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Community Resilience to Cyclone Disasters in Coastal Bangladesh

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Abstract: Bangladesh is one of the poorest and most disaster-prone countries in the world. To address both problems simultaneously, sustainable livelihoods (SL) could be better connected with disaster risk reduction (DRR). For this purpose, one initiative implemented in Bangladesh is called the Vulnerability to Resilience (V2R) programme which ran from 2013 to 2016. This programme was primarily initiated and funded by the British Red Cross in a consortium with the Swedish Red Cross and the German Red Cross. This article presents the first evaluation of the V2R programme with three objectives. The first objective was to measure whether the selected communities have achieved community resilience characteristics as defined by the programme. The second objective was to conduct a cost-benefit analysis for the intervention. The third objective was to analyse V2R's impact on the communities in terms of DRR and SL. Community-based focus group discussions and household-based surveys were conducted before and after the intervention (2013–2016) in two coastal communities in Patuakhali district, Nowapara and Pashurbunia. The analysis found that community members are now engaged with many hazard-resilient and vulnerability-reducing livelihood activities, using SL to implement DRR, yet these approaches were almost absent prior to V2R. Consequently, the communities have achieved resilience characteristics, being more well-organized and better connected; having better access to infrastructure, services, and economic opportunities; are more knowledgeable and healthier; and are better managing their available resources. Critiques of the concepts are discussed, although in this case, DRR based on SL has shown positive results, exactly as development theory suggests.

Keywords: cyclone; coastal community; resilience; vulnerability; sustainable livelihoods; disaster risk reduction; Bangladesh

1. Introduction

1.1. Bangladesh, Disaster Risk Reduction, and Sustainable Livelihoods

Bangladesh is ranked as the world's 6th most disaster-prone country [1]. From 1994 to 2013, at least 24,376 people were killed and at least 129 million people were reportedly affected by disasters

in Bangladesh [2]. The dominating disasters were cyclones and associated storm surges in the southern coastal region of Bangladesh. Cyclones that frequently hit the coastal districts cause massive human casualties, property damage and economic loss. Over the years, numerous public institutions, national and international non-governmental organizations (NGOs) and volunteer-based humanitarian networks have been working to increase the community level resilience in those multi-hazard prone areas while recognising significant structural constraints related to poverty, governance and history which create vulnerability and disaster risk over the long-term [3–8]. They have been implementing projects with varying budgets and timeframes to achieve two basic goals: (i) to make the communities resilient and (ii) to foster sustainable development. For example, the International Centre for Climate Change and Development is leading a project (2013–2018) to promote livelihood resilience and progress toward development in the coastal belt of Bangladesh [9]. The Bangladesh Centre for Advanced Studies is leading another project to reduce climate disaster risks and enhance resilience of the vulnerable coastal communities in Bangladesh [10]. This article evaluates one programme known as Vulnerability to Resilience (V2R) that was primarily funded by the British Red Cross (BRC). The programme has recently finished by analysing its impact at the community level in relation to disaster risk reduction (DRR) and sustainable livelihoods (SL).

The importance of connecting DRR and SL has long been shown in theoretical analyses with the argument that SL gives people options to implement DRR for themselves while implementing DRR averts disasters so that people can build SL [5,11–13]. In practice, particularly for project implementation, silos tend to emerge so that interventions are labelled DRR, SL, or another area such as climate change mitigation or climate change adaptation. In the meantime, livelihoods of agriculture-dependent coastal communities in Bangladesh have been seriously hampered by two decades of cyclones and storm surges, degrading livelihood sources and increasing vulnerabilities [14]. These vulnerabilities emerge from ongoing, underlying, chronic poverty and underdevelopment [5], indicating the need to address DRR including climate change by focusing on these wider challenges, many of which are encompassed by SL. Some fully connected on-the-ground examples are starting to appear in the literature [7,8,14] with frequent calls for further analyses, especially those which connect DRR and SL from the beginning, rather than afterwards for analysis. This study contributes one such case study, deliberately focusing on the bottom-up and small-scale so that direct impacts become more apparent and more verifiable, thereby testing long-standing development theories which connect DRR and SL [5,12,13,15].

