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A Study on Cyclone Aila Recovery in Koyra, Bangladesh: Evaluating the Inclusiveness of Recovery with Respect to Predisaster Vulnerability Reduction

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Abstract The need to consider disaster risk reduction at the time of recovery is well-recognized. Viable disaster risk reduction measures should resolve the root causes of pre-disaster vulnerabilities. Accordingly, we investigated the recovery from the impact of Cyclone Aila in Koyra Upazila, Bangladesh, which was severely damaged by this 2009 cyclone. Our research focused on understanding pre-Aila vulnerabilities to cyclone impact and examined the degree of inclusion of vulnerability reduction measures within the recovery process. A composite methodology that included an institutional survey, key informant interviews, collection of the judgment of experts, focus group discussions, and a score-based quantification technique was adopted. Through a process of understanding pre-Aila vulnerabilities, recognition of the root causes of these inherent weaknesses, and identification of appropriate measures for pre-Aila vulnerability reduction, a set of 23 indicators were selected to represent the most desirable vulnerability reduction measures to implement during recovery. A score-based technique was applied to measure the degree of inclusion of vulnerability reduction within the recovery with respect to the indicators. The scoring result shows that the degree of inclusion of vulnerability reduction within the recovery was poor. The result specifies that among the 23 indicators of potential vulnerability reduction measures, 10 are completely missing and the rest are only partially included. The overall findings imply that the Koyra community continues to live with a vulnerability similar to that of the pre-Aila period.

Keywords Bangladesh · Cyclone Aila · Diagnostic analysis · Disaster risk reduction · Post-disaster reconstruction

1 Introduction

Bangladesh is geographically located in a cyclone-prone area, and has a long history of being hit by cyclones (Akhand 2003). Historically, cyclone risk reduction initiatives in Bangladesh have focused on saving lives (Haque et al. 2012). Prompted by the deadly Bhola cyclone in 1970 soon after Bangladesh's independence, the new government launched a cyclone preparedness program, which established a vast network of volunteers for risk communication and evacuation management in 1972. After a cyclone in 1985, the government constructed multipurpose cyclone shelters across the coastal areas (Shah Alam Khan 2008). Coastal embankments were constructed to prevent the high tides often associated with cyclones, which had the additional benefit of also effectively preventing damage from low-intensity storm surges (Shah Alam Khan 2008). After yet another devastating cyclone in 1991, these initiatives were further strengthened, along with coastal

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afforestation, the creation of a preparedness policy, and enhanced disaster awareness. Since these initiatives have successfully reduced the loss of lives in several cyclone events, Bangladesh has been praised internationally as a pioneer in disaster preparedness (Haque et al. 2012). This success story and the presence of the coastal embankment created a false sense of security within Bangladeshi society, an overconfidence reflected in evacuation behavior during recent cyclones (Paul and Dutt 2010; Saha and James 2016).

Despite an extensive history of cyclone activity, many sources of vulnerability to cyclone disaster still exist. Poverty, settlement in low-lying coastal areas, inadequate availability of cyclone shelters, and overdependence on traditional livelihood are still considered major sources of vulnerabilities (Alam and Collins 2010; Mallick et al. 2017). After two recent cyclones (Sidr in 2007 and Aila in 2009), researchers were attracted to issues of disaster recovery. Several studies have been conducted on recovery needs (Mallick et al. 2011), changes of income after recovery (Abdullah et al. 2016), individual recovery strategy (Parvin and Shaw 2013), housing recovery initiatives (Mallick and Islam 2014), and resilience building (Ahmed et al. 2016). Whether the post-disaster recovery initiatives have eliminated the root causes of vulnerabilities is still underinvestigated. In-depth research on recovery from the perspective of vulnerability reduction is still needed, which has prompted this research effort to examine the recovery from cyclone Aila in Bangladesh.

Cyclone Aila, which induced a storm surge that varied from two to four meters high (IFNet 2009; Mallick et al. 2011), struck the southwest coast of Bangladesh on 25 May 2009. It was a severe cyclone with an intensity (Fig. 1) similar to a Category 1 cyclone as per the Saffir-Simpson scale (Sadik et al. 2017). The cyclone affected 3.9 million people, and caused 190 deaths (UNDP 2010). The coastal defense structure and road communication system in the affected area collapsed, as 237 km of embankment, 2233 km of roads, 175 bridges, and multiple culverts were seriously damaged or destroyed (UNDP 2010). Post-storm damage assessment revealed huge economic loss, prolonged suspension of livelihood activities, and long-term suffering related to deplorable housing, food, sanitation, and drinking water conditions in the affected areas (Tada 2011; UNDP 2010; Mallick et al. 2011). Koyra, a coastal upazila (similar to a subdistrict), was one of the areas most severely affected by the cyclone (UNDP 2010).

The government and humanitarian organizations responded quickly with emergency support (UNDP 2010). Later, the government appealed for international assistance with recovery and reconstruction (Tada 2011). In response, different bilateral and multidonor organizations assisted with recovery support projects for housing, livelihood stabilization, sanitation, and coastal embankment and other infrastructure rebuilding (UNDP et al. 2013; EKN and UNDP 2015). Although a few innovative approaches emerged from different studies, such as the disaster resilient habitat promoted by Mallick and Islam (2014) and an attempt to build community resilience through integrated water management (EKN and UNDP 2015), these initiatives were not widely implemented. Community suffering due to continued tidal flooding, income insecurity, lack of freshwater supply, and vulnerabilities due to weak coastal embankments was still visible 7 years after the cyclone (Hossen 2016; New Age 2016). This persistent situation justifies research into whether the recovery process paid attention to pre-Aila vulnerability reduction (PAVR) as part of its mission.
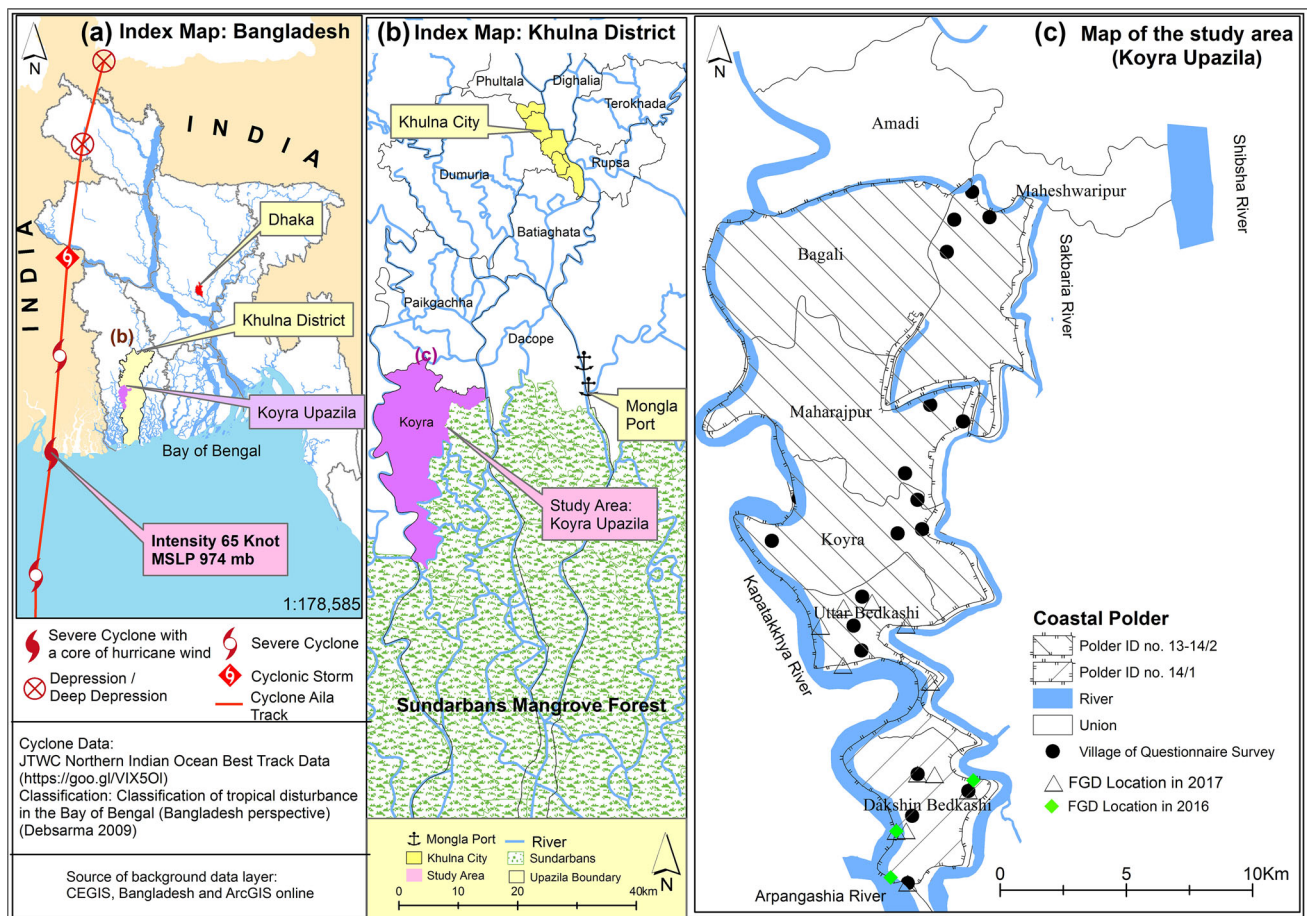
2 Study Area

