Synergies and trade-offs between sustainable economic development and climate change adaptation

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Abstract

This research aims to ascertain whether two designated sustainable pathways for economic development enable or constrain effective response to climate-related disaster risks. We identify the processes and outcomes of economic development that have changed the capacity of local community for managing the increasing risks of typhoon and flooding. Evidence is sought from two rural communities in southern China.

We find that local economic transition can enhance the capacities for addressing these risks and adapting to future climate change by attracting institutional attention and resources to a locality. However, it can also turn into a contested process of transformation that destabilizes some of the social conditions underlying existing coping and adaptive capacities. The emergent processes of a broadly sustainable pathway have reduced some vulnerabilities but reinforced other ones.

The case studies show that sustainable economic development has mixed implications for disaster risk reduction and adaptation to climate change. The synergies are clearer in driving incremental adjustments. Clearly delineated and proximal consequences of climate change are seen as impeding progress and requiring an immediate response. In contrast, the conditions for synergies are less stable at the system level. Transformative changes in economic and social structures involve negotiations of processes and actions at multiple scales and a wider range of interests, and therefore are more controversial and difficult to navigate. There are different views and disputes about what to sustain and what is vulnerable. These tensions can complicate and impede the process of integrating adaptation objectives, which are often couched in terms of sustainability and vulnerability, into system-wide transformation. Because sustainability benefits are neither fully attained nor evenly distributed, a broadly sustainable pathway for economic development does not necessarily increase adaptive capacity.

Keywords: sustainable economic development, vulnerability reduction, tourism, fisheries, typhoon, sea level rise, China
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Introduction

Sustainable development pursues a balance of social inclusion and justice, environmental protection, and economic growth. The United Nations calls for action to achieve seventeen ‘Sustainable Development Goals’, which include eradicating poverty, improving health and well-being, reducing pollution, creating decent jobs and improving living standards, among others. Addressing these goals is crucial for meeting the interlinked challenges of human-induced climate change and natural disaster.

People’s vulnerabilities to climate change impacts are often described as an outcome of development deficits. As Ayers and Dodman (2010, p. 161) explain:

sustainable development can reduce vulnerability to climate change, because vulnerability depends on factors linked to development, including access to economic, ecological, social and human resources, and inadequate institutions, governance and infrastructure

Therefore, as Smit et al. 2001 (p. 879) have suggested: activities required for the enhancement of adaptive capacity are essentially equivalent to those promoting sustainable development

These views call for interventions that explicitly address the fundamental conditions pertaining to human security (e.g., poverty, gender and racial inequities, power hierarchies) that make climate change impacts intractable and vulnerabilities accumulate (Ayers and Dodman 2010; O’Brien et al. 2007; O’Brien 2012; Eriksen et al. 2019). By controlling these conditions, sustainable pathways for development can increase the resilience of people and communities to natural disasters and help them adapt to longer-term climate change impacts (Schipper 2007).

In practice, the linkages between sustainable development and adaptation processes are complex and dynamic (Few et al. 2017; Eriksen et al. 2021; Klein et al. 2014). Although there are synergies between these processes, tensions can arise from the unintended consequences or unevenly distributed impacts of a particular development pathway. Such tensions may impede long-term adaptation or lead to maladaptation, which refers to “action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups” (Barnett and O’Neill 2010, p. 211). Heightened challenges are particularly evident in processes that seek to achieve sustainable economic outcomes.

Economic development constrains adaptation to climate change. For example, the expansion of shrimp aquaculture at the expense of mangrove forests can increase flood risk and reduce community resilience to coastal hazards (Adger et al. 2002); large-scale developments in coastal areas change coastal morphology and can potentially increase erosion and put more properties and people at risk of storm surges (Petzold, Ratter, and Holdschlag 2018). Sustainable pathways for economic development can produce diverse outcomes, some of which might eventually compromise adaptive capacity. For instance, sustainable tourism can generate development benefits by creating jobs and alleviating poverty (Rogerson and Visser 2004), but tourists attracted by an untouched culture and environment may not appreciate any activity that looks like a manipulation of what should otherwise be left alone, such as building coastal defenses against storm surges (Petzold, 2017, p. 154). Sustainability benefits can be highly concentrated in certain groups of people or locations, and not always those that are crucial for climate change adaptation (longer term and future risks) or disaster risk reduction
(DRR) (shorter term and present risks) (see Mercer (2010) for the differences between climate change adaptation and DRR).

However, the conditions for such tensions (and synergies) to arise remain poorly understood. Eriksen et al. (2011) have described how adaptation interventions become unsustainable, but their analysis is predisposed to a specific (albeit commonly adopted) view of sustainable development that emphasizes social and environmental dimensions. This represents a departure from the reality of less developed areas that are experiencing fast economic growth and in which imaginations of economic futures dominate, or have strongly influenced, the local ‘sustainable’ development discourse and planning processes. Moreover, scholarly discussions tend to prioritize DRR or adaptation needs and advocate deliberate transformational action1 (O’Brien 2012; Fazey et al. 2018; Park et al. 2012), which require creating spaces for contesting and reflecting on established values, knowledge, and power that impede adaptation processes (Pelling 2011; Eriksen et al. 2021; Eriksen et al. 2019). This is linked to a broad skepticism toward adaptations or DRR achieved solely by technocratic means and their ability to account for social structures and power relations that contribute to vulnerabilities (Godfrey-Wood and Naess 2016). The calls for transformational adaptation are expressed as visions for a resilient future amenable to a finite set of sustainable development goals. In practice, however, successful transformational adaptation is rare (Godfrey-Wood and Naess 2016; Marshall et al. 2014; Fedele et al. 2020). The impacts of wider societal and economic transformations that are not directly driven by adaptation or DRR goals, such as economic migration, are more profound and pervasive, but these processes typically do not prioritize or even recognize the imperative of reducing disaster risks and avoiding dangerous changes in the climate. A focus on these transformative processes and their broader sustainability implications is important for understanding the conditions for adaptation and DRR to be effective.

