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How do households respond to coastal hazards? A framework for accommodating strategies using the example of Semarang Bay, Indonesia

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ABSTRACT

Responding to coastal hazards is a daily challenge for populations in low-lying coastal areas all over the globe. How local communities develop accommodating strategies for these hazards remains largely under-emphasized. Filling this knowledge gap is vital to connect the big picture science of sea-level rise with the adaptation needs and capabilities of affected communities. This paper contributes new understanding by presenting the results of original, mixed-methods research (a household survey and focus group discussions) that documents the accommodating strategies of communities and households in the Semarang Bay on northern Java. We find that participatory capacity and self-organization are key factors in enabling communities to live in unstable environments. Coastal hazards have become a normal element of live and are not perceived as severe risks. Rather than retreating or gaining permanent protection, people found ways to accommodate to and hence live with floods. This result adds an important dimension to contemporary theorization of responding to coastal hazards. Although the IPCC (2014) acknowledges 'accommodating' as one form of adaptation alongside 'retreating' and 'protecting', it tends to be overlooked as temporary and insubstantial compared with the latter responses. This research finds that accommodating strategies, such as informal loans, are effective means for people to maintain their livelihoods in hazard-affected coastal areas on a more substantial basis than recognized in much of the literature. We therefore argue that accommodating should be distinguished from both long-term adaptation and short-term coping and deserves elevated consideration by researchers examining hazard response modes among coastal populations.

1. Introduction

How humans respond to environmental change is one of the most challenging questions of the 21st century. Coastal areas are particularly concerned as more than 10% of the world's population (600 million) lives in low elevated areas < 10 m, most of them in Asia [1,2]. Low-lying areas are sensitive to a number of hazards such as storms, floods, tsunamis and sea level rise. A better understanding of human responses to environmental risks helps to reduce vulnerabilities and to increase response capacities in these coupled social-ecological systems[1] [3].

The understanding of human responses to coastal hazards has been advanced by the IPCC (2014) which developed a tripartite framework of retreat (moving away from the coast), protect (structural and soft measures) and accommodate (changes in human activities and infrastructure) [4]. Both the issues of protect and retreat are prominent topics in the media and in science. In fact, the debate about climate-induced migration is one of the most heated ones of our times [5–12]. Sure enough, talking about 'hundreds of millions of people' that might be affected by coastal flooding by 2100 and who will, without adaptation, potentially become climate migrants [4] sounds like a big picture indication of climate change; and large structural measures such as the proposed 'Giant Seawall' project in Jakarta call widespread attention [13–15].

The problem, however, is that the retreat/protect dualism does not represent the reality of the lives of most coastal inhabitants (in the Global South). This is especially relevant with regards to contemporary sea-level rise, which is a hazard with slow-onset characteristics. In these contexts, it becomes highly relevant to give close consideration to accommodating strategies, namely, the processes through which people change their day to day practices. Compared to retreat/protect scenarios, accommodation is less visible and may seem less substantial. Yet, empirical evidence suggests that it is important; people tend to stay

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[1] Social-ecological systems describe coupled systems of natural and human aspects. Natural systems include the ecosystems and their physical features. Human systems contain the built environment, human activities and institutions. These systems can range from local communities to global scales [4,38].

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in hazard-affected areas even when environmental conditions progressively become unfavorable [6,11,16]. In fact, most coastal urban areas in the Global South are rather gaining than losing population [1,17]. Hence, accommodating strategies can be assumed to be carried out to a much larger extent than commonly imagined. This is especially so in regions with complex coastal morphologies and risk constellations, such as subsiding areas, and where individuals and communities lack the financial capital and resources required to retreat or to carry out large-scale structural protection measures [18]. A key question in studying human responses to coastal hazards therefore is: How important are accommodating strategies in areas that are strongly affected by coastal hazards and where resources to structurally protect populations are limited, and how viable are these approaches?

In seeking to answer this question, our paper draws attention to the importance of understanding accommodation to coastal hazards. We thereby focus on community-based responses which ensures that coastal dwellers are not depicted as passive victims in the face of natural hazards; instead we emphasis their active agency [19–21]. Bottom-up strategies become especially relevant where local and regional administrations lack the resources to adequately cope with natural disasters and environmental change [22]. However, they can often escape the purview of policy makers, who still tend to plan for coastal adaptation with minimal understanding or consideration of household response strategies, which can lead to adverse effects [23]. Thus, there is a strong demand for concepts to assimilate these bottom-up approaches with top-down knowledge about processes of coastal environmental change [18]. Recognizing this reality, we argue that researchers who use the IPCC's tripartite framework should find room to embrace the category of 'accommodating change' more explicitly, and through community-based methodological insights.

Consistent with this aim, this research uses mixed-method data collected in the Semarang Bay area on the north coast of Java to assess three questions: (1) How do households accommodate the uncertainties of coastal flooding and sea level rise? (2) Which strategies are applied by the communities to self-organize and to absorb the risk of coastal hazards? And (3) what conceptual lessons can be deducted from these empirical insights to advance the theorization of accommodating?