Our research considered Koyra Upazila (Fig. 1) as the case study site because the area was severely damaged by Cyclone Aila. But the general mechanism of planning and implementing government and aid-assisted recovery projects is similar in other parts of the country, as all plans and projects are formulated at the headquarters of relevant government departments and NGOs based in Dhaka.

Koyra is a coastal upazila of the Khulna District. The upazila is located at the border of the Sundarbans mangrove forest and about 100 km by road from Khulna City (Fig. 1). When the cyclone struck, the entire upazila was inundated because of overtopping and breaching at 34 separate places of the coastal embankments (Roy et al. 2009). The cyclone affected a population of 152,496 in Koyra (Koyra Upazila Nirbahi Officer's Office 2010). Aila damaged 81 km of embankments (between polder 13–14/2 and 14/1), 680 km of earthen road, 163.5 km of asphalt road, 49 bridge culverts, 42,440 houses, nine academic institutions, 192 religious institutions, the crops on 11,500 hectares, and 10,364 fish aquaculture farms in the upazila (Koyra Upazila Nirbahi Officer's Office 2010). Thereafter, the government and its development partners considered Koyra Upazila a priority area for recovery and reconstruction.

3 Methodology

This research involved two steps: (1) development of a recovery storyline; and (2) diagnostic analysis of the post-disaster recovery. The overall research evolved through theoretical and subjective analysis supported by literature reviews and policy, stakeholder, and institutional analyses to support of the theoretical and subjective findings by

Fig. 1 Map of the study area, Koyra Upazila (subdistrict), Khulna District, Bangladesh

institutional surveys, key informant interviews (KII), focus group discussions (FGD) with local people, and expert interviews.

3.1 Developing the Overall Storyline

The recovery storyline of Aila was developed from the literature review and data collected from the institutional surveys, FGD, and KII.

3.1.1 Institutional Survey and Key Informant Interview

Institutions, especially local NGOs involved in recovery and reconstruction in Koyra, were identified using a snowball sampling technique (Goodman 1961). Since the list of NGOs involved in Aila recovery and their activities were not well-documented and archived in any single place (for example, local government offices), we adopted the snowball technique as described in Fig. 2.
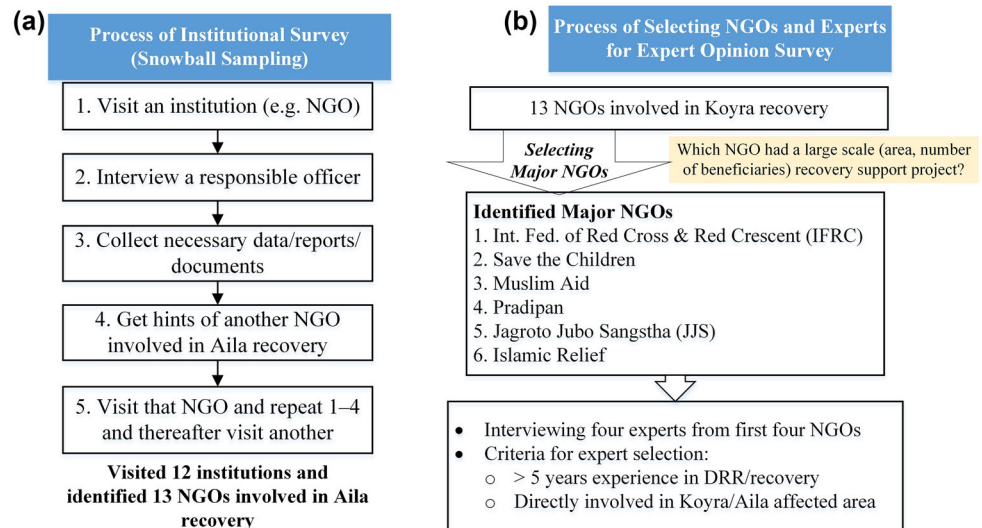
Additionally, local representatives of the Department of Disaster Management, the Bangladesh Water Development Board (BWDB), the local Government Engineering

Department, the deputy team leader of the Coastal Embankment Improvement Project (CEIP), and the director general of the Water Resources Planning Organization were interviewed as key informants.

3.1.2 Focus Group Discussion

To comprehend the overall storyline of the recovery, FGDs consisting of local people were conducted at 14 villages (Fig. 1). Although FGDs were conducted informally, interviewers followed structured questionnaires and compiled notes on discussion issues. The average number of participants in the 14 FGDs was 10 (maximum 13 and minimum seven), with one-third of participants being female (except at three locations where participants were only male). The three males-only FGDs were conducted at rural growth centers (market places) with mostly local traders and shoppers where women are rarely found.

Before conducting the FGDs, a questionnaire survey was carried out in five unions (the smallest administrative units in rural area of Bangladesh). A total of 150 household heads were interviewed (Fig. 1). Although the quantitative

Fig. 2 Process of institutional surveys and expert interviews

(a) Process of Institutional Survey (Snowball Sampling)

1. Visit an institution (e.g. NGO)

2. Interview a responsible officer

3. Collect necessary data/reports/documents

4. Get hints of another NGO involved in Aila recovery

5. Visit that NGO and repeat 1–4 and thereafter visit another

Visited 12 institutions and identified 13 NGOs involved in Aila recovery

(b) Process of Selecting NGOs and Experts for Expert Opinion Survey

13 NGOs involved in Koyra recovery

Selecting Major NGOs — Which NGO had a large scale (area, number of beneficiaries) recovery support project?