Transformative social and economic changes can produce broadly sustainable outcomes without enabling long-term adaptation. This paper aims to describe the enabling conditions as well as constraints in the processes of social and economic transformation. It explains how the changes and new arrangements associated with a transforming local economy influence the underlying capacities for coping with natural hazards and adapting to climate change. We investigate social and economic changes that are driven by development objectives but could incidentally achieve adaptation and DRR objectives. Adaptation may be initiated or undertaken in the context of non-climatic change (Moser and Ekstrom 2010; Smit and Wandel 2006). We aim to investigate the extent to which processes of societal and economic transformations create spaces for climate change adaptation and DRR, and therefore focus on unintentional efforts that are not primarily driven by adaptation or DRR.

Our main argument is that, because sustainability benefits are rarely fully attained and evenly distributed, a broadly sustainable pathway for economic development does not necessarily increase adaptive capacity. The research is situated in a context in which climate change-related disaster risks are intensifying, and the future of the rural economy is central to the local development discourse. We adhere to a more balanced view of sustainable development that is couched not only in terms of social justice and environmental integrity, but also economic

1 According to Few et al. (2017), ‘transformational adaptation’ refers to the transformation of adaptation practice, whereas ‘transformative adaptation’ is the transformation of broader aspects of development through adaptation activity. In this paper, we adopt their terminology by using the former to describe adaptation activities, and the later to describe wider social and economic changes in a community.
growth and employment. This paper indicates that the ongoing struggles in the community revolve around the questions of ‘what to sustain’ and ‘what is vulnerable’. We use two Chinese case studies to illustrate the challenges and opportunities presented by a ‘sustainable’ pathway for local economic development.

Case studies from China

The two study areas are Tai O and Wailingding Island, which are located at the rural fringes of Hong Kong and Zhuhai, respectively (Figure 1). Both Hong Kong and Zhuhai are coastal cities lying to the north of South China Sea and consist of predominantly ethnic Chinese communities.

Tai O, Hong Kong

Hong Kong was under British colonial rule for more than a hundred years. Since 1997, it has operated as a Special Administrative Region (SAR) of China and is formally demarcated from their Mainland counterparts by adopting a different governance arrangement known as ‘One Country, Two Systems’. Tai O is located at the northwestern corner of Lantau Island, which is a big land mass at a distance from the city’s core built-up areas. Tai O is a high-density coastal village sitting on a small area of 46 hectares divided by a creek extending from Pearl River. The small town once had a population of 8,833 back in 1961 (Chan 2008), but economic contraction and out-migration reduced the population to 3,283 in 2016 (Census and Statistics Department 2017).

Tai O is poorly connected with urban centers. Buses and ferries are the main forms of public transport connecting Tai O with the rest of Hong Kong. Mostly shouldering through hilly terrain, the motor road between Tai O and the regional center of Lantau Island is steep, winding and compact. Road conditions prohibit vehicular traffic in the event of extreme weather, such as rainstorms, which can reduce visibility and cause landslides. Ferries run on a loose schedule, and they are suspended when higher typhoon signals come into effect.

At the end of the 19th century, Tai O’s prosperity was based on fisheries, followed by the manufacture of salt (Hayes 2012). Today, the local economy depends on tourism, which benefits from its tranquil natural setting and maritime cultural heritage, including a variety of ecologically sensitive habitats, the stilt houses, and a collection of vernacular architecture and historic buildings (Chan, 2008). Tourists are also attracted by its intangible cultural resources, such as the Dragon Boat Water Parade, fisheries traditions, local history, and the village ambience. These natural and cultural resources allow Tai O to be officially promoted as a place of special character suitable for sustainable tourism since the 2000s (Lantau Development Task Force 2007; Planning Department 2002).

In 2017, the government released a long-term regional development strategy, known as the “Sustainable Lantau Blueprint”, which has re-branded the fishing town as “Tai O Nature and Cultural Heritage District” (Development Bureau 2017). A range of initiatives has been introduced to strengthen the image of Tai O as a model of sustainable tourism development. However, Tai O is vulnerable to extreme weather. The main streets are compact and full of houses and shops. Local residents and business operators have shown difficulties in coping with storm surges and flooding, due to their limited resources and the space and geographical constraints of the area in which Tai O is situated (Chan et al. 2013).
**Wailingding Island, Zhuhai**

Zhuhai has a population of 1.6 million and is a major city within the fast-growing Pearl River Delta. Like the rest of the Mainland China, it is ruled by the Communist Party of China since 1949 and accountable to the Chinese Central Government. Although the fast economic growth since 1978 aggravated the problems of environmental degradation and pollution inherited from Mao’s communist regime (Economy 2004; Shapiro 2012), Mainland China has begun to pursue models of sustainable urbanization since 1999 (Liu et al. 2014). Following the national policy directions, Zhuhai has steered itself towards sustainable urban development and established a suite of eco-towns (or rebranded existing ones) (Fu and Zhang 2018). Smaller-scale sustainability transitions are also found in remote towns within the city’s boundary.