Many local communities worldwide have developed successful strategies to deal with coastal hazards collectively as all social systems possess inherent capacities to do so [24]. We found that accommodate practices are thereby distinguishable in timescale and quality from the response cycles of both short-term reactive coping and long-term innovative adaptation. Therefore, we argue that researchers need to give elevated attention to accommodating strategies within a new three-scale framework. Developing a new framework is highly relevant for policy makers as sustainable coastal risk planning needs to more firmly articulate the role of accommodating practices, and thus requires their inclusion in conceptual frameworks that guide further research [25].

In moving forward with this paper, we first describe the IPCC understanding of response options to coastal hazards followed by a short introduction of key analytical concepts for assessing the viability of those response option, before coming to the sections about methods and the study area. After setting this scene, we describe our empirical findings, and building on these results, we establish the new theoretical framework of accommodating coastal hazards in the discussion section before concluding the paper.

2. Response options to coastal hazards discussed in literature

Research on how households and communities respond to past, present and future coastal hazards is crucial for understanding human-environmental systems. Literature names the following respective options for carrying out coastal adaptation under the IPCC framework (Fig. 1) [4,25–29]: *Protection* typically consists of 'hard' structural measures such as dikes, seawalls and floodgates, but also 'soft' structural options such as periodic beach nourishment and dune restauration, and more indigenous options such as afforestation, stone walls or coconut leaf walls. *Retreat* "involves moving away from the coast" [4p.387]. Besides migration and population resettlement, it includes options such as relocating buildings and infrastructure to higher grounds or further inland, spatial planning for no-development zones, managed plot and river realignment, and setback zones. *Accommodate* involves changes and modification in existing structures and in human behavior, which allow to sustain the use of land [4,18]. Thus, accommodating can be translated into "living with risks". It refers to top-down measures such as modification of land use and building styles, and early warning systems, as well as to community-based measures such as informal money pooling and collective workforce organization.

Of these three response options, protection and retreat tend to be more amenable entry-points for governmental action and top-down risk management. This is due to several reasons among them the higher visibility of the measures taken. In contrast, while accommodation can benefit from top-down interventions, in practice it tends to be is more frequently undertaken as a set of initiatives by households and communities. Perhaps for this reason, accommodation has garnered less research attention than the other two types of strategic responses. Retreat strategies (including resettlement planning and climate-induced migration) have been discussed extensively in the social sciences [25,26,30–33]. The literature on protection is also extensive, with additional strong input from natural and engineering sciences [29,34–37].

Compared with these literatures, the consideration of accommodation has remained relatively undertheorized. This neglect is unwarranted. Accommodating options are more easily accessible for local communities in the Global South than are protect and retreat. As Gibbs [28] argues, although protect and retreat options offer potential large-scale solutions for affected communities, they come with high costs. Accommodation strategies potentially offer less substantial long-term solutions, but are the most viable option for many communities due to their lower financial costs. Additionally, they embody an important principle revealed in much hazards-related research: that people often prefer to stay and continue their lives within their communities in the face of environmental risk [6,11,16]. In the following this paper focusses on community-based accommodating strategies in a Global South context.

3. Concepts for analyzing the viability of response options to coastal hazards

In this paper, we use 'response' as an umbrella term for coping and adaptation [38]. However, to analyze the viability of coastal hazard response options, such as accommodating, a closer look at the timescale, quality, and agency is necessary..

While some authors use adaptation and coping synonymously [39–41], others have illustrated fundamental differences between them [42–44]. In line with the later, we argue that these concepts are distinguishable first of all by timescale (short-to long-term), point of time (before, during, after an event), quality (innovative, future-oriented or simple recovering) and agency (top-down or bottom-up).

While different protect and retreat option have already been examined under these different distinguishing parameters (technical measures such as permanent embankment systems and permanent resettlement offer long-term solutions; and sand sack walls and emergency evacuations can be regarded as short-term), options of accommodating have yet to be analyzed. In the following we use these distinction parameters for assessing the viability of accommodating strategies.

Coping in this paper is understood as mostly short-term actions undertaken during and shortly after an event to recuperate. The focus of action lies on the present situation and learning from past events is limited – typically the same measures are repeated [42,44,45].