Identified Major NGOs
1. Int. Fed. of Red Cross & Red Crescent (IFRC)
2. Save the Children
3. Muslim Aid
4. Pradipan
5. Jagroto Jubo Sangstha (JJS)
6. Islamic Relief

- Interviewing four experts from first four NGOs
- Criteria for expert selection:
  ○ > 5 years experience in DRR/recovery
  ○ Directly involved in Koyra/Aila affected area

data of the survey is currently being analyzed and results are not available, the collective understanding of and information obtained through this survey helped in the planning and implementation of the FGDs.

3.2 Diagnostic Analysis of Recovery

Diagnostic analysis is related to the performance of a system and includes an organized way of identifying problems and the causes of these difficulties (Edquist 2011). Our research examined the recovery from Aila to determine whether it was planned considering appropriate measures for pre-Aila vulnerability reduction (PAVR). To this end, pre-Aila vulnerabilities (PAV) with root causes were identified; this led to the selection of a set of PAVR indicators. A score-based approach was applied to measure the degree of inclusion of each indicator within recovery.

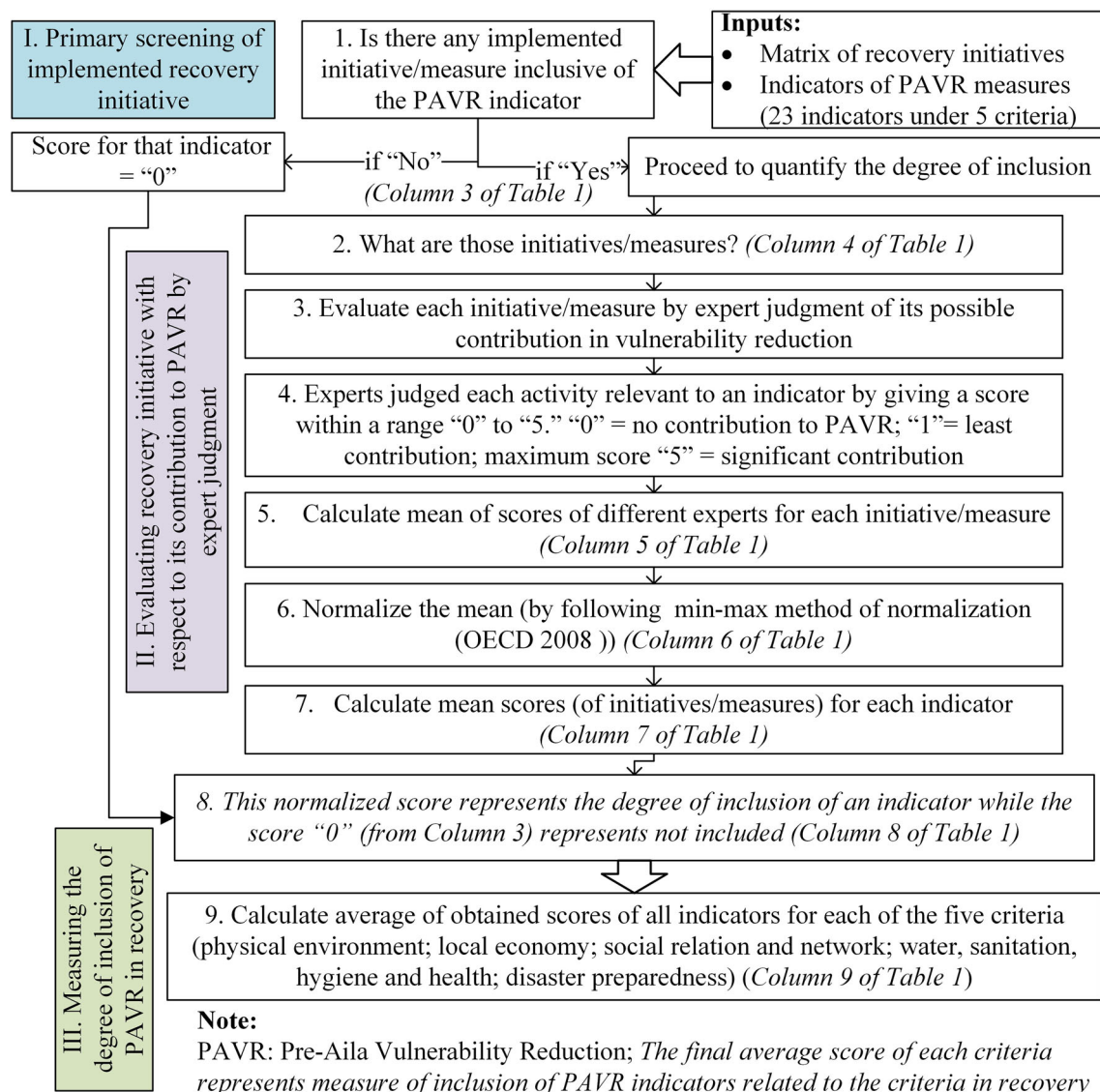#### 3.2.1 Analysis of PAV and Selection of Indicators for Diagnostic Analysis

Understanding Koyra's PAV followed the pressure and release (PAR) model approach (Wisner et al. 2004) and was the first step of our diagnostic analysis. The theoretical assumptions of the frequently-cited PAR model (Wisner et al. 2004) define vulnerability as a product of unsafe conditions that originate from a problem's root causes. In addition, the Access model of vulnerability (Wisner et al. 2004) implies that if the root causes and resultant pressures are not resolved through recovery, the unsafe condition will continue. Chhotray and Few's (2012) case study of the recovery from Cyclone Orissa supports the PAR theory. Field observation and news reports regarding ongoing human suffering in Koyra Upazila identified repeated embankment failure, erosion, and inundation (Hossen

2016; New Age 2016; The Independent 2016) as major problems and convinced us to examine the Aila recovery from a context of vulnerability reduction as described by the PAR model. The root causes of pre-Aila vulnerabilities were identified by a review of relevant existing studies, and were validated by the FGDs. A modified PAR model for a Bangladesh cyclone case (Awal 2015), the Disaster Crunch Model, was developed through a systematic analysis of post-Aila conditions (Saha 2015) and NGO assessments regarding Aila's damage and local community needs (ECHO 2009; Roy et al. 2009). There was a great amount of help available in identifying PAVs and their nature and dynamics. Several case studies (Mallick et al. 2011; Mallick and Vogt 2014; Islam and Walkerden 2015; Abdullah et al. 2016) helped to identify the root causes of vulnerabilities, dynamic pressures, and possible reduction measures. FGDs with local people helped validate the root causes of endemic problems, clarified the overall PAV context, and finalized indicators of PAVR measures. The process of understanding PAV ultimately helped with the selection of a set of indicators for the diagnostic analysis of the ongoing recovery regarding PAVR.