The territory of Zhuhai includes many small islands off its south-eastern shores that are closer to Hong Kong than the city’s mainland. One of these islands is Wailingding, which forms part of the Wanshan Archipelago and is the administrative center of Dangan Town Government. The island has a population of 3,080 in 2014 and a land area of 430 hectares (Zhuhai Wanshan Marine Development Experimental Zone 2020). Residents and visitors rely on ferries to reach the island, but a one-way trip takes 1.5 hours and there are only two departures from each side between Xiangzhou Port (at Zhuhai’s mainland) and Wailingding each day.

Wailingding Island was a productive fishery village subsequently turned into an iconic tourist destination. Prior to 1990s, the local economy benefited from the island’s privileged location at the Wanshan fishing ground, nurturing decades of steady growth based on onshore fishing and related activities, including seafood trading, seafood processing, production of commercial fishing tools, and maintenance of fishing vessels. In the mid-1990s, Wailingding Island became a refuge for visitors from British-ruled Hong Kong, who travelled into China waters illegally to reach the island in 30 minutes (i.e., a much shorter route than travelling via the mainland). The main attractions were the small casinos and brothels developed under the town government’s acquiescence (Wang and Bennett, 2020). Easy access and low living costs had also attracted a small number of Hong Kong residents to set up their second home with their mainland mistresses in Wailingding. After 1997, however, the Chinese government succeeded in eliminating gambling and prostitution, and banned direct passenger fleet between Wailingding and Hong Kong (now a SAR of China), leading to the demise of these illegal, if not unethical, leisure industries.

The economy of Wailingding did not recover until 2005, when the Dangan Town Government decided to move away from the ‘unsustainable’ development model and re-branded the island as a ‘weekend haven’ for summer holidaymakers. Various measures were implemented to improve infrastructure and attract investment in Wailingding, such as constructing a promenade and plaza, expanding the main beach, and recruiting large tourism developers from the mainland. A new tourism industry has emerged, capitalizing on the island’s natural beauty and drawing sun-, sea-, and sand-seeking tourists (Wang and Bennett, 2020). The beachside tourism has also enabled some local residents and migrants to adopt alternative livelihood activities targeting domestic tourists, such as operating restaurants and selling dried seafood. The increasing livelihood diversity contributes to a relatively more sustainable local tourism than in the past.
Extreme weather events

Coastal flood risks across the Pearl River Delta area are increasing, due to the combined effects of globally intensifying tropical cyclones and accelerating sea level rise (Chen et al. 2020). Tai O and Wailingding are in the vicinity of each other and have often recorded significant damage from the same extreme typhoon events. While both of them are vulnerable to these impacts of global climate change, there are nuanced differences in the source of their vulnerabilities.

Tai O is one of the low-lying towns across the city that will experience the greatest impacts associated with rising sea levels and warmer temperatures (Lee, Wong, and Woo. 2010). The threat of extreme rainfall events and storm surges associated with tropical cyclones will intensify (Environment Bureau 2015). Tai O is exposed to flash and coastal flooding throughout the summer. The village is located on alluvium and marine deposits, with most of the town center only approximately 2.90–3.40m above Mean Sea Level (MSL) (Chan et al. 2013). The watercourses bring large amounts of floodwater into the village when a typhoon and high tides occurred at the same time. Typhoons and intense rainfall events resulted in two extreme storm surge events in 2008 and 2017. Typhoon Hagupit swept the village on 23 September 2008. Residents witnessed a seawater overflow of more than 1.3m. More than 200 premises were cut off from the electricity supply, and many residents recorded significant damage on properties (Environment Bureau 2015). Rising by 4.91 m above MSL, the 2008 storm surge was believed to be a 1-in-50-year event (Woo and Wong 2010).

The second extreme weather event came with Typhoon Hato. On 23 August 2017, Hong Kong raised its tropical cyclone signal to the highest category. The serious tropical cyclone brought severe storm surge and record-high sea levels to the coast of the Pearl River Estuary. The storm surge rose to 3.8m above MSL (Lai 2017). Although the newly built river wall slowed down the rate of flooding, seawater overflow and the failure of pumping facilities caused prolonged inundation. The flooding was considered to be more damaging than that of Hagupit in 2008 (Hong Kong Observatory undated).

Powerful typhoons make landfalls on Wailingding Island every summer, but flooding events are historically less damaging than those occurring in Tai O. However, Wailingding is fully surrounded by the sea, physically more isolated, and has fewer outgoing transport options than Tai O. Consequently, the island is more sensitive to milder weather events. Also, Wailingding is at the frontline of the Pearl River Delta Estuary directly facing the typhoon-prone Luzon Strait to the east, without any mountain barriers at the near front. This makes the small island more exposed to unstable systems of tropical cyclone from the east and south of the sea. Despite regular attacks by typhoons, disaster risk planning did not gain traction until local residents and authorities woke up to Typhoon Hato in the summer of 2017.