Adaptation in turn is understood as socio-economic practices that moderate current or expected negative environmental impacts and

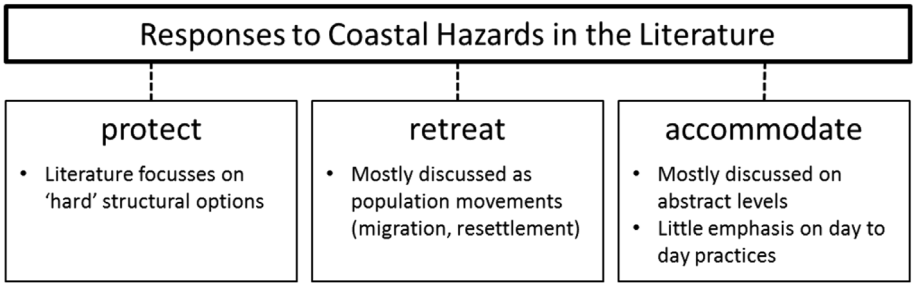

Fig. 1. The IPCC framework of responses to coastal hazards and how it is mainly discussed in the literature.

hazard risks, and practices that take advantage of favorable environmental changes [46]. Adaptation thereby has a planned and proactive character, and social learning from previous events is essential [47].

A critical input that shapes both coping and adaptation, is the extent to which affected populations possess self-organization capacities and collaborative agency [43,48,49]. This notion of *participatory capacity* describes the ability of a social system to self-organize and to use its internal coping and adaptive capacities into action. Participatory capacity becomes manifested both within and between social systems.

Empirical studies in many parts of the world indicate that collaborations are easier to achieve in communities with higher *social capital* and denser *social networks* (e.g. Refs. [22,50–54]). Through networks of trust, people have access to loans, information, and mutual help that become valuable resources for their coping and adaptive capacities. Therefore, analyzing social networks is essential to better understand accommodating behavior.

Linked to these observations is the importance of bonding, bridging, and linking ties [54,55]. *Bonding ties* describe relations within a closely connected and largely homogeneous community [56]. They are primarily associated with immediate support. *Bridging ties* emerge between members of different ethnic, cultural, and occupational backgrounds, but with more or less similar socio-economic status. *Linking ties* describe connections over hierarchical stratums connecting members of different socio-economic classes. Bridging and linking ties are often described as less close (weaker) and less frequent than bonding ties. However, because they connect people from different backgrounds and living environments, and thus different knowledge and experiences, these ties can offer particularly promising pathways for innovations and new ideas [57,58]. These concepts underline how the direction that participatory capacity takes is carried by unequal distributions of power, prestige, and social connectedness within and between communities.

Thus, the process of accommodating coastal hazards needs to be understood as a set of strategies infused by political economies of power in socio-ecological contexts defined by information uncertainty and capital limitations. These general points having been established, attention turns now to the empirical contribution of this paper, which is the specific question of how coastal dwellers in the Semarang Bay of the north coast of Central Java have been accommodating coastal hazards.

4. Methods

In a first explorative research phase (August and September 2016), we conducted eight focus group discussions (FGD) with community members[2] in seven hazard prone coastal urban quarters of Semarang. The FGD guideline questionnaire was structured in five main sections containing questions on community/household characteristics, perceptions of coastal hazards, repose options, social capital, and social networks. This method allowed us not only to gain relevant qualitative information, but to analyze the interactions and communication patterns between participants [59]. In this paper, qualitative data are used for in-depth analysis of perception and behavior e.g. on collective accommodating strategies, community self-organization, and daily routines (chapter 6.2). Each FGD had 7 to 11 participants, with a total of 29 female and 46 male discussants. The FGDs were conducted by the first author with the help of three Indonesian student assistants.

We subsequently developed a standardized household survey based on the results of the FGDs, structured in the same five question sections. For formulating the questions on social capital and networks, and to build on well-established indicators, we consulted the World Bank Social Capital Assessment Tool, which contains guideline questions for household and community investigations [60]. The resulting quantitative data are analyzed mostly descriptively to show percentages and general trends and to support the qualitative findings.

In March and April 2017, 650 households were surveyed along the Semarang Bay area, including the City of Semarang (n = 330) as well as the adjoining districts Kendal and Demak (n = 160 each). The households where selected based on random walks, choosing every fifth house in a street. Sixteen student assistants conducted the survey in Bahasa Indonesia. These assistants were trained in a five days kick-off workshop, during which a pre-test was conducted. The reference units of the questionnaire were households defined as entities for collective decision-making. 49% of the respondents were female, 51% male, representing a total of 1462 female and 1381 male household members. Additional open and semi-structured key informant interviews with local leaders and municipal officials were conducted throughout both research phases to gain additional background information.

We selected 18 study areas along the entire Semarang Bay based on on-site inspections and with the help of local experts (Fig. 2). All selected areas are prone to flooding and subsidence. The study areas in Semarang City cover 50% of all urban quarters (Kelurahan) with direct coastal access and represent a large share of all coastal residential quarters. They include fishing communities, industrial worker areas, and settlements of the lower urban middle class. The studied district Kendal faces an ongoing industrial suburbanization. Major roads and the railway connect the coastal areas of Kendal to Semarang. The rural villages (Desa) in Demak remain largely aqua- and agriculture based.

We found that while there are some differences in protection strategies based on financial resources and building material available, the results show no significant rural urban divides when it comes to social capital and collective strategies to respond to coastal hazards. Therefore, a rural-urban comparison is not in the main focus of this paper, but differences in exposure and finances are highlighted when we found them to be significant.