3.2.2 Calculating the Degree of Inclusion of PAVR in Recovery

A simple screening method of assessing recovery (Contreras 2016) was modified by combining expert judgment and a scoring approach (Gain et al. 2015; Giupponi et al. 2015). Details of the scoring and computation are displayed in Fig. 3 and Table 1. As illustrated in Fig. 3, the scoring technique included three processes: (1) a primary screening of recovery initiatives; (2) an expert evaluation; and (3) calculation of the degree of inclusion of PAVR measures in recovery. The first step was started by cross-checking and

I. Primary screening of implemented recovery initiative

1. Is there any implemented initiative/measure inclusive of the PAVR indicator

Inputs:
- Matrix of recovery initiatives
- Indicators of PAVR measures (23 indicators under 5 criteria)

Score for that indicator = "0"

if "No" *(Column 3 of Table 1)* — if "Yes" → Proceed to quantify the degree of inclusion

II. Evaluating recovery initiative with respect to its contribution to PAVR by expert judgment

2. What are those initiatives/measures? *(Column 4 of Table 1)*

3. Evaluate each initiative/measure by expert judgment of its possible contribution in vulnerability reduction

4. Experts judged each activity relevant to an indicator by giving a score within a range "0" to "5." "0" = no contribution to PAVR; "1"= least contribution; maximum score "5" = significant contribution

5. Calculate mean of scores of different experts for each initiative/measure *(Column 5 of Table 1)*

6. Normalize the mean (by following min-max method of normalization (OECD 2008)) *(Column 6 of Table 1)*

7. Calculate mean scores (of initiatives/measures) for each indicator *(Column 7 of Table 1)*

8. This normalized score represents the degree of inclusion of an indicator while the score "0" (from Column 3) represents not included (Column 8 of Table 1)

III. Measuring the degree of inclusion of PAVR in recovery

9. Calculate average of obtained scores of all indicators for each of the five criteria (physical environment; local economy; social relation and network; water, sanitation, hygiene and health; disaster preparedness) *(Column 9 of Table 1)*

Note:
PAVR: Pre-Aila Vulnerability Reduction; *The final average score of each criteria represents measure of inclusion of PAVR indicators related to the criteria in recovery*

Fig. 3 The diagnostic analysis process to examine inclusion of PAVR in Cyclone Aila recovery

reviewing the relevant reports of Aila response projects (ECHO 2009; Roy et al. 2009; Walton-Ellery 2009; IFRC 2010), project documents of different donors (IOM 2010; EKN and UNDP 2015), relevant reviews (Tada 2011; JICA and OCCL 2012; Abdullah et al. 2016), project documents of UNDP early recovery facilities (UNDP 2011; UNDP et al. 2013), and unpublished documents collected from local NGOs. Findings of this preliminary scoring were cross-checked by interviewing representatives of different institutions as illustrated in Fig. 2. In the second step, the evaluation of identified recovery initiatives was done by expert judgment. Experts were asked to provide scores within the range of 0 (no contribution) to 5 (significant contribution), which were then normalized using the min–max method (OECD 2008). The process of expert selection is presented in Fig. 2b. Finally, the score representing the

degree of inclusion was calculated for each indicator. The 0–5 scores represent measurements of inclusion of an indicator within the recovery process. Since all the indicators were grouped into five criteria, an average was also calculated for each criterion, representing the degree of inclusion of the PAVR criterion in recovery.

4 Storyline of Aila Recovery at Koyra

The storyline can be simply described with a matrix (Table 2), which presents a list of recovery activities along with implementing agencies. The matrix highlights the involvement of a large number of nongovernmental organizations (NGOs) along with relevant government organizations (GOs) in Koyra's recovery. The table suggests a

Table 1 A sample table showing details of scoring and calculating inclusivity of PAVR indicators

		I	II				III	
1. Criterion	2. PAVR indicators	3. Primary screening[a]	4. Implemented actions/measures related to the indicator[b]	5. Experts' judgment on impact on PAVR (0–5 scale)[c]	6. Normalization of expert judgment[d]	7. Average of scores of relevant measures[e]	8. Degree of inclusion of the indicator in recovery[f]	9. Degree of inclusion of the PAVR criteria in recovery[g]
Water, sanitation, and hygiene (WASH) and health	Introduce appropriate water supply technology	FE[a]	Re-excavation/construction of ponds	2.8	0.56	0.58	0.58	0.43
			Installation of deep tube wells/RHS	3	0.60			
	WASH and health promotion	FE[a]	WASH and health promotional activities	3.6	0.72	0.72	0.72	
	Capacity building of health institutions for disaster response	0	NA				0	

[a]If the indicator is not included/covered by any recovery initiative, then the score=0, meaning non-inclusion of the indicator. If it is included, then the score was decided by further expert evaluation and judgment and marked as "Further Evaluation (FE)"

[b]The list of initiatives inclusive of the indicator

[c]Mean of scores given by five experts, who were asked to evaluate the potential impact of the action/initiative on PAVR. Experts evaluated the action/initiative by giving a score between "0" and "5". "0"=no contribution to PAVR, 1=the least contribution, and 5=significant contribution

[d]Normalization of the score using min–max method (OECD 2008)

[e]Arithmetic average of calculated scores in column 6 for each indicator

[f]Column 3 multiplied by column 7

[g]Mean of scores in column 8 under each criterion

coordination structure at a local level that was not perfectly functional at the time recovery activities were implemented in post-Aila Koyra (Sadik, Nakagawa, Rahman et al. 2017).

The matrix depicts the sectors that different NGOs preferred, and which sectors were ignored. A large number of NGOs were involved in emergency relief operations, livelihood support, sanitation, and emergency repair of infrastructure; fewer were involved in the health, cyclone shelter, safety, and rehabilitation sectors. In general, NGO activity was limited to short-term measures, whereas GOs were involved in both long-term and short-term measures. All the recovery initiatives can be divided into four major work groups: humanitarian aid-driven emergency response, emergency repair of critical infrastructures, humanitarian aid-driven recovery, and government-led emergency recovery and rehabilitation.

4.1 Humanitarian Aid-Driven Emergency Response

The government, as well as international communities, responded immediately to the cyclone damage through provision of humanitarian assistance (Table 2). The government primarily provided cash grants, rice, and food assistance (through programs for vulnerable groups) (UNDP 2010; Tada 2011; Koyra Upazila Nirbahi Officer's Office 2010). NGOs, with help from the international community, provided emergency material relief (food and nonfood items), emergency shelter and housing, emergency water supply and sanitation, cash grants (to compensate for work and training), and emergency health support (Table 2; Roy et al. 2009; UNDP 2010; Tada 2011). Humanitarian aid-driven responses were commonly criticized for the lack of coordination among NGOs, overlapping activities, gaps in service areas, insensitivity to local needs, and corruption (Rahaman and Khan 2010; Mahmud and Prowse 2012).

Table 2 The matrix of Cyclone Aila recovery activities in Koyra Upazila, Khulna District, Bangladesh. *Source*: Institutional Survey in 2016 and 2017

Organizations / Recovery Initiatives	Emergency Relief and Response	Water and Sanitation	Health	Housing	Cyclone Shelter	Safety	Education	Poverty/Livelihood	Awareness	Infrastructures
Humanitarian Organizations / NGOs										
Jagroto Jubo Shangho (JJS)	● ● ●	● ● ● ●	●	● ●	●	●	● ● ●	● ● ●	● ●	●
Rupantor	● ● ●	● ●			●		● ● ●	●	●	●
Uttaran	●	● ● ●				●		● ● ● ● ●	● ●	●
Pradipan	●		●					●	● ●	●
Shushilan	● ● ●	●		● ●				●		●
Int. Fed. of Red Cross and Red Crescent Society/Bang. Red Crescent Society	● ● ● ●									
Islamic Relief	● ● ●	● ●		● ●		● ●	●	● ● ● ●	● ●	●
Premere Urgence	● ●									●
Progoti	● ● ●	●			●			● ●		●
Caritas	●							●		●
Action Aid	●						● ● ●	●		●
OXFAM	●									
World Vision	●									
Muslim Aid	●	●		●					●	
Government Organizations										
Dept. of Disaster Mgt.	● ● ● ● ●			●				● ●		●
Local Govt. Eng. Dept.					● ●		● ●			● ●
Bang. Water Dev. Board						● ● ●				
Dept. of Public Health Eng.	●	● ●								
Dept. of Agricultual Ext.								●		
Dept. of Fisheries								●		
Dept. of Health	●		●							
Dept. of Education							●			