1.2. Vulnerability to Resilience (V2R) Programme

One major initiative that has been implemented for connecting DRR and SL from the bottom-up is called the V2R programme [16]. V2R's goal is to reduce vulnerability and increase resilience of target communities by supporting strategies (see Section 3.2) that enable them to prepare for, mitigate and respond to multiple hazards. On 6 August 2012, a memorandum of understanding was signed between the Bangladesh Red Crescent Society (BDRCS) and the Consortium members of the British Red Cross (BRC), the Swedish Red Cross and the German Red Cross to support the V2R programme. BDRCS is the implementing partner of the V2R project which covers 27 communities in two districts in south-west Bangladesh: Barguna and Patuakhali. The inception phase of the V2R programme ended on 31 December 2012 leading into a 3.5-year implementation period. The programme concluded on 30 April 2016 [17].

Barguna and Patuakhali districts sit on the coast of the Bay of Bengal and are exposed to tropical cyclones which bring storm surges. Most of the population in these areas depends on agriculture and fishing for their livelihoods. These areas were badly affected by Cyclone Sidr in 2007 and Cyclone Aila in 2009. Before 2007, the 52% poverty rate in this region, called Barisal, was already the highest in the country, whereas the national average was 40%. For example, in *Kalapara* Upazila (upazila is sub-district, an administrative unit) of Patuakhali district, 64% of the population are rated to live in extreme poverty [18]. Growth in agricultural GDP (Gross Domestic Product) and in per

capita income of Barguna and Patuakhali districts is also much lower than the national average [19]. These communities need both DRR and SL, preferably linked.

1.3. Research Objectives

The aim of this article is to evaluate the V2R programme in two communities in Patuakhali district. The objectives are:

(a) To measure whether the selected communities have achieved the resilience characteristics set out by V2R.
(b) To conduct a cost-benefit analysis for the V2R intervention.
(c) To analyse V2R's impact on the communities in terms of DRR and SL.

2. Theoretical Framework

Vulnerability and resilience have long been theorised in the academic literature (e.g., [12,13,15,20,21]) as well as being assessed in practice with interventions to reduce vulnerability and to increase resilience (e.g., [11,22–24]). Because this study evaluates a particular project from a particular perspective, the definitions of "vulnerability" and "resilience" for this project are presented and adopted here.

The International Federation of Red Cross and Red Crescent Societies (IFRC) defines resilience as, "the ability of individuals, communities, organizations or countries exposed to disasters, crises and underlying vulnerabilities to anticipate, prepare for, reduce the impact of, cope with and recover from the effects of shocks and stresses without compromising their long-term prospects" [25]. Vulnerability is defined as, "the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard".

These two definitions do not immediately suggest that vulnerability and resilience are direct opposites, which is the claim of some work (e.g., [26]). Conversely, the definitions used here are much more in line with the literature countering the oppositional view (e.g., [11–13,20,27–29]), recognising that individuals and communities can simultaneously have vulnerabilities and resiliences. Much depends on to what they are vulnerable or resilient along with recognising that, within a community, some sectors can be highly vulnerable to the same phenomenon to which other sectors are resilient.

In fact, IFRC's definition of "community" is "a group of people who may or may not live within the same area, village or neighbourhood, share a similar culture, habits and resources. They are also exposed to same threats and risks such as disease, political and economic issues and natural disasters" [25]. This definition explicitly recognises different sectors within a community, so that even if a single community is "exposed to the same threats and risks", different sectors can have differential responses indicating different vulnerabilities and resiliences. Furthermore, this definition of "community" has high materiality and low conceptuality. "Community" is something tangibly identifiable as "a group of people" with similarities and differences, rather than the more nebulous conceptualisations often seen in development which foist notions of inseparable and indistinguishable individuals living together—notions which have been heavily criticised as being idealised and unrealistic while brushing aside internal differences and dynamism [30–32].