5. Study area: the character of coastal hazards in the Semarang Bay Area

The Semarang Bay area is a prominent example of a highly exposed low-lying coastal region. Both floods and slowly emerging relative sea level rise are threatening the local population, creating a multi-risk environment [61–63]. Most of the coastal inhabitants belong to the low

[2] In this paper, we understand 'community' as a place-based neighbourhood unit. Within one community, members know each other, reside in the same neighbourhood, and share some degree of common narratives and beliefs [53].

Fig. 2. Study areas and land use in the Semarang Bay Area. Sources: OpenStreetMap, Landsat 8 Natural Color (6/5/4) 2017-04-07 [USGS/EROS]; Layout: LM Bott; Cartography: R Spohner. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

and lower middle income class, thus, financial capital to respond to coastal hazards is limited [64].

Semarang City, the province capital of Central Java with 1.5 million inhabitants in the municipal area, is especially affected. Natural consolidation of geologically young alluvial soils is strongly accelerated by the urbanization of sensitive coastal areas, which becomes manifested in high surface loads and excessive and largely uncontrolled groundwater extraction [61,63]. The causes of local coastal hazards are thereby largely human-made. As a consequence, the coastal stretch of Semarang now faces massive land subsidence with an average rate of 6–7 cm/a, and maximum rates up to 19 cm/a in some industrial areas in the north-eastern district, Genuk [61]. 59% of our researched households claim to be affected by subsidence. The exposure is significantly higher in industrialized urban areas with 64% of subsiding households, but even in agriculture-based rural areas 46% experience subsidence.

While the absolute sea level rise in this region shows no significant trend, subsidence leads to a measured increase of the relative sea level of about 10 cm/a [65][3]. Consequently, the streets in low-lying coastal areas (22% of the city's area) are frequently flooded up to 40–60 cm by high tide [63,66]. About 150 000 urban dwellers are regularly affected [67]. 43% of our surveyed households experience frequent tidal flooding of their streets. The exposure is higher in peri-urban and rural areas (50 and 54% respectively) compared to urban areas (34%) due to the better flood protection infrastructure in Semarang City.

In addition to the tidal floods, the annual mean precipitation of 2065 to 2460 mm/a strongly exposes coastal settlements to inland river and rain floods during the monsoon season from December to February [68]. During this time, 22% and 28% of the surveyed households said they were frequently exposed to river and rain floods respectively. Our FGDs revealed that the vulnerability of the urban population towards flooding is further aggravated by a lack of waste management. Domestic and industrial waste piles up in the rivers and along the shore. It blocks drainage channels and watergates, and in extreme cases can even lead to breaks in dikes and embankments. Indonesian rivers are highly contaminated with plastic waste in international comparison [69]. These problems affect not only residential areas, but also important job-relevant industries [70] and crucial transport infrastructure, such as the international airport, the sea port, and the central train station (Fig. 2). 22% of the respondents stated that reaching their work place can be inhibited by flooded roads. Tidal floods are a frequent phenomenon and subsidence is ongoing. Floods last a median of three hours and although usually do not inundate streets and houses more than ankle deep, they have wide-ranging effects. Because of their limited and regular nature, people generally stay in their houses during floods, and 95% of respondents have never had to evacuate. However, important assets can be lost in floods such as electronic devices (experienced by 14%), clothes (17%) and furniture (36%). Flooding is also a health issue. Skin infections are common in 51% of households and gastro intestinal diseases in 24%. Therefore, coastal hazards have considerable impacts on local people's lives, and hence, the issue of how people respond is crucially relevant to their wellbeing. These issues are now addressed. We first discuss retreat and protection measures, before analyzing accommodating behavior in more detail in the second part of the results section.

6. Results

6.1. Strategies of retreat and protect in the Semarang Bay Area

While accommodating strategies are in center of our analysis, a

[3] Absolute sea level rise would stand in relation to global warming and is measured by radar altimetry, which is independent of the landmass, but in relation to a reference ellipsoid. Relative sea level rise in contrast is only measureable in relation to the respective coast line using local tide gauge stations.

short look at retreat and protection options is required to gain a full picture of response options to coastal hazards in the Semarang Bay.

So far, retreat is not an option of choice in our study areas. Despite the high exposure to multiple and frequent coastal hazards, our results show that coastal dwellers are not leaving the flood affected areas along the Semarang Bay, confirming findings of Hillmann and Ziegelmayer [64]. This holds true even for the most exposed areas in north-eastern Genuk. 95% of all surveyed households stated that they are not planning to relocate within the next five years. Regardless of the high exposure, floods and subsidence do not push people to migrate. North-East Semarang still experiences a net population gain, mostly due to labor migration from Kendal and Demak [64]. This propensity to stay accords with the argument of Abu et al. [71] that physical events which are experienced over a long period of time become perceived as 'normal' and as a result do not motivate people to migrate away.