4.2 Emergency Repair of Critical Infrastructures

Several initiatives to repair rural infrastructure by engaging local people under "cash for work" or "food for work" schemes were initiated by the GOs and NGOs. But all such programs were short-term measures (Mallick and Islam 2014; Ashraf and Shaha 2016), and were not always successful due to the delay experienced in repair of damaged coastal polders (polder 13–14/2 and polder 14/1). The embankment's repair was urgently needed by the local people as any delay hindered the implementation of other recovery initiatives (ECHO 2009). Weather conditions during monsoon season and the shortage of emergency funds exacerbated the delay and increased storm impact on agricultural output (Tada 2011). Due to constraints in the emergency budget, the completion of urgent repair work was limited in scope. In response to this, different NGOs offered their assistance to repair the embankments, but the BWDB could not allow this due to legal barriers, and concern for the NGOs' engineering capabilities.

4.3 Humanitarian Aid-Driven Recovery

Development partners and different NGOs worked together to promote recovery under a coordination mechanism—the Local Consultative Group, or LCG—jointly established by the government and the development partners. Following the cluster approach of aid coordination (IASC 2012), the LCG rolled out an early recovery cluster that led to the formation of a multidonor project entitled the Early

Recovery Facility (ERF) led by UNDP. The LCG evolved into an umbrella body for enhanced financing and implementation of all aided recovery efforts (UNDP 2011). In Koyra, the major recovery efforts implemented by ERF included construction of new houses with sanitation facilities; support for education, health, and nutrition programs; support for the formulation of national disaster management plan (2010–2015) (DMB-MFDM 2010); and guidelines on emergency response procedures (UNDP 2011). Under the umbrella of ERF, the Embassy of the Kingdom of the Netherlands (EKN) formulated a project entitled "Improved Resilience of Coastal Communities through Rehabilitation of Coastal Embankments" (EKN and UNDP 2015). The reconstruction of a 2.92 km section of the embankment, installation of new drinking water sources (tube wells and ponds), cash grant support to certain households for alternative livelihood development, and tree planting were highlights of this project in Koyra.

Although the UNDP-ERF, along with the LCG, acted as the national-level coordination structure, local (upazila)-level coordination was maintained by an UNO (Upazila Nirbahi Officer, the chief executive officer of the local government). The coordination structure at upazila level suffered from a lack of resources (manpower, financial, and technical) and effective coordination and monitoring mechanisms (Sadik et al. 2017).

4.4 Government-Led Emergency Recovery and Rehabilitation

Cyclone Aila hit the southwestern region at a time when the government was trying to rehabilitate the area after the damage caused by a previous cyclone (Sidr) that struck in 2007. To initiate the Cyclone Aila recovery, the government first attempted to include Aila recovery initiatives in the aid that supported Cyclone Sidr recovery projects. Later the government adopted specific plans for Aila recovery followed two approaches: (1) segmenting and prioritizing the reconstruction activities under the Annual Development Plan (ADP) of the government; and (2) formulating special projects (with foreign aid) for large-scale projects. For example, rural roads were reconstructed initially by modifying the Emergency 2007 Cyclone (Sidr) Recovery and Restoration Project (ECRRP) initiated by the World Bank (2013). Later the ADP and Rehabilitation of Aila-Affected Rural Infrastructure Project (RAARIP) were formulated to complete the unfinished rehabilitation tasks (Sadik, Nakagawa, Shaw et al. 2017). A few coastal polders and allied structures were restored to predisaster design condition by modifying the World Bank-funded Water Management Improvement Project. The remaining polders were restored by the ADP and a project funded by EKN. Unfortunately, none of these projects considered the

improvement and incorporation of new disaster risk reduction (DRR) measures. For the improvement of coastal polders, the BWDB initiated the Coastal Embankment Improvement Project (CEIP) in 2013, which includes one of Koyra's polders (polder no 14-1). However, the physical work in Koyra has yet to start as the detail design is still in progress according to interviews with project officials in 2016 and 2017. Apparently, the overall recovery is very encouraging due to the joint approach of government and development partners, and a wide range of rehabilitation and development activity is soon to begin. But interviews indicate little evidence that recovery activities undertaken thus far have reduced the preexisting vulnerabilities of the community.

5 Analysis of PAV and Selection of Indicators for Diagnostic Analysis of Recovery

The PAVs have been classified into five major unsafe categories: (1) physical environment; (2) local economy and livelihood; (3) social relations and networks; (4) water, sanitation, and hygiene (WASH) and health; and (5) public actions and institutions for disaster preparedness (Fig. 4). The success of recovery in DRR would largely depend on inclusion of appropriate measures to resolve unsafe conditions in these categories. Therefore, to examine Aila recovery, 23 indicators were selected, which corresponded to necessary PAVR measures. The summary of the PAV assessment and the 23 selected indicators for recovery inclusive of PAVR are provided in Fig. 4 and briefly discussed thereafter.

5.1 PAV of Physical Environment and Relevant PAVR Measures

The poor structural condition of the coastal embankment was the most critical unsafe condition, responsible for 34 storm surge breaches within around 119 km of the embankment during Cyclone Aila (Roy et al. 2009; Tada 2011; JICA and OCCL 2012). Poor maintenance of the embankments, illegal breaching by saltwater shrimp farmers, and river erosion had already weakened the structural condition of coastal and riverine barriers (Tada 2011). In the 1960s, coastal polders were constructed to promote rice cultivation. Later, due to attractive market of shrimp, rising salinity, and adverse impact of polders (for example, water logging) large farmers shifted from rice to shrimp farming. Shrimp farmers started either installing pipes or cutting the embankment to irrigate their shrimp aquaculture ponds by salinity rich river water. Thus, reduction of these root causes of the vulnerability is linked to the improvement of embankment structure with a new

design, community agreement to shift from saltwater shrimp farming to rice cultivation, a comprehensive land-use plan for zoning of shrimp farming and settlements, and an improved maintenance plan and budget according to remarks obtained during FGDs and interviews with BWDB personnel. Poorly developed road networks and inadequate maintenance investment in transportation infrastructure were other major unsafe conditions of the physical environment pre-Aila that impeded emergency evacuation and response (Mallick et al. 2011). Existing roads in poor condition were easily eroded by the storm surge. Cyclone Aila washed away 23,820 houses and partially damaged 18,620 houses (Koyra Upazila Office 2010), and finally forced around 42,000 people to migrate from Koyra (Islam and Hasan 2016). The weak house structures and scattered settlements along the river were unsafe conditions that resulted in housing-related vulnerabilities (Alam and Collins 2010). Traditional scattered settlements had grown without an integrated embankment system to protect them from the tidal flood, establishment of evacuation routes was deficient, and construction of cyclone shelters was inadequate to absorb refugees. The result was a population highly exposed to cyclone damage and storm surge (Mallick and Islam 2014). A land-use management practice that is inclusive of new settlement conception and construction, practices spatial planning, and prioritizes comprehensive land management is a key to vulnerability reduction (Mallick and Islam 2014).

