard reduction is impossible for tsunamis; large emphasis on evacuation and preparedness to save lives and reduce consequences	Hazard reduction is impossible for hurricanes; Hurricane risk is accepted; Dorian is seen as a wakeup call to reduce damage sensitivity
	study project	Spatial planning based on reduction of consequences and saving lives. Disaster is an opportunity to Build Back Better	The projects basically follow the risk approach of the reconstruction plan but expand it with the connection to spatial and social quality	The study introduces spatial planning integrated with engineered collective flood defense in the center zone, and individual protection and improvement of evacuation in the unprotected areas
Capacities for vulnerability reduction	**current situation**	Spatial planning independent of vulnerability reduction	Reconstruction only focusing on creatingThreshold capacity	There is no plan, people are coping with the situation
	study project	Including vulnerability reduction as part of spatial planning is the specific aim of the study	Study introduces Coping, Recovery and, Adaptive capacities by focusing on reduction of consequences and strengthening socio- economic sectors through spatial planning	Study strengthens coping and recovery capacity, Adaptive capacity is improved on the architectural scale by building regulations
3-point approach	**current situation**	Missing in both cases	Strong focus on standards for threshold capacity / protection levels; mono-functional solutions; no additional measures for adding value or reducing sensitivity	Focus on individual protection without specific standards, and coping capacity in a responsive way
	study project	Introduce multi-functionality and damage sensitivity in order to achieve three-point approach	Technical optimization is integrated with spatial planning. Every-day added value is especially addressed in Otsuchi	Technical optimization is integrated with spatial planning. Every-day added value is addressed in the protected area center, while sensitivity reduction characterizes the plans for the airport and unprotected area
Four ways to reduce flood	**current situation**	Improved drainage and preparedness are common components for flood protection, levees; land level	Tsunami preparedness is high, Raising land level is essential component of protection strategy, buildings are not adapted to flood risk	Preparedness is the essential protection strategy, local examples of improved drainage, buildings are improved to avoid wind damage, not for flood damage protection

Physical concepts and interdisciplinary planning approach		Interdisciplinary approach	Japan	Bahamas
		changes and adapted building are not		
	study project	Spatial planning and building codes as integrated part of disaster risk reduction	In addition to the reconstruction plan drainage infrastructure improvements and flood resilient building practices are proposed	Improvements are proposed in drainage infrastructure, land level and flood resilient building
Hybrid solutions	current situation	Combinations of grey, high-tech solutions with nature-based solutions. Focus on reconstruction of housing	Flood walls and levees are in some places combined with coastal forests for impact reduction. Limited attention for reconstruction of economic activities	Forest are applied for impact reduction; grey solutions for flood protection hardly or not applied. reconstruction of economic activities is a private responsibility
	study project	Exploring combinations of grey, high-tech solutions with nature-based solutions.	In addition to the reconstruction plan nature-based solutions are applied for urban drainage and ecological recovery	Nature-based solutions are applied for urban drainage,stormwater retention and rainwater harvesting
Scoping	current situation	Scoping was not part of the (mono-disciplinary) planning process	There is no practice in Japan that integrates engineering with spatial planning principles or processes, spatial planning is engineering-oriented	There is no practice in the Bahamas that integrates engineering with spatial planning principles or processes., Planning on Grand Bahamas is done by a private party (GPPA)
	study project		Study was based on scoping.	Study was based on scoping.
Charette	current situation	Charrette-approach was not part of the planning process	There is no practice in Japan that uses charrettes for multidisciplinary collaborative planning; reconstruction planning is top down, making local stakeholder choose from unintegrated technical solutions.	There is no practice in Bahamas that uses charrettes or other forms of co-creative comprehensive planning; Reconstruction is considered to be a private responsibility, with some top down activities
	study project		Study was based on charrette to produce a comprehensive plan.	Study was based on charrette to produce a comprehensive plan.

Conclusions

As can be seen in all the cases, hardly any efforts are made to match all existing interests in a comprehensive reconstruction plan. Driven by the need for improved safety, the people and the authorities tend to select and implement strong flood defence structures, without added value for everyday use, due to their mono-functionaldesign. “Build Back Better” is interpreted in a narrow way, focused on flood protection only, and limited to creating threshold protection capacity with levees, seawalls and land raising . Collective protective infrastructural measures on public land are often preferred over individual or hybrid solutions that also involve investment on private property. These collectively protected areas are often exposed to a significant risk of flooding by extreme rainfall; sufficient stormwater drainage and storage capacity should therefore be provided. Individual solutions to protect houses, buildings and other infrastructure by a water-robust construction are, if at all, chosen only for areas with very low housing density.

The reconstruction of the destroyed area is hardly, or not used at all, as an opportunity to develop other values, introduce changes in the local economy, introduce a more sustainable urban system in terms of drainage, building materials, energy, waste disposal, etc. Preparedness for recovery, reduction of damage sensitivity and strengthening adaptation capacity are not objectives of the reconstruction plan. Vulnerability reduction is most often only achieved by increasing threshold capacity. And whereas ground level raising is part of the protection strategy in Japan, this is not a typical practice in the Bahamas.

Comprehensive spatial planning requires the involvement of a multi-disciplinary team of experts and local stakeholders. In a collaborative design process, a vision for the future of the recovered community is to be built. Scoping can be used to translate this vision into an integrated reconstruction plan. This process, however, seems difficult to organize due to the existing national spatial planning infrastructure. Moreover, authorities are under pressure to reconstruct housing for the survivors, but it is equally important to reconstruct factories, industries, warehouses and shops, so that survivors can get jobs, an income and access to supplies of food, building materials and so on. Moreover, the survivors need a social shelter point, to overcome the pain of the trauma that is engraved in their minds. To Build Back Better, physical reconstruction and the social recovery of communities must go hand in hand.

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