Typhoon Hato caused a maximum storm surge of 2.79 m in Zhuhai (Chen et al., 2020). It is described by a Zhuhai planning authority as the most destructive typhoon since 1964 (Zhuhai Municipal Commission of Housing and Rural and Urban Construction 2017). The extraordinarily strong winds created massive damage on properties and assets on the island, and severely interrupted the transportation of supplies and people, including tourists, via the sea. The sensitivity of Wailingding to extreme weather also stems from the seasonality of its beachside tourism, which attracts more visitor traffic and generates more incomes during summer (typhoon season). However, the paralysis of island transport, prolonged interruptions of lifeline services, and weeks of post-disaster recovery had discouraged leisure visits well
beyond the days of weather disruptions, resulting in substantial business losses during the peak season.

The study

The research is based on a largely qualitative study conducted between 2011 and 2018 (Table 1). In 2011, one of the authors gained access to the Tai O and Wailingding communities and spent three months each to collect ethnographic evidence. The work done focused on the social and cultural aspects of economic transition in the recent past and present. Sources of information included local residents, business owners, and stakeholders. In the winter of 2011/12, we interviewed thirteen government officials and practitioners in Tai O, including engineers, planners, meteorological scientists and social workers, who were involved in flood risk management. Semi-structured interviews were conducted to understand the main constraints on coastal flood management and the future impacts of climate change. In 2015, we conducted an extensive survey of local residents and small business operators to explore social and cultural factors underlying the development of sustainable tourism in Tai O. Between March 2016 and December 2017, we organized 21 semi-structured interviews in Tai O and the city, which revolved around local economic development, nature and cultural conservation, flood risk management, and the social context of current controversies.

Similar work was carried out in Wailingding in different periods of time from 2012. We interviewed local residents and migrants conducting different livelihood activities to understand how the local economy and community have transformed since the 1990s. In order to understand institutions and organizations at multiple levels, government officials at different levels, members of rural committees, staff from different NGOs, and companies in the private sector were also selected as respondents. The final set of interviews, completed in May 2018, focused on community members’ experience in Typhoon Hato and the ways in which local government responded to the event.
Main findings

Our findings are organized and discussed under three main themes, namely, resource dependency and livelihood change, domestic migration, and emergency management and infrastructure. These changes or new arrangements in the two communities present a combination of opportunities and challenges for local economic development, with significant implications for climate change adaptation and disaster risk reduction.

Tai O

Resource dependency and livelihood change

Sustainable tourism development in Tai O has contributed to the decline of traditional primary industries, especially fisheries, which are very sensitive to climate variability. Retail, service, and catering sectors, which are less resource-intensive, are growing on the success of tourism development. Although this economic transformation can reduce resource dependency and alleviate the vulnerability of the rural economy to climatic changes, the decline of the traditional economy has affected the role of households in maintaining familial ties. In Tai O, fishing families used to operate as informal micro-businesses providing jobs for members of the extended family. Nearshore fish stocks are near depletion and the business environment has deteriorated, due to increasing mechanization and corporate involvement. Larger, formal fishing businesses tend to hire non-local fishery workers. As the small fishing families are marginalized and forced out of the market, those local fishery workers depending on family businesses have to seek an alternative livelihood or retire. Families no longer act as micro-economic institutions and their role in preserving family-based social capital through sustaining livelihoods has diminished.

The transformation has also created discursive barriers to the integration of future climatic changes into local planning. The current developments across Lantau Island reveal a neoliberal tendency for commodifying and gentrifying various sites into lucrative tourist spots. People in Tai O have been struggling over attempts to develop the compact town with impressive cultural endowments, sparking reflections and bitter debates on collective identity and the meaning of place. For in-migration, concerns about expansive development have engendered destabilizing social forces, diverting attention from climate change.

Tai O has become divisive since the small town was placed on the government’s development agenda. People with conflicting views on development are becoming divided and going against each other. Prohibitive space constraints and high densities force Tai O to make hard choices (e.g., height of the river wall) (Chan et al., 2013), causing social conflicts to intensify. Withdrawal from village governance activities, including flood risk management, is one of the frustrating consequences we heard from our informants, indicating that social divisions have become a hurdle to participatory decision-making processes that are needed for mainstreaming climate change into local planning. There was a weakening of the ‘moral economy’ as conflicts between shop owners intensified. As a shop vendor indicated:

Some non-locals run a shop here because they like Tai O, but they don't want neighbors to interfere in their lives. They neither discuss with each other nor try to accommodate differences. They choose to complain. (personal interview, April 2017)
In a small village experiencing such a system-wide transformation, environmental and social activists are at pains to integrate long-term adaptation into the local agenda. Capacity building activities related to climate change have attracted little audience beyond their allies. There is limited discussion within Tai O on coping with longer-term flooding issues, as this is regarded as “too far away to consider” and most of the local residents “are satisfied with the current situation” (personal interview, December 2016). Despite extensive media coverage and efforts made by various parties since 2008, climate change continues to be understood in terms of a regularly and naturally occurring event.