Consequently, IFRC's definitions permit differences to emerge within a community with respect to vulnerability and resilience, while expressing that vulnerability and resilience can co-exist simultaneously and can be affected differently by interventions. Yet IFRC's definitions of vulnerability and resilience deliberately highlight disasters and focus on capacity for dealing with disasters (compare with [29]). Often, it can appear that increasing vulnerability immediately decreases resilience and vice versa—especially in the context of V2R. Careful reflection will be needed when evaluating V2R to see how much of the vulnerability-resilience opposition emerges and how much vulnerability and resilience are seen as related but with different characteristics.

This reflection can begin with IFRC's definitions of characteristics of a resilient community which are [25]:

Characteristic 1: is knowledgeable, healthy and can meet its basic needs.
Characteristic 2: has well-maintained and accessible infrastructure and services.
Characteristic 3: has economic opportunities.
Characteristic 4: is socially cohesive.
Characteristic 5: can manage its natural assets.
Characteristic 6: is connected.

Other examinations of resilient community characteristics [33,34] interrogate further many of the terms used by IFRC, indicating more nuances and subtleties. A trade-off between straightforwardness/do-ability and comprehensiveness/efficiency frequently emerges in the literature which aims to connect theory and practice for determining a community's vulnerabilities and resiliences. Whilst the simplicity of IFRC's characteristics has the potential for obscuring chronic, deep-seated vulnerabilities [12,29], this simplicity also has advantages in terms of being more easily communicated to community sectors and evaluated in the field.

Additionally, the open-endedness of these characteristics can permit evaluations with different technical levels. Characteristic 6 could invite a full, mixed methods Social Network Analysis or might merely enquire qualitatively about remittances and intra-community neighbourly assistance. Characteristic 3 could be critiqued as favouring a cash economy too much, rather than highlighting livelihoods involving bartering and subsistence—yet the latter is arguably enveloped in Characteristic 1 with economic opportunities enhancing subsistence livelihoods, thereby providing further opportunities and increased flexibility. As such, consistency in exploring the resilience characteristics of communities might not always be achieved. Conversely, when evaluating a specific intervention in a specific community, as occurs here, IFRC's characteristics provide a useful baseline which can be explored and analysed pragmatically followed by critique. In particular, IFRC's characteristics are used operationally for V2R meaning that they can be examined and evaluated in the context in which they are applied, as is done for this paper for specific case studies.

The definition of SL is adopted from Chambers and Conway, 1992 [35]: "a livelihood is sustainable when it can cope with and recover from the stress and shocks, and provide similar opportunities for the next generation".

3. Methodology

3.1. Study Area

Cyclones regularly strike the coastal region of Bangladesh, with the vulnerabilities causing major disasters. For example, Cyclone Sidr that struck the south-west coast of Bangladesh on 15 November 2007 with wind speeds up to 240 km/h accompanied by 6 m of tidal waves caused 3406 fatalities with 1001 still missing and over 55,000 people sustaining physical injuries. Cyclone Sidr affected about 2.3 million households and damaged or destroyed 2.5 million acres of cropland, affecting around 8.9 million people experiencing estimated damages and losses of approximately US$1.7 billion [36].

Cyclone Aila hit the same region on 25 May 2009, leading to 190 deaths, injuring more than 7000 people, affecting nearly 5 million people, and destroying or damaging more than 500,000 houses. Cyclone Aila also extensively damaged more than 1400 km of embankments, an estimated 8800 km of roads, and 350,000 acres of cropland [37]. Cyclone Mahasen made landfall in the Patuakhali district on 16 May 2013, affected 1,498,579 people and left 17 people dead. More than 26,500 houses were destroyed and almost 124,000 damaged. Thousands of acres of cropland, fish ponds and fish culture were washed away by Cyclone Mahasen [38]. Cyclone Komen made landfall along the coast of south-eastern Bangladesh on 30 July 2015, but relatively small-scale damage resulted [39]. Meanwhile, sea-level rise due to climate change will be influencing meteorological hazards [14]. In total, 20.1% of Bangladesh's shoreline (i.e., 57.9 km of total coastline in the Ganges delta) is highly vulnerable to such hazards, whilst 17.5% (50 km) of the shoreline is estimated to be highly vulnerable when examining multiple hazards [40].