5.2 PAV of Local Economy and Livelihood and Relevant PAVR Measures

The shrimp farming- and fishing-based livelihood system (with its high dependency on nature) was another PAV that resulted in a sudden drop in the local economic output due to the suspension of all agricultural-related activities in the post-Aila period (Abdullah et al. 2016). The survey undertaken by Abdullah and his colleagues in 2016 showed that economic loss, income loss, and general suffering were highest for shrimp farmers, small businessmen, and agricultural farmers. Reduction of this livelihood-related vulnerability is linked with short-term measures (for example,
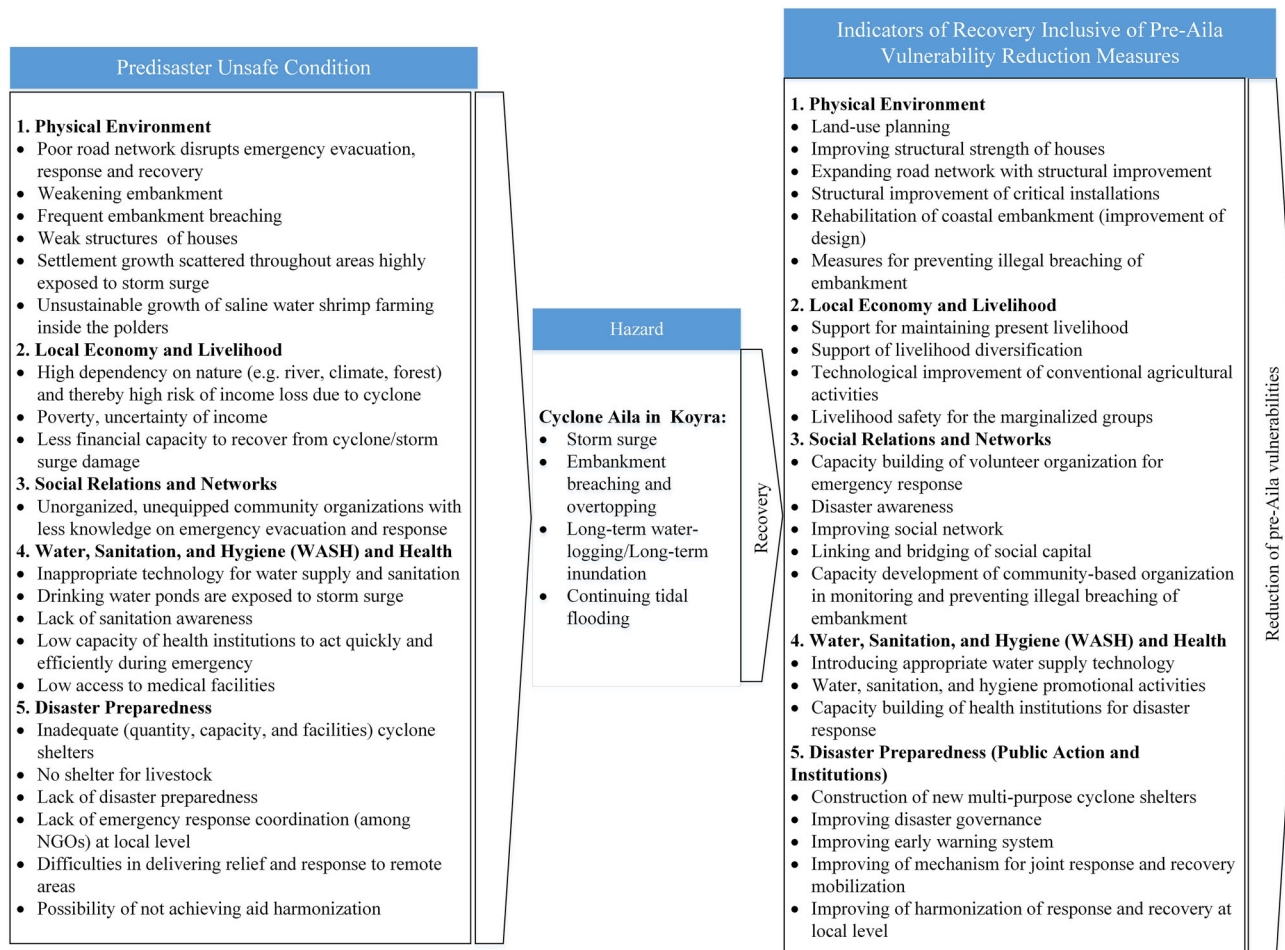
Fig. 4 Pre-Aila vulnerabilities and indicators of the recovery contributing to Pre-Aila Vulnerability Reduction (PAVR) measures

relief, cash for work, and cash for training). More dependable and resilient vulnerability reduction must involve long-term measures that achieve diversification of the economy, improvement of structural safety, and technological improvement of agricultural activities, for example, by the introduction of saline-tolerant rice (ECHO 2009; Abdullah et al. 2016).

5.3 Social Relation and Network-Related PAV and Relevant PAVR Measures

Community-based organizations have limited capability to carry out emergency evacuation and response. This restricted ability is due to capital constraints, both financial and technical, and poor social networking (Islam and Walkerden 2015; Saha C. 2015). Together these deficiencies ultimately weakened the ability of community organizations to respond to a regional disaster. In both coastal and riverine areas, community participation in water management was also very vague and suffered from inefficiency, inequality, and unsustainability (Dewan et al. 2014; Gain et al. 2017). Lacking meaningful local authority and control, most communities could not prevent illegal embankment breaching. Capacity development of social organizations and linking, bridging, and networking social capital (Nakagawa and Shaw 2004; Islam and Walkerden 2015) are keys to promoting and achieving PAVR. Capacity development of community-based organizations to ensure participation in water management is another key measure to realize PAVR. Meaningful involvement of local governments in and management responsibility for a permanent polder maintenance fund could institutionalize participatory coastal water management (Dewan et al. 2014) and should be considered an important component in the recovery process.

5.4 Water, Sanitation, and Hygiene (WASH) and Health-Related PAV and Relevant PAVR Measures

Lack of appropriate fresh water supply technology for the saline coastal region, high dependency on pondwater, which was exposed to storm surge, and lack of sanitation awareness were the major pre-Aila unsafe conditions that resulted in long-term post-Aila suffering (Mallick et al. 2011; Tada 2011). Access to health facilities and the capacity of health institutions were limited, which disrupted emergency health response and caused inadequate health support post-Aila (Mallick et al. 2011; Tada 2011). Three viable measures are needed to achieve PAVR: (1) promote water, sanitation, and hygiene (WASH) and health; (2) build the capacity of health institutions to improve the medical response to disaster; and (3) introduce

appropriate technology for an upgraded, protected post-cyclone water supply.

5.5 PAV of Disaster Preparedness and Relevant PAVR Measures

From the standpoint of disaster preparedness, the poor capacity of cyclone shelters to house evacuees, a conventional cyclone warning system that was no longer adequate, uncoordinated NGO relief efforts, and a lack of proactive disaster preparedness were major pre-Aila unsafe conditions that resulted in prolonged human suffering (Mallick et al. 2011; Tada 2011). The people in the area affected by Aila did not follow evacuation orders because of a lack of trust in the warning system, ignorance, and the challenge of low capacity cyclone shelters with no space for livestock (Saha and James 2016). Clumsy humanitarian aid and NGO coordination mechanisms at the local level were additional vulnerability conditions that hindered an efficient disaster emergency response (Sadik, Nakagawa, Rahman et al. 2017). A large number of NGOs started providing recovery support to the local people under the coordination structure of UNO office. The approach of NGO coordination was only arranging monthly coordination meetings at UNO office, which did not ensure effective coordination (Sadik, Nakagawa, Rahman et al. 2017). With no additional resources for monitoring and coordinating humanitarian organizations involved in relief and recovery, it became a very difficult challenge for the UNO office to ensure alignment of humanitarian support to local needs and national disaster management plans.