In-migration

The acceleration of local economic development helped Tai O to reverse some of the demographic tendencies that contribute to people’s vulnerabilities to extreme weather. One of these tendencies is the village’s aging and declining population, which can be overcome by encouraging migration from other parts of Hong Kong. Local pro-development stakeholders, including elected members of the Rural Committee, are convinced that sustainable (tourism) development can keep the community from falling apart, and keen to encourage people to settle in Tai O. At the same time, the number of outsiders coming to live in Tai O has reached a record high. In 2014, the Housing Authority received some 12,400 applications competing for only 85 subsidized flats in Tai O (Information Services Department 2015). Most of these flats are occupied by outsiders, whose intention to relocate remains high, due to a lingering preference for urban dwelling.

Migration can pose challenges to the receiving community. More people will live in the floodplain and find themselves exposed to the risk of storm surges. Few of them have prior experience with catastrophic flooding at their doorstep, because the majority of urban dwellers in Hong Kong live in high-rise buildings and their homes are immune from inundation. Moreover, many new residents are younger, with a different social routine and higher mobility (e.g., ‘weekend residents’), making it harder for them to establish and maintain close relationships with their older counterparts. Those who set up a new business here inevitably intensify competition, and the rate of business demise is high, resulting in the high mobility of people. Consequently, few newcomers are fully integrated into the Tai O community.

Strong social bonds, trusted relationships, extensive social networks, and the norms of reciprocity proved to be instrumental for Tai O to enhance resilience to devastating typhoons (Lo, Liu, and Cheung 2019). However, the weakening of social cohesion has affected the density of networks of reciprocity and their functioning in coping with environmental shocks. Although the new residents are generally aware of climate change, they have mixed feelings and different views on economic development. A small group of them are environmental and social activists, but they are excluded from formal institutions due to their strong resistance to pro-development ideologies and radical response. Their advocacy for climate change action is barely heard by the more influential progressive stakeholders, whose interests in economic development keep growing.

Emergency management and infrastructure

The local planning regime is open to changes in management practice and technology that address clearly identifiable problems and can deliver widely shared benefits. In Tai O, an ‘Emergency Response Plan’ (ERP) was set up in the wake of the 2008 flooding event, consisting of an early flood alert, evacuation, and rescue. The ERP was well received by the Tai O community and demonstrated its effectiveness in the 2017 flooding event. Early
warnings allowed residents and shop vendors to lift housewares, inventories, and equipment to higher places to avoid inundation, and provided time for evacuation. This mechanism makes good use of pre-existing social and institutional networks by enlisting village representatives as messengers to mobilize people and resources to cope with impending floods. The prompt response enabled by the ERP lowered the damage created by Typhoon Hato. This mechanism is considered to be aligned with local development needs in the prospect of intensifying flooding and storm surges.

The biggest adaptation investment was the construction of a river wall. As part of the village development plan, the project was proposed by the government in 2002 to alleviate localized flooding (Development Bureau 2010; Planning Department 2002). The 220-meter long piece of infrastructure runs along a creek parallel to the village center, stretching into the core built-up area. Raised platforms are built from the two ends of the river wall to prevent the ingress of seawater. Stormwater falling within the enclosed area is diverted through drainage channels to flood pumping stations for discharge. Typhoon Hato posed the largest challenge to the river wall since its completion in 2013. Some shop vendors located within the enclosed area endorsed the project for keeping storm water at bay. However, the water came from all directions; it did not go away but flowed to other areas. Recession decelerated as the wall blocked outflowing water, resulting in more severe inundation outside the core built-up area. The overflow and displacement of stormwater upset some shop vendors.

There was a need to balance diverse interests. The government initially proposed a river wall at +4.0m MSL, but the final product was only 3.3m MSL (within the 1-in-10-year flood-return period) and was inadequate for coping with the floods induced by Hato. The original design lost local political support because it would obstruct scenic views along the creek, where tourists can see the iconic stilt houses (a tourist attraction). Shop owners also did not want a wall stretching into the main walkway and surrounding their premises at the expense of their convenience and tourist experiences. The height and spatial reach of the river wall were eventually curtailed. The infrastructure managed to defend against periodic, astronomical peak tides, but will require significant upgrading as climate change risks escalate.

Wailingding

Resource dependency and livelihood change

Since the late 1990s, the underground economy of Wailingding Island, built upon gambling and prostitution, has been replaced by sustainable fisheries and tourism. To demonstrate its commitment to sustainable development as outlined in China Ocean Agenda 21 (State Oceanic Administration 1996), Chinese Central Government amended the Fisheries Law in 2004 (Standing Committee of the National People’s Congress 1994) and introduced a series of regulatory measures to make fisheries a ‘sustainable’ industry. These measures include issuing fisheries license, setting zoning and seasonal moratorium, reducing the mesh size of fishing nets (to protect juvenile fishes), banning destructive fishing methods, and constructing artificial fish reefs, etc. Along with these new arrangements is a restructuring of the local tourism industry to attract summer visitors and families. Both of these strategies contain elements of sustainability, but they involve trades-off and create perverse incentives, indicating conflicts between different visions of sustainable future.