For this study, two communities were selected: Nowapara and Pashurbunia under the sub-district of Kalapara of Patuakhali district (Figure 1a). Annual average temperature of Patuakhali district varies from a maximum of 25.3 °C to a minimum of 12.2 °C, and average annual rainfall is 2377 mm [41,42]. Kalapara sub-district is located between 21°48′ and 22°05′ north in latitude and between 90°05′ and 90°20′ east in longitude [43]. It is bounded by Amtali Upazila (i.e., sub-district) both on the north and west, Rabnabad channel and Galachipa Upazila on the east, and Bay of Bengal on the south (Figure 1b).

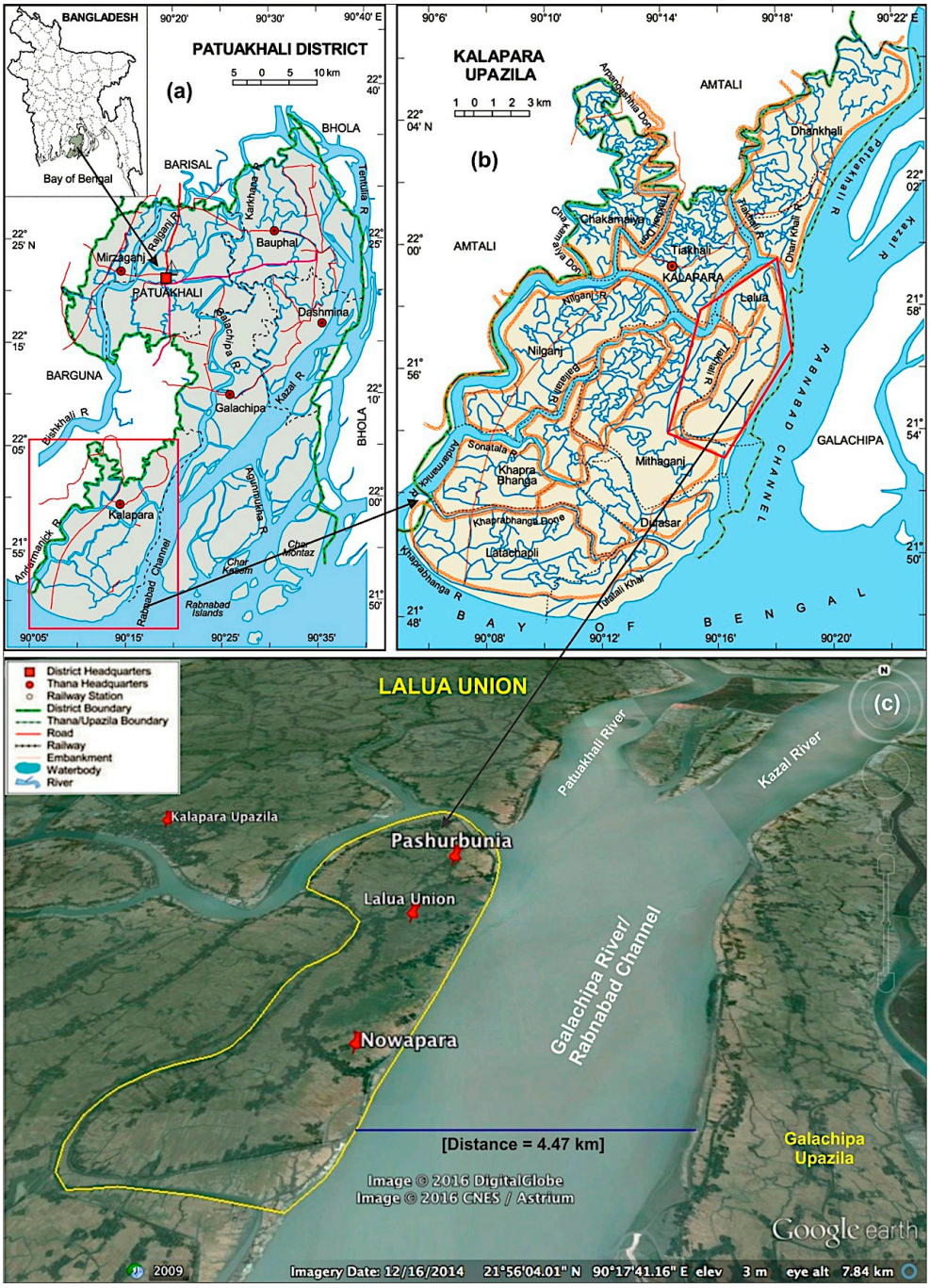

Figure 1. Location of (**a**) Patuakhali district and Kalapara Upazila in Bangladesh; (**b**) Lalua Union in Kalapara Upazila; and (**c**) Nowapara and Pashurbunia communities in Lalua Union. Sources: (**a**) and (**b**) National Encyclopaedia of Bangladesh, 2015 [5,6]; and (**c**) Google Earth Image, 2016.

Kalapara upazila comprises nine Unions (a Union is the smallest administrative rural geographic unit in Bangladesh). Nowapara and Pashurbunia communities are located in Lalua Union (Figure 1c). The distance from Kalapara Upazila to Lalua Union is 6.7 km; the total area of Lalua Union is 39 km^2; and the total population is 14,139 [44]. There are in total 13 primary and 3 secondary schools in Lalua Union. The primary occupation is fishing. It has one Union Disaster Management Committee and one Union Development Coordination Committee. The estimated population of Nowapara and Pashurbunia communities is 3800 in 900 households. The communities are located about 0–30 cm above mean sea level (MSL) [45]. This is a pilot study where Nowapara and Pashurbunia communities are selected because of their geographical location close to Bay of Bengal, economic instability (i.e., living behind poverty line) and vulnerability to cyclone disasters. These two communities are representative of the general circumstances of communities along coastal Bangladesh.