6 Measuring Inclusion of PAVR within Aila Recovery in Koyra

The 23 indicators presented in Fig. 4 constitute the departure point for this section. The diagnostic analysis discussed in Sect. 3.2.2 was applied to measure the inclusion of PAVR in Aila recovery. A quantified score was calculated for each indicator to measure the degree of inclusion of each indicator and each criterion. These results are presented in Table 3.

Table 3 presents only the 23 indicators that represent viable PAVR measures. Of the 23 indicators, 10 were excluded from integration into post-disaster recovery projects and plans, 12 were partially included, and only one was completely included. The indicators were grouped under five criteria. A score measuring degree of inclusion is calculated for each indicator. The average score of the indicators under each criterion reflects the degree to which a particular aspect of PAVR is included in recovery activities. The details of the results are presented in the five

Table 3 Inclusion of PAVR measures in Aila recovery activities in Koyra Upazila, Khulna District, Bangladesh

PAVR criteria	Indicator of recovery initiatives inclusive of PAVR	Degree of inclusion in Aila recovery	Criteria average
Physical environment	Land-use planning	0	0.22
	Improving structural strength of houses	0.58	
	Expanding road network with structural improvement	0	
	Structural improvement to critical installations (administrative installations, cyclone shelters, and so on)	0.74	
	Rehabilitation of coastal embankments (improvement of design)	0	
	Measures for preventing illegal breaching of embankment	0	
Local economy/livelihood activities	Support for maintaining present livelihood	0.61	0.47
	Support for livelihood diversification	0.56	
	Technological improvement of conventional agricultural activities	0	
	Livelihood safety for the marginalized groups	0.72	
Social relations and networks	Capacity building of volunteer organization for emergency response	0.68	0.41
	Disaster awareness	0.69	
	Improving social network	0.67	
	Linking and bridging of social capital	0	
	Capacity development of community based organization in monitoring and preventing illegal breaching of embankment	0	
Water, sanitation, and hygiene (WASH) and health	Introducing appropriate water supply technology	0.58	0.43
	WASH and health promotion	0.72	
	Capacity building of health institutions for disaster response	0	
Disaster Preparedness (Public Action and Institutions)	Construction of new cyclone shelter	1	0.47
	Improving disaster governance	0.66	
	Improving early warning system	0	
	Improving mechanism for joint response and recovery mobilization	0.68	
	Improving harmonization of response and recovery at local level	0	

Scores are numbers representing inclusion of indicator within recovery. Maximum number 1=completely included, minimum number 0=not included. Numbers in between 1 and 0 can be qualitatively described as: 0.76–0.99=included to a large extent, 0.51–0.75=moderate inclusion, 0.26–0.50=poor inclusion, 0.01–0.25=very poor inclusion

subsections that follow, together with the necessary reasoning and justification for their importance in reducing future vulnerability.

6.1 Inclusion of Physical Environment-Related PAVR Measures

As we see in Table 3, creation of a land-use plan, increased road network, improvement of coastal embankments, and viable measures for preventing embankment breaching were completely missing in Aila recovery in Koyra. Eventually, the exclusion of four indicators and only the partial inclusion of two indicators made the degree of inclusion of the criteria, physical environment-related PAVR in the recovery, very low.

A hazard map-based land-use plan that would regulate the practice of saltwater shrimp farming inside the polder areas and the growth of scattered settlements in high risk

areas is considered neither in practice nor in theory. Housing was a focus sector and the NGOs provided improved houses with a raised plinth level and measures for withstanding windstorms to many impacted families. These improved homes were provided to only 20–30% of the affected families and were planned without consulting local hazard maps or land-use plans (Sadik, Nakagawa, Rahman et al. 2017). This seemingly random process led the experts that we consulted to give only a moderate score to the contribution of housing to PAVR. Although both GOs and NGOs reconstructed damaged roads (UNDP 2011; LGED 2016), no new roads have yet been constructed to expand the road network (according to information provided by the LGED office Koyra), which was a major unsafe condition leading to vulnerability before Cyclone Aila (Mallick et al. 2011). In all cases, typical design with no hazard mitigation improvement was followed. Field observation and FGDs indicate that the lack of

DRR measures is evidenced by frequent road damage from heavy rain and tidal flooding. Several of the damaged administration buildings of the upazila were reconstituted specifically to take into account the need for additional DRR measures and improvements. For example, buildings were elevated on multistoried stilt-structures, constructed with reinforced cement concrete (RCC) foundations, and built on elevated sites, among other improvements. New cyclone shelters were also constructed in compliance with improved designs and new guidelines were recommended for the coastal area (UNDP et al. 2013; LGED 2016). But only a small number of the shelters were constructed with associated livestock shelters, which discouraged experts from giving the maximum score possible during their evaluation. Coastal embankments were restored without improvement of their original design, and with neither maintenance mechanisms nor additional DRR. The only project that considered the improvement of the embankment is still in a study phase. Since no viable measures for preventing the illegal breaching of an embankment could be found in recovery initiatives, the relevant indicator was considered as missing.

6.2 Inclusion of Local Economy and Livelihood-Related PAVR Measures

As discussed in Sect. 5.2, increasing livelihood safety for marginalized populations by providing support for their present livelihood, encouraging livelihood diversification, and promoting technological improvement of conventional agricultural activities are keys to PAVR. Unfortunately, no initiative was found in recovery that addressed technological improvements to the conventional, unsustainable practices of shrimp farming and other agricultural activities. Since livelihood stability was a priority goal in the recovery process, the NGOs and GOs provided different support programs, including cash aid, cash for work and training, and training for alternative livelihoods to promote self-recovery (Walton-Ellery 2009; Tada 2011; JICA and OCCL 2012; Mahmud and Prowse 2012). These support actions were short-term measures, and the reduction of uncertainties and vulnerabilities embedded in these economic activities due to the cyclone disaster was not ensured by these support initiatives (Sadik, Nakagawa, Shaw et al. 2017). With these facts very much in mind, experts judged the immediate post-disaster economic initiatives as moderate contributors to PAVR, and this influenced the moderate scores assigned to their degree of inclusion within recovery programs (Table 3). One indicator (technological improvement of agricultural practice) was missing; thus the final score for the inclusion of this cluster of initiatives—the reduction of local economy and livelihood activity related PAV—was lowered (Table 3).

6.3 Inclusion of Social Relation-Related PAVR Measures

The degree to which viable measures related to social capital are included in PAVR is low. Table 3 shows that two indicators were completely missing and three were only partially considered in the recovery process. Experts' judgment of the potential contribution made by implemented social measures to PAVR within recovery programs was at a moderate level. For example, due to the continuing uncertainty about the technological and financial capacities of the local volunteer organizations, experts considered the initiative of forming local volunteer groups to broadcast warnings and assist with emergency evacuations as a moderate contributor. Similarly, since the sustainability and continuation of disaster awareness by training programs and information campaigns were not assured, experts judged the initiative as a moderate PAVR contributor.

New groups of local volunteers, better community-NGO partnerships, and expanded community training might improve social networks, but institutionalization of these networks still needs to be resolved (Islam and Walkerden 2017). Similar to the social network expansion, building more links and bridges between social capital centers is also important (Nakagawa and Shaw 2004). During Aila recovery, links and bridges between local communities and local administrations, local government institutions, academic societies, science and technological societies, and neighboring communities were overlooked. These concerns influenced the experts to give a moderate score for the contribution of network improvement to PAVR.