Beachside tourism is a lucrative industry in Wailingding Island, which took off in 2005 and has demonstrated a higher potential for growth than fisheries. Since the mid-2000s, large state-owned enterprises have begun investing in various businesses in the island, such as hotels,
groceries, and restaurants (Liu 2014; Wang and Bennett 2020). As the direct benefits from tourism materialized, the local government managing the island (i.e., Dangan Town Government) began to restrict onshore fisheries when the older industry becomes an impediment to tourism development. Local government officials strengthened its action against illegal fishing activities (in the name of marine conservation) and provided economic incentives for local fishers to invest in tourism-related businesses. This managed sustainability transition, however, has reproduced an inequitable practice in population management.

Benefits of this transition are unevenly distributed between those residents with and without a local hukou. China’s hukou system is a family registration programme that regulates people’s movement across the country, especially between rural and urban areas. Migrants are required to register a hukou with the local government in order to receive welfare and service. The programme enables local governments to deny, at their discretion, migrants of the same rights and benefits given to native residents (born with local hukou), or charge them higher taxes or fees for service. In Wailingding, some migrants have transferred their hukou to Dangan Town, but the new policy measures continue to discriminate migrants. For example, migrants, especially those without local hukou, are more likely to participate in illegal fishing and use destructive fish methods, which are now prohibited. Although native residents are similarly affected by the new regulations, they receive more government subsidies, compensation, and technical support for occupational transition. Native residents have stronger incentives to retire from onshore fishing, as they are given higher priority to practice mariculture within Wanshan waters and to use government land for running a tourism business. On the other hand, migrant fishers receive little support for adopting an alternative livelihood. Some of them continue to work at a higher cost by venturing to other waters and navigating into another jurisdiction (i.e., Hong Kong) to conduct offshore fishing, which is against the law and exposed to higher uncertainties, including wild weather. As a result, while the fisher population has diminished, a larger proportion of fishers find their business operation at higher risks.

Accelerating tourism development is conducive to reducing the community’s resource dependency and livelihood diversification. A growing number of residents, including migrants, have established their own businesses targeting tourists, such as guesthouses, souvenir stores, and restaurants. Because the beachside tourism is seasonal, some of them continue to operate other businesses, including fishing, during off-peak season and both within and outside Wailingding Island. Local residents have become generally better off, especially native residents who gain an advantage from the transition. Many of them can afford a second home in Zhuhai’s mainland, which increases their mobility and resilience. The greater diversity and flexibility in livelihood and lifestyle have enhanced capacity of residents for coping with extreme weather. However, the ongoing transformation has created unintended consequences.

In-migration

Because the tourism bloom promises to improve people’s well-being, it has driven a new wave of domestic economic migration into the physically isolated, hazard-prone community. One of the outcomes is a growing population of migrants in Wailingding, intensifying the social inequalities arising from hukou system and increasing the proportion of residents not properly covered by the social security systems. While migrant workers have fairly strong social capital among themselves, social divides exist between migrants and native residents, further
exacerbated by hukou system. Consequently, the community as a whole has become more diverse with weaker social cohesion.

There are also direct implications for coping with coastal hazards. Most of the migrant workers originally come from inland provinces. They are generally poorly aware of coastal hazards and have limited skills or knowledge for coping with these hazards. Learning to cope is a slow process, due to their weak social connections with the rest of the community as well as limited support from formal institutions. Furthermore, discussions about long-term adaptation to climate change are rare, if ever take place, in Wailingding Island. When asked, many local residents either conflated climate change with naturally occurring weather events, or indicated that they had never heard about the term. The influxes of migrant workers have reinforced the marginalization of climate change action here. They expressed little concern about climate change issues generally, and climate-related coastal hazards specifically, because their migration is primarily driven by job or business opportunities and short-term economic benefits, which do not fit into the much longer timeframe of climate change. Not all of them have plans for settling in the island for an extended period of time. Nor is there any environmental or social activist from within or outside the community to advocate for climate change action in the island or Dangan Town. As a result, there is low motivation among the growing migrant population to support or participate in long-term planning against extreme weather.

**Emergency management and infrastructure**

Emergency arrangements and risk management systems were far from complete before Typhoon Hato devastated the island. Such extreme weather events are damaging not only because of their physical impacts, but also because of the increasing importance of infrastructure and lifeline supplies, especially those that are important for tourism activities, such as the recently built promenade and plaza. The overlapping of typhoon and tourism seasons has also increased economic vulnerability. The combined effects of Typhoon Hato and the growing attention to such economic infrastructure and stability of lifeline supplies have motivated the local authorities to formulate a new plan for managing extreme weather (Zhuhai Municipal Commission of Housing and Rural and Urban Construction 2017). This disaster management plan is not yet fully implemented, but has indicated a clear focus on preventive engineering solutions and infrastructure upgrading. Proposed measures include infrastructure retreat, new building codes, early warning systems, and construction of desalination facilities. Properly implemented, these measures can accelerate recovery from extreme weather events, but considerations of future climate change risks remain obscure in the official response.
Discussion

The restructuring of the local economy and the demographic regime of Tai O and Wailingding Island represents system-wide social and economic transformations. Their similar development pathways have sustainability elements, e.g., promoting cultural and nature conservation (Tai O), protecting marine wildlife and displacing underground businesses (Wailingding), and supporting economic growth and improving the livelihood of local residents (both places). Some of these changes and new arrangements increase sustainability in one area, but not other areas, and some benefits of sustainable development are accrued to one group of people but not others. There are also tensions and disputes as to what sustainability means and entails, who or what is vulnerable, and adapting to what. These challenges unfold or intensify when the development pathway involves systemic changes that affect a wider range of interests and create broader and deeper impacts at multiple scales.