An embankment, property of the Bangladesh Water Development Board, is located within 20–500 m of the Rabnabad Channel and serves both communities (Figure 2a,b). Most households are located very close to the channel and embankment (Figure 2c,d). Almost every year during the monsoon period, the embankment breaks and the communities are inundated. Cyclones, rainfall-induced flooding, and tidal surges also frequently hit these communities. Therefore, they are affected by multiple hazards and have high vulnerability including fragile livelihoods, making them a suitable case study sites for implementing and evaluating V2R.

Figure 2. (**a**,**b**) The embankment in the community; (**c**,**d**) households located just near to the Rabnabad Channel. Source: Bayes Ahmed, fieldwork, February 2016.

3.2. V2R Project Activities

V2R for these communities started in January 2013. At first, the community boundary was demarcated in consultation with the local government and civil society members. Several micro-groups were formed per community to provide information on the project, called Community Disaster Management Committees (CDMCs). CDMCs represent the focal points for all project decision-making and social development within each community, sitting for monthly meetings to review project progress and to plan for actions. CDMCs work closely with the Union Disaster Management Committee and with the Water and Sanitation (WATSAN) Committee (a formal local Government body) and now

(with one representative from each CDMC) they are part of Union Disaster Management and WATSAN Committee. The V2R project comprises three major sub-components: SL, Water, Sanitation and Hygiene (WASH), and DRR.

Under the sub-components, a range of activities was carried out including cash for work (for constructing/rebuilding community access roads); cash for starting poultry, fishery, vegetation, and grocery businesses; buying animals, sewing machines, and other livelihoods goods; establishing sanitary latrine and tube-wells; and providing safety equipment for the fishermen. People in the communities were trained for community mapping, first aid, search and rescue, and early warning. Technical and market access training was provided to all producer groups with respect to their particular specialism. Other workshops and training were conducted to enhance the capacity development of micro-groups and CDMCs and for developing social linkages with relevant NGOs and government organizations.