Close social ties and community belonging were mentioned as major reasons to stay for these hazard-prone populations (67% of survey respondents). Our FGDs revealed that the participants had hardly any contacts to people outside their villages, which reinforced the importance of localness. Thus, bridging and linking ties to other places, which could create migration corridors, are lacking [72].

Economic factors are important contributors to the unwillingness to migrate. 39% of respondents stated that migrating would be too expensive, and proximity to job opportunities motivate people to remain in their living environment (49%). So far, the majority of local firms in Semarang is not planning to relocate either [73].

Because retreating is currently socially and financially unattractive for most households, communities in the study areas have developed various strategies to protect themselves against flooding and land subsidence. With regards to flooding, the majority of strategies are 'soft' or indigenous protection measures such as afforestation of mangroves (applied by 13% of the households), sand sack walls (11%), and private pumps (2% only in Semarang City). People protect their homes by building small drainage channels around them (5%), by increasing thresholds in front of their doors (16%) or by covering their floors with ceramic tiles (31%). To prepare for water entering the house, coastal dwellers sleep in beds (51%), instead of on a traditional mattress on the floor, and they store their belongings on shelves (55%). Because tidal and rain floods are frequent, but normally low-level (high frequency, relatively low magnitude), these small-scale protection options are in fact sufficient during most flood incidents.

Permanent protection options, however, mainly exceed the financial resources and the know-how of most communities. For implementation they would need municipal engagement. We found that these linking ties between municipal and community stakeholders need to be enhanced in most study areas. That way, the required know-how and funding could be provided to 'up-scale' existing community protection strategies [74].

With regards to land subsidence, the protection response of affected private houses is undertaken through investments in elevation. The high rate of subsidence means that houses need to be elevated every five to ten years. This creates a huge financial burden for the households. Only 17% of urban, 6% of peri-urban and 5% of rural households have savings of 11 million IDR or more, the minimum amount required for elevating a house according to the FGDs. The money required for elevation purposes is lacking for other acquisitions, education, etc., and the economic advancement is hence restrained.

Most identified soft protection strategies of households are temporary or semi-permanent, mainly allowing people to get by. This finding holds true especially for subsidence, a hazard which requires frequent house and infrastructure elevation. In fact, a permanent solution for subsidence is not possible to achieve by protection at the household level, it requires top-down mitigation approaches. The example of Tokyo proves that subsidence can actually be stopped relatively quickly by implementing mitigation options such as fresh water supply from surface water, spatial planning with no-development zones and coastal setback zones [75,76]. However, all these options require a high level of governmental and municipal engagement. Our findings regarding available retreat and protection options leave accommodating as the option of choice for communities and households in the Semarang Bay.

6.2. How do people accommodate coastal hazards?

The predominance of accommodating practices (as opposed to retreat or protect strategies) reflects the risk perceptions of householders. In our survey, we asked households about the risks imposed by natural hazards. We asked this openly, so that respondents would self-nominate the particular hazards they regarded as most important. 39% named tidal floods and 14% named land subsidence as hazards they faced. Notably however, these results underrepresented the proportion of survey respondents facing these hazards, indicating that they had been normalized in respondents' eyes, and alternatively perceived as something 'natural': "*We can´t resist land subsidence because it is the law of nature." (FGD Tawangsari, M2)*.[4] *"Here, tidal flood is not a disaster. We get used to it. It´s like a daily activity." (FGD Terboyo Kulon, F3). "At the beginning, [the tidal floods] disturbed us, but now they become part of our habit." (FGD Tanjungmas, M8)*. Thus, living with floods and subsidence has become a habit and an integral part of the daily practices of local communities. "*We get used to it. When the tidal floods recede, we clean the house, the road." (FGD Terboyo Kulon, F1). "When small tidal floods occur, the children have to go to school. The children take off their shoes and carry their shoes with them to school." (FGD Trimulyo, F3)*.

The ability to enact most accommodating strategies (such as collective money pooling and community workforce organization) is strongly tied to communities' social capital and requires a high participatory capacity. Our survey data affirms these characteristics in the case study sites. We identified a dominant inward-oriented bonding social capital in the Semarang Bay area. Accordingly, trust levels between people are high. "*Those who trust us are actually the people in the village. Because they already know about my behavior and attitude." (FGD Mangunharjo, M3). "People are close to each other. We are tight. […] You can come to this area in the afternoon, and I'll show you the keys of every house in this area." (FGD Terboyo Kulon, M8)*. In line with the FGDs, 98% of all survey respondents perceive the trust levels within their village communities as mediate or high. 95% believe that people are willing to help them if they need support, and 97% feel accepted as a respected community member. On the other hand, such close social networks not only require high trust levels, but are also based on social control. People who do not engage in community matters risk to lose respect or to be ignored by the community. "*For example, if these people are sick, the others will not visit them because they never take care of other people. That's the social punishment." (FGD Tawangsari, M1)*.