The acceleration of tourism development has reduced the resource dependency of the Tai O and Wailingding economies, both originally founded on fisheries. This makes the two rural economies less sensitive to storms in the long term. The strong economic momentum has also given impetus to a set of ‘resilient’ or ‘resistant’ measures, which involve marginal changes in (risk) management practice or technology (Pelling 2011; Pelling, O’Brien, and Matyas 2015). Examples include the ERP and the river wall in Tai O, and the post-disaster recovery and risk management plan of Wailingding Island. These interventions directly deal with the immediate impacts of coastal hazards and are compatible with the narrative of economic development. They address clearly identifiable and well-known problems (e.g., flooding), and their benefits are easier to demonstrate and shared by most if not all local residents. Although these interventions do not address “non-climatic factors that are the underlying ‘drivers’ of vulnerability” (Ayers and Dodman, 2010, p. 165), they are integrated into wider community planning and recognized in official reports (Environment Bureau, 2015; Zhuhai, 2017), and their importance to the high value-added tourism economy is evident.

As Adger et al. (2016) have demonstrated, a strong focus on macroeconomic performance is likely to result in the prioritizing of a rationalist-economic framing that favors the use of technological fixes in flood risk management. Dealing with the loss of economic competitiveness and the declines of some sectors entails introducing some rationalist measures targeted at protecting properties and lives that are valued more favorably from physical damage as the economy becomes strategically significant. Thus, there has been a preference for incremental, problem-oriented approaches, which present decision-makers a narrower range of variables and fewer political risks than do transformational responses (Wise et al. 2014). Synergies between economic development and climate change adaptation - or more accurately, DRR - are clearer in these terms.

Economic transition and migration are changes at a larger scale than the improvements in emergency management and infrastructure. They are part of a complex process of social and economic transformation and associated with adaptive as well as maladaptive elements. In Tai O, the aging and diminishing population was one of the underlying drivers of the community’s vulnerability to natural hazards and climate change. Increasing the population by creating more business (tourism) opportunities can reduce the risk of aging, thereby alleviating vulnerability. Economic growth has also attracted more environmentally aware, younger individuals to settle in or work in Tai O. In Wailingding, the inequitable access to resources perpetuated by the hukou system is one of the ‘contextual’ vulnerabilities (O’Brien et al. 2007)
legitimized by a state-enforced population management tactic, forcing migrant workers to participate in prohibited fishing activities and creating barriers to livelihood transition.

The development interventions in the two rural communities have either created new vulnerabilities or reinforced existing ones. Although the local economy and population of Tai O have become more ‘sustainable’ in some ways, development has also engendered destabilizing social forces and undermined the social basis of informal institutions. There are new benefits as well as new (social) costs, such as the impending decline of social capital and networks and the individualization of behavior, as the local economy progresses, people’s mobility increases, and social routines are reconfigured (Fazey et al. 2011; Ford, Smit, and Wandell 2006). Sustainability benefits are partially attained.

In Wailingding, sustainable fisheries are conducive to marine conservation, and tourism development has contributed to livelihood diversification. However, the benefits and opportunities are distributed in ways that cost the well-being of migrants, who are generally worse-off than native residents. Some of these migrants have encountered more barriers to switching to a tourism-related livelihood, and there are perverse incentives for taking higher risks in pursuing an existing livelihood. There are disagreements between migrants and natives as to whether these interventions address problems or act as problems themselves. The economic transition has also encouraged in-migration into a hazard-prone area. Many of these economic migrants find themselves removed from the long-term climate change impacts on the island. Social cohesion remains weak, if not becomes weaker, undermining the prospects for collective action on coping with coastal risks.

The two case studies show that, although the transformations in local economic and demographic structures could overcome some contextual sources of vulnerability, they also create new uncertainties and conflicts. As Ford et al. (2006) have indicated, adverse changes in the larger social environment, driven by factors such as increasing social divides and inequalities, and breakdowns of social and familial ties, can weaken the trust and reciprocity that have facilitated the sharing and pooling of risk. Systems-level social and institutional changes driven by a sustainability transition do not always move in the same direction as the processes required for climate change adaptation, but more so with those of disaster risk reduction, which concern existing risks and observed consequences.

The imperative of avoiding dangerous changes in the climate is often taken for granted when arguing for deliberate adaptation (O’Brien, 2012; Fazey et al., 2018; Park et al., 2012). However, communities are exposed to multiple threats at multiple scales, with multiple goals to achieve (Gaillard and Mercer 2013). In practice, non-climatic goals often predominate over others (Fazey et al. 2011), and most adaptations are originally designed to address non-climatic issues (McGray, Hammill, and Bradley 2007). Although system-wide social and economic restructuring could provide opportunities for transformational forms of adaptation, climate change has to compete with other pressing issues for attention and resources in the course of restructuring. In such a transforming economic and social context filled with big questions, colliding interests, and competing visions for future, the terms by which sustainability and vulnerability are understood and articulated are highly variable and contested. In Tai O, for example, a ‘sustainable’ development pathway is understood by influential stakeholders and most residents as one that helps rejuvenate the economy and increase local population. Vulnerabilities are seen as arising from the otherwise shrinking community, culture, and population, and not primarily in relation to climate change impacts (or natural hazards at best). In Wailingding, the new economic regime pursues sustainability in
industry development. The ‘vulnerable’ groups are the traditional and migrant fishers who fall victims of the new regulations, and the older industries and their operators who have lost a livelihood to the tightened control over underground businesses nationwide. In both Tai O and Wailingding, the local economy is regarded as what needs to sustain, and broader social and economic vulnerabilities loom larger than specific climate change vulnerabilities.