As part of the V2R livelihood activities, initially the poorest and most vulnerable 12% people from each community were selected for cash grants. Households identified as being landless or particularly vulnerable in other ways—such as poor female-headed households and households with people with disabilities, elderly, or children—were given priority. Each household was granted 15,000 BDT (BDT = Bangladeshi Taka, with the exchange rate being approximately 78.50 BDT = $1 USD on 5 May 2016). The expenditure was restricted according to business plans and, in some cases, priorities such as food or debt. The business plans included livelihood activities leading to producer groups such as cattle rearing (beef and milk), handicrafts (sewing and quilting), homestead gardens, aquaculture, rice production, poultry (chicken and ducks), and retail businesses (small shops). The profitability was also calculated for each business plan. A monitoring system was developed for all the beneficiary households after the grants had been disbursed.

For the cash-for-work scheme, the poorest and most vulnerable 20% of households with labour capability (including women) were selected. Each selected member was paid approximately 3000–4000 BDT for 15–20 days of work at 5 h per day. Cash-for-work included construction of internal community roads, rehabilitation of ponds used for drinking water, embankment repair, and tree plantation on embankments. In all cases, the most vulnerable households were selected in consultation with the micro-groups and CDMCs.

Overall, the SL activities comprise selecting appropriate producer groups, providing relevant training, and arranging for cash grants and/or cash-for-work. V2R particularly aimed to increase female income earning potential alongside improving household food and income sources [46].

3.3. Household and Community Surveying

At the project's beginning, a household baseline survey was conducted in early 2013. Later in February 2016, a similar survey was implemented to complete a before-intervention and after-intervention comparison. Information on household demography, education, income, savings, land ownership, profession, micro-credit, water supply, sanitation, household waste, health and hygiene, diseases, hazard exposure, disaster governance and DRR were collected using an open-ended questionnaire. The questionnaire was tested in the field before conducting the data collection. The first and fourth authors conducted the field survey with the help of other BRC field officials and local people. A total of 90 households (i.e., 10% sampling and 45 from each community) was surveyed (Figure 3a) using a stratified random sampling method. The survey team visited the households and asked for permission from the available adult male/female head for conducting the questionnaire. Statistics from the two different years (project start and end) are compared to track the changes in community resilience and SL.

Additionally, community-based focus group discussions (FGDs) were conducted (Figure 3b) in each community to collect generalised information about the project intervention and to get ideas on non-monetary and indirect benefits. For conducting FGDs, the CDMC members and community people were invited to exchange their views. The first author facilitated a group of attendees, introduced

the topics for discussion and ensured community and representative participation. FGDs have been widely used in DRR research for generating bottom-up community information that is not always possible to analyse or explain statistically [47,48].

Figure 3. (**a**) Household level questionnaire surveying in Nowapara; and (**b**) community-based focus group discussion in Pashurbunia. Source: Bayes Ahmed, fieldwork, February 2016.

3.4. Cost-Benefit Analysis

Cost-benefit analysis (CBA) is an economic method which, despite severe critiques in the context of development [49–51], continues to be supported and applied in many development contexts. For example, in DRR, cost-benefit ratios have been calculated for drought interventions in Malawi [52], flood early warning in Fiji [53], and many hazards across the USA [54]. Shreve and Kelman (2014) completed a meta-analysis of dozens of cost-benefit studies for DRR demonstrating how high the benefit-to-cost ratios can be for solid DRR interventions [55]. They also summarised numerous limitations of the analyses including the absence of sensitivity checks, lack of long-term data, uncritical use of discount rates, not addressing root causes of vulnerability which are often obscured by the calculations, and failure to include any dis-benefits from DRR interventions. Additionally, most of the studies do not consider the full SL implications of DRR interventions through using baseline data from before and after the intervention. Instead, the studies focus mainly on loss and damages averted [55]. Due to the popularity of cost-benefit analyses and the credibility which decision-makers place on them, a gap remains to be filled in analysing a DRR intervention from a SL perspective. This study contributes to filling this gap by providing a detailed analysis from two communities which have baseline data from before and after an intervention, including a cost-benefit analysis.