The strength of this bonding social capital is reflected in how local communities have found ways to accommodate to, and hence, live with their environmental situation through mechanisms such as installing collective money pooling (non-bank savings) or by holding community meetings to deal with floods and subsidence. To implement these kinds of non-physical risk reduction strategies, a high level of community self-organization is necessary. In the Semarang Bay area, self-organization capacity and the internal participatory capacity are assisted by the highly institutionalized social orders in communities. Every Kelurahan or Desa has a governmental appointed village head. Furthermore, each village is formally structured in local neighborhood associations (RT, ~30–50 households) and higher ranking neighborhood associations (RW, ~2–5 RTs) [74]. The heads of the RW and RT are elected by the adult community members and represent their members at the village level. With a few exceptions, RW and RT heads are male. Their wives,

[4] All quotes from FDGs are structured in: (FGD Place, M = male/F = female and no. of participant).

however, are usually the leaders of the corresponding PKK (wives and mothers association).

Collective action, and thereby accommodating activities, are organized in meetings at RT and RW levels. Men and women meet separately and their meetings have distinct functions. Male RT and RW meetings are more strongly related to legal issues, construction work, and security, while female PKK meetings focus more on communal festivities, health care, and vocational training. The frequency of meetings varies between different communities from weekly to at least monthly. Participation in both male and female meetings is high (90% of households participate regularly in RT and 74% in PKK meetings). While there is a clear division between the tasks of man and women, both take on agency and bring forward ideas for community and risk management [77].

These experiences of self-organization and participatory local action in the Semarang Bay area are by no means unique in the Indonesian context. RT, RW, and PKK meetings are the social backbone of Javanese villages in rural and urban areas [78]. Collective practices provide organizational structures for social care and community money pooling, which fulfills micro-insurance functions. Both male and female meetings organize communal money pooling by collecting contributions from members, which is accessible as loans by community members in need or are provided freely in emergency cases such as the death of a family member for funeral arrangements. The purpose of collective action and regular meetings is thereby not solely on hazard risk reduction, but of community welfare and social protection in general. Thus, accommodating as a routinized practice is less clearly separable from daily actions for other purposes than are retreat and protect options. Yet, these collective activities result in higher coping and adaptive capacities and are, in turn, crucial for hazard risk reduction. In fact, two additional Chi2-tests also show that people participating in RT meetings are significantly more engaged in community hazard response actions such as collective waste cleaning.

The village-level institutional fabric of RT, RW and PKK coexists in the Semarang Bay area with the traditional Javanese collective working system of '*gotong-royong*', which translates loosely as 'mutual assistance'. It is one of the main non-structural community actions to reduce flood risks [74]. This accommodating practice is deeply rooted in the tradition of working for the common good of the whole village and "inspires a strong volunteer culture" [79, p.79] – a habit which is very important in a coastal hazard-prone environment. Mutual aid and working together help people not only in arranging community activities, such as funerals and festivities, but are key in preparing for coastal hazards, e.g. in keeping drainages and channels free of waste and operational. In the case of extraordinary strong floods (spring tides, small tsunamis, or broken river embankments after heavy rainfall), people organize first response activities such as evacuation and emergency kitchens [77]. A study by Taylor and Peace [79] in Surakarta, Central Java, found that gotong-royong has a positive influence on children's resilience towards floods, as their inclusion in disaster response activities is promoted.

The following dialog from the FGD in Terboyo Kulon (East-Semarang) describes gotong-royong activities: "*Togetherness here means that we don't hurt each other, we respect each other." (M2). "We help each other." (M8). "It also means that, if we can, we contribute our money to do something good for the community." (M2). "We help by providing labor, we also help by praying." (M1). "Providing food." (M 3).*

Gotong-royong, as an accommodating practice and as a function of participatory capacity, allows community members to absorb shocks and to live with floods and subsidence. Lack of other forms of capital can be at least partly compensated. "*The quality of the human resource in this area is relatively low […]. But, Alhamdulillah [thanks God] the people here have quite a good sense of gotong-royong. […] The economic condition of this area is low. […] Every time there is an activity in the area, the gotong-royong is reliable." (FGD Terboyo Kulon, M4).* 86% of all households were revealed by the survey as participating regularly in gotong-royong activities.

In contrast to retreat and protect, accommodating is usually carried out less intentionally with regards to coastal hazards and has more the character of an autonomous habit. For coastal dwellers in Semarang Bay responding to floods and subsidence is thus less a planned problem solving strategy, but more a daily social practice. This is made achievable by high participatory capacities, strong bonding social capital, and the resulting collective practices which allow people not only to stay in these areas but to accommodate their multi-risk environment.