To ensure community participation in water management, the BWDB plans to form several water management committees comprised of local people. Taking into account examples from other coastal areas of Bangladesh, these committees are often not effective in maintaining embankment fidelity due to political and financial challenges, as well as weak legitimacy (Gain and Schwab 2012; Dewan et al. 2015). The capacity development of community-based organizations in monitoring and preventing illegal breaching of embankments is also a missing link.

6.4 Inclusion of WASH and Health-Related PAVR Measures

The GOs and NGOs installed hand-pump tube wells, re-excavated ponds, and installed pond sand filters (PSF) and household-level rainwater-harvesting systems (RHS) in different affected villages (Tada 2011; JICA and OCCL 2012; EKN and UNDP 2015). In a few villages, ponds and PSFs were not effective due to salinity intrusion from the nearby saltwater shrimp farms (Sadik, Nakagawa, Shaw

et al. 2017). Similarly, RHS suffered from maintenance issues and capacity limitation. Therefore, experts judged these promising initiatives as only moderate contributors to PAVR (Table 3).

In their promotion of WASH and health, NGOs and GOs have partnered to launch several nationwide campaigns. Sanitation was one of the priority issues in humanitarian aid. The housing units provided by NGOs for affected families were equipped with sanitation facilities. However, these facilities did not include DRR measures to ensure safety from a tidal flood. A number of campaign programs were only short-term and project-based, which reduced their impact. Experts therefore evaluated them as moderate contributors (Table 3).

Although sanitation was partially included in recovery, the improvement of health facilities was not included. No project or initiative was found that targeted capacity building of the local health institutions to enhance effective and quick response during a disaster emergency.

6.5 Inclusion of Disaster Preparedness and Governance-Related PAVR Measures

The degree of inclusion of PAVR measures related to disaster preparedness was judged to be somewhere between low and moderate (Table 3). Only the initiative to construct cyclone shelters was comprehensively included in recovery efforts. Twelve new cyclone shelters have since been constructed and six more are under construction (Sadik, Nakagawa, Shaw et al. 2017).

The ERF had components related to improving disaster governance that included capacity building of GOs and NGOs in disaster management, and policy and guideline formulation for emergency response and NGO coordination (UNDP 2011; UNDP et al. 2013). The government prepared a national plan for disaster management (DMB-

MFDM 2010). But the practice of the plans and policies was limited because the capacity of local government to implement the new initiatives was deficient. Despite establishing a new national level coordination structure, local level coordination suffers from a lack of harmonization, difficulties with coordination among NGOs, and inexperience with proper monitoring (Sadik, Nakagawa, Rahman et al. 2017). Therefore experts judged these initiatives as moderate contributors to PAVR.

The early warning system that was designed to protect rivers and seaports of the country (Akhand 2003) has not been changed. Nonetheless the existence of a warning system and its dissemination do not guarantee that people will follow the evacuation order unless the reasons for noncompliance are addressed (Saha and James 2016). By improving the warning system in the recovery phase without addressing the root causes of why people ignored cyclone warnings during the Aila emergency, this indicator was considered excluded as a PAVR contributor. Harmonization is a product of integration, coordination, and alignment (Rahaman and Khan 2010). The integration of different sectoral recovery at a local level—for example, infrastructures, coastal embankments, and livelihoods—is still missing in Aila recovery. The coordination and alignment of humanitarian aid lack an efficient coordination structure at a local level (Sadik, Nakagawa, Rahman et al. 2017). Therefore the indicator "harmonization of response and recovery at the local level" was considered excluded from the recovery.

6.6 The Overall Scenario of the Inclusiveness of Aila Recovery

The diagnostic analysis clearly presents the evidence that Aila recovery is a poor vehicle by which to achieve PAVR measures. The spider diagram in Fig. 5 illustrates the

Fig. 5 Inclusion of the PAVR within Aila recovery in Koyra Upazila, Khulna District, Bangladesh
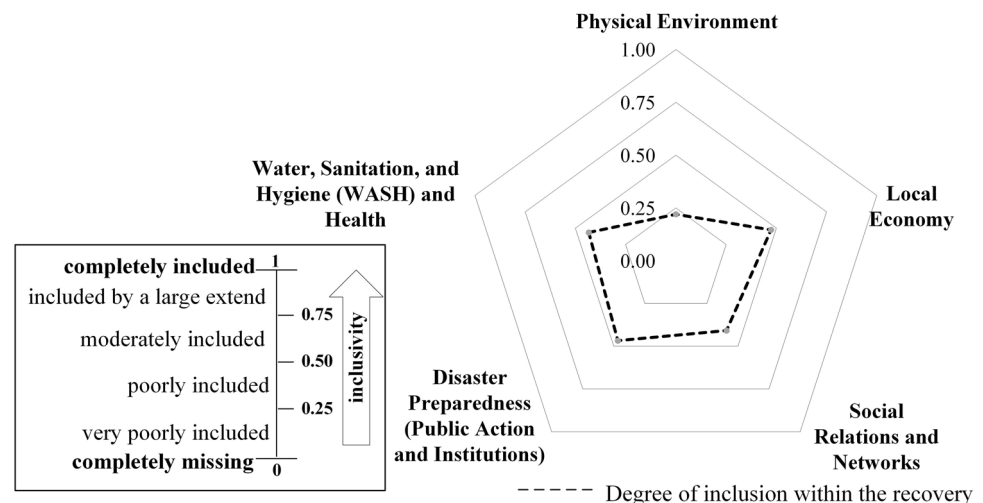
overall pattern of inclusiveness of Aila recovery by comparing the degree of inclusiveness of the five indicator categories in improving PAVR.

The pattern of inclusion in Fig. 5 does not look balanced. It suggests less fruitful results from the recovery and logically indicates that physical environment, WASH and health, local economy, and livelihoods are still in a vulnerable condition similar to the pre-Aila period. The overall result of the diagnostic analysis strongly reveals the shortcomings of the attempt to include vulnerability reduction within the post-Aila recovery programs. Thus the finding implicitly states that the community in Koyra is still living in an underlying vulnerability similar to the pre-Aila period despite the recovery effort.

7 Concluding Remarks

The Cyclone Aila recovery is a new example of the GO-NGO joint approach for recovery. Unfortunately, our findings indicate that short-term initiatives, such as temporary housing, small cash grants, cash for work, awareness building, short-term policy formulation, community training, and support for ongoing livelihood activities, were prioritized in the recovery period. Viable measures for eliminating the root causes of the vulnerabilities were not properly addressed. Necessary measures, like hazard-based land-use planning, expanded road networks, improved coastal embankments, technologically advanced agricultural practices, linking of social capital, improved early warning system, coordination and harmonization of NGO efforts at a local level, and increasing capacities of health institutions were completely missing from recovery planning and practice. The results clearly show that the degree of inclusion of viable PAVR measures within Aila recovery was poor. The lack of viable PAVR measures in the recovery results in an ongoing vulnerability. Because cyclones are a frequent, recurrant hazard, the community is still vulnerable, just as it was before Aila. At the time of identifying viable DRR measures, root causes of PAV should be considered carefully. The present situation in Koyra, as well as in other similar areas affected by Cyclone Aila, calls for DRR investment. Such investment has been advocated by the global community as part of a broader concern for development issues (Aitsi-Selmi et al. 2016), and it is a priority for Bangladesh at present.

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