Strategic sustainable development pathways that involve systems-level transformations open up debates as to what to sustain and what is vulnerable. They are not bound to idealized forms of development that are conducive to long-term adaptation planning. The larger the changes involved, the wider range of sustainable futures and vulnerabilities competing for attention and resources. While contestations, deliberations and grassroots participatory initiatives can guide the processes of transformation towards sustainable ends (Eriksen et al., 2021; O’Brien, 2012), vulnerability reduction and resilient outcomes do not always ensue (Godfrey-Wood and Naess, 2016). As shown in our case studies, an economic framing is prioritized or widely accepted in geographically and historically marginalized areas that have begun to demonstrate growth potential. Certain forms of sustainable economic transition can result in the reinforcing, redistribution or creation of new vulnerabilities to climate change2, rather than mitigating them.

Our findings are summarized in Table 2. The findings lend some support to the view that “[e]nhancement of adaptive capacity involves similar requirements as promotion of sustainable development” (Smit and Pilifosova, 2001, p. 899), but raise issues about the scale at which sustainable development is aligned with adaptation goals. Incremental adjustments to climate-related natural hazards more easily find their way in a sustainable economic transition. They typically involve the use of technology and rationalist approaches to deal with observed impacts and present a strong and less disputable case for reducing potential damage on infrastructure, properties, and people’s well-being. A narrower instrumentalist problem framing of DRR at finer scales is more compatible with a development narrative with salient economic elements.

On the other hand, transformational response to climate change is not evident in the two case studies. Progressive and radical adaptation action requires deconstructing and removing the fundamental, underlying drivers of vulnerability, such as social inequities and hierarchical power structures (Few et al., 2017), and is often framed in terms of social and environmental sustainability. Tensions and barriers to integrating such action into a sustainable economic transition arise when sustainability and vulnerability are interpreted in the broadest terms, encompassing not only social and environmental dimensions, but also the economic ones. Alternative ways for understanding sustainable future and vulnerability complicate questions as to what or who need to adapt to what. As a result, cases of fundamental change are also more likely to incur important trade-offs (Sikor 2013). Systems-level transformations put more interests and people at stake, and their rising to the local debates and policy agenda can result in the marginalization of adaptation goals and impede adaptation interventions.

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2 Eriksen et al. (2021) use the same terms to describe how adaptation interventions increase vulnerabilities, while we use them to describe transformative changes that are not originally driven by climate change adaptation goals.
Conclusions

This research helps to understand how local economic development shapes adaptive capacity. It is particularly relevant to coastal areas of high development potential and tourism-based economies that are struggling to mainstream DRR and climate change adaptation. Our case studies show that the processes of economic development can overcome some sources of vulnerability, while creating new ones. Systems-level societal and economic transformations typically do not take into account climate change effects, putting some interventions or system re-configurations at risk of maladaptation. In fast-growing areas where the momentum for economic expansion is strong, an emerging issue of concern is the deterioration of the social and cultural landscape to the detriment of social capital and cohesion. Local economic transition can enhance the capacities for addressing these risks and adapting to future climate change by attracting institutional attention and resources to a locality. However, it can also turn into a contested process of transformation that destabilizes some of the social conditions underlying existing adaptive capacities. The emergent processes of a broadly sustainable pathway have reduced some vulnerabilities but reinforced other ones.

The two case studies described in this paper have shown that local economic development has mixed implications for vulnerability reduction and community resilience to natural hazards and climate change. Synergies between economic development and climate change adaptation – or more accurately, DRR - are clearer in driving incremental adjustments. Clearly delineated and proximal consequences of climate change are seen as impeding progress and requiring an immediate response. Installing a floodwall at the doorstep of a business premise before floodwater arrives is an illustrative example. Compatibility is clearer when the challenges can be understood and articulated in similar terms. In contrast, the conditions for synergies are less stable at the system level. Transformative changes in economic and social structures involve negotiations of processes and actions at multiple scales and a wider range of interests, and therefore are more controversial and difficult to navigate. The lack of clarity or agreement about the terms by which the problem is understood and articulated precludes one objective from being couched in terms of another one. There is no doubt that economic development should be sustainable and overcome contextual vulnerabilities, but there are different views and disputes about what to sustain and what is vulnerable. These tensions can complicate and impede the process of integrating adaptation objectives, which are often couched in terms of sustainability and vulnerability, into system-wide transformation. Not all outcomes and processes of sustainable economic development are inherently sustainable, and some sustainable benefits may be distributed in ways that privilege certain groups of people over others. Transformative changes are more likely than not to result in such partial achievements and uneven distribution of benefits, consequently compromising coping and adaptive capacity and perpetuating vulnerability.
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