Nevertheless, our survey found that local knowledge about possible future environmental changes is restricted. Only 45% of all surveyed households have ever heard about the term or the concept of 'sea level rise'. If the north coast of Central Java were to experience an increase in absolute and not just relative sea level in the future, additional flood stress would arise. Recent estimates derived from satellite altimetry indicate a significant acceleration of global sea level rise [80].

7. Discussion: establishing a new conceptualization of accommodating coastal hazards

The insights from Semarang Bay have wider resonance for the conceptualization of how communities respond to coastal hazards. As noted earlier, although accommodating has been conceptualized as one of three broad options of response to coastal hazards (along with retreat and protect), it has generally not held as much policy clout as those other two responses [4,27–29]. Our fieldwork results suggest such dismissal of accommodating is misguided. Based on our findings in the Semarang Bay, we argue that accommodating strategies are viably enacted by hazard-affected communities.

In addition to distinguishing accommodating from the other two response options, retreat and protect, we now analysis the viability of community-based accommodating by comparing it to the concepts of adaptation and coping. As being a constant habit, accommodating shows key distinctions in quality and timescale from long-term proactive adaptation and short-term reactive coping (Table 1).

Accommodating strategies are strongly based upon participatory capacities which empower communities to access and carry out their response capacities [43,49]. The timescale of community-based accommodating options can be both short- and long-term and accommodating has gained the character of a continuous habit – which leads to a different quality of responding to coastal hazards than the classical concepts of coping and adaptation, as described in chapter 3.

Accommodating is not a single 'strategy' directly implied to reduce hazard risk, it is rather a daily practice deeply embedded in livelihood and habit in face of an ever-present hazard. This daily habit of living with costal hazards changes perceptions and narratives from 'risk' towards a 'given and tolerated environment'. In contrast to adaptation strategies such as permanent resettlement and hard structural protection, which potentially allow for a long-term or permanent risk reduction, the exposure under accommodating strategies remains largely unchanged. However, they are *accommodated*, as the term itself implies. Thus, typical accommodating measures are not only applied reactively after a shock but also in preparation for shocks and are therefore different from coping, such as repeated elevation (protect) and short-term evacuations (retreat). Accommodating is thus not an option specifically activated prior, during, or after an event, but rather a constantly applied and partly unintentional way of doing things. People slowly change their day to day practices – which leads to different points in time when action is taken. Thus, in contrast to most protect and retreat options, that can be classified as either adaptation or coping, accommodating can be placed between the latter concepts (Table 1).

A further distinction is the collective nature of accommodating strategies. While coping strategies can be both collective and individual, "living with risk" requires a high level of participatory capacity and self-organization, e.g. the mentioned money pooling and gotong-royong activities. Collective practices of accommodating are

Table 1
Key distinctions in time and quality between adaption, accommodating, and coping.

Response to coastal hazards	adapting	accommodating	coping
Timescale	Long-term	Several but mostly mid-term timescales	Short-term
Level of preparedness	Pro-active	Daily practice/habit, continuously	Reactive
Level of planning	Planned	Autonomous	Spontaneous
Dynamics of development prospects	'Moving ahead'	'Making a living'	'Getting by'
Logic of action	Science- based, instrumental	Routinized practice	Mostly repetitive
Point in time of action	Preparing for shocks	Living with 'shocks' that become 'normal'	Recovering from shocks
Learning dynamics	Learning from shocks, scientific learning	Learning as part of living in the given environment	Learning by repetition
Actor's level	Top-down (and bottom-up aligned)	High participatory capacity	Individual/collective
Level of knowledge	Knowledge about past and present causes and future scenarios	Indigenous knowledge, mostly limited knowledge about future scenarios	Limited knowledge about underlying event causes and future scenarios
Examples	Permanent resettlement, permanent embankments	Collective money pooling, gotong royong	Short-term evacuation, repeated house elevation

carried out continuously by communities with strong bonding ties, whereas long-term adaptation requires bridging and linking ties, and usually higher level planning and some form of top-down involvement.

As a consequence of lacking bridging and linking ties required for adaptation in our regional case study, knowledge transfer is constrained and the potential for preparing for future developments is limited. One could argue that accommodating strategies in Semarang Bay currently have to be regarded as mid-term solutions. So far, people in the Semarang Bay area respond to current, but not to possible future climate patters.

Finally, a key characteristic of accommodating is its flexibility. Our example of the Semarang Bay area considers responses within a relatively stable hazard context. Flood cycles are regular (tidal and monsoonal) and subsidence is ongoing. We have argued that accommodating is a response strategy that is fitting to this scenario, because it corresponds to the size and scope of affected households' financial and social assets. However, it also provides a platform for dealing with changes to communities' threat horizons. This capability is displayed in Fig. 3. When communities are facing uncertainty, and in particular an intensification of coastal hazards, accommodating can be considered as a bridge between short-term and long-term cycles and thereby provide insights in how top-down and bottom-up approaches can be aligned.

Reactive short-term responses can be upgraded to mid-term accommodating habits by a higher level of participatory capacity and self-organization. Thus, community cohesion and self-organization capacities are key and should be empowered by local governments and NGOs. To further upscale accommodating practices to a long-term response cycle, all levels of actor involvement are required and it is necessary to foster knowledge transfer and learning capacities which prepare local people for the future. Hence, additional top-down and multi-level stakeholder engagement is needed. By this engagement, knowledge transfers can be introduced to respond not only to current, but to expected future impacts, and the required funding could be provided for additional structural protection and accommodating options, such as formal insurances and early warning systems. Especially the empowerment of local community leaders is key. These people can work as gatekeepers and well-connected leaders could strengthen bridging and linking from and towards their communities [74].

A potential risk for downgrading from long-term response cycles lies in maladaptation practices. In our case study of Semarang Bay, an example of this would be the further expansion of urbanized and industrialized areas into heavily subsidence-prone coastal zones, such as in peri-urban areas of Kendal. Accelerating land subsidence is the biggest barrier for any response to coastal hazards in the Semarang Bay area and might even reach a tipping point after which living with coastal hazards would no longer be a feasible option.

Downgrading on the community levels from accommodating to a short-term response cycle can happen by destroying or eroding the social capital and participatory capacity of hazard-affected communities. Therefore, top-down coastal management approaches have to keep social cohesion in mind, e.g. in regard to relocation plans.

8. Conclusion

Using the example of the Semarang Bay area, we have shown how communities are able to collectively accommodate coastal hazards. Our empirical findings have verified that community-based collective accommodating can be a successful approach to deal with ever present, but usually low intensity coastal hazards. So far, local households and communities in our study areas do not retreat, but are able to protect themselves from coastal hazards with small-scale options and, more importantly, their ability to accommodate their multi-risk environment.

Greater recognition of accommodating is important because top-down policy-making has tendencies to overlook the daily practices of communities and instead prioritize big picture forms of adaptation associated with retreat and protect. However, for affected communities, accommodating is typically the unsung, dominant bottom-up practice that leaves the most tangible mark in terms of ongoing community life. Thus, if coastal risk management is going to be effective, it needs not only to include, but to put an emphasis on accommodating, as the most practiced bottom-up response.

Evidently, as threat horizons intensify because of climate change,

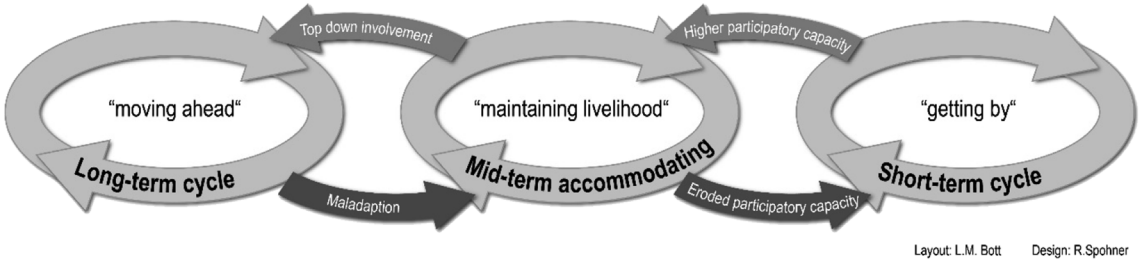

Fig. 3. Response cycles of accommodating coastal hazards with up- and downscaling pathways.

strategies of accommodation may be insufficient. The new framework presented here, however, indicates they are not irrelevant. It is important to appreciate their role within cycles of upgrading and downgrading community responses to coastal hazards. This draws attention to the pathways of collective action and into bringing top-down and bottom-up strategies together, one of the biggest challenges for costal risk management.

In the case of Semarang Bay, this framework offers critical insights for policy futures. In order to respond to expected and uncertain future developments, accommodating, as a habit of living with water, needs to be recognized as the foundation upon which upgrading response options are built from. Accommodating could be enhanced by municipal and NGO engagement. In addition, more technologically advanced accommodate and protection options such as early warning systems or even submersible infrastructure and floating buildings could further improve the ability to live with floods in the Semarang Bay area, but are very cost-intensive. Integrating accommodating into the city's resilient strategy would be a first step. Such a city adaptation plan, focusing on accommodating would probably be adapted very well by the local people as it fits into their social habits, daily practices and attachments to their place of residence. So far, our research shows no evidence of successful alignment of top-down and community-based accommodating measures in the Semarang Bay.

These observations are relevant not only in the Indonesian context, but provide insights and starting points for integrated coastal urban planning across the world. Participatory capacity and collective action are basic attributes of local communities worldwide, and especially in the Global South. Further research might apply our proposed framework to focus on accommodating practices and collective bottom-up strategies in different spatial and social contexts. This would be an important contribution to the development of coastal risk management plans which go align with and make use of community capacities for accommodating. Planning “with” and not “for” the people is key.

Declarations of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2019.101177.

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