4. Results and Discussion

4.1. Household Survey

Changes in household data are measured for 2013 and 2016 (the project start and end years respectively), with Appendix A providing details and major points being summarised in this section. Population growth rate is only 0.02% annually (Table A1(P1)), whereas the national population growth rate is 1.2% annually. Gender balance exists (Table A1(P1)). Everyone owns a house (100%), while some have additional land (42.2%) and land for farming (22.2%) (Table A1(P2)). The number of pupils going to school has increased by 55.2% (67–104) (Table A1(P3)).

The main earning sources of the heads of household remain almost unchanged (Table A1(P4)), but the secondary earning sources have increased dramatically (67.8%) (Table A1(P5)), demonstrating that the households engage in multiple secondary earning sources. The major occupations within the communities are fishing, farming, poultry rearing, cattle rearing and day labour (Table A1(P4)). The ownership of agricultural land has increased by 7% (Table A1(P6)).

The total number of household assets (e.g., sewing machines, sanitary latrines, poultry, and other animals) has increased from 678 to 1998 (Table A1(P8)). The total value of household assets and

agricultural products has increased 223% (1,084,950–3,500,600 BDT) and 1702% (8,312,940–14,977,440 BDT) respectively. On average, the increment is 2684 BDT and 7405 BDT, respectively for each household (Table A1(P7 and P9)).

The individual household level income has also increased rapidly. For example, at V2R's finish, 40% of households earned 6001–9000 BDT per month, a rate which was only 8.9% at V2R's beginning (Table A1(P10)). In 2013, 31.1% of households' monthly income was under 3000 BDT; this figure is now only 2.2%. In 2013, there were no households with a monthly income in the range of 9001–15,000 but that had increased to 11.1% in 2016 (Table A1(P10)). The households are now earning more while fewer people are suffering from extreme poverty.

Household savings have increased from 3,240,000 BDT to 6,885,594 BDT on average. In 2013, no households had monthly savings in the range of 501–1000 BDT, a rate which had increased to 32.4% in 2016. An additional 13.2% of households are saving in the range of 1501–2000 BDT per month. On average, each household is saving 4050 BDT yearly (Table A1(P11)).

Household members are now well-aware of where to go for advice on issues related to livelihood support. Most of them (63.3%) now go to the government line departments for advice on agriculture, livestock, fisheries and other livelihood-related queries. This figure was only 4.4% in 2013. Previously, 51.1% people did not seek advice, a rate that has now reduced to 7.8%. Moreover, 25.6% households are now self-trained to tackle SL-related problems, compared to none in 2013 (Table A1(P12)).

Twenty-five percent of households borrow money from micro-finance institutions (MFIs) compared to 62.3% in 2013 (Table A1(P13)). The borrowers are mostly (90.9%) dependent on one MFI (Table A1(P13.1)) and they use it for investing in businesses (44.1%), family maintenance (24.7%) and to repay old debts (18.8%) (Table A1(P13.2)). The reduction in borrowing money from MFIs suggests that the households are now better off than before and have other or better sources of income for meeting basic needs.

The V2R project strategically installed tube-wells and water points within the communities. Consequently, the distance to the nearest water supply reduced by 20% in the dry season and 21% in the wet season. 82.2% of households stated that they now do not have any problem with pure drinking water supply (Table A1(P14–P18)). Now women and young girls, in particular, do not have to spend time fetching water from far away and have more time for other activities. For example, women now can dedicate time for SL activities and so increase household income.

In 2016, 87.8% of households owned a latrine and the rest used a shared latrine. In 2013, only 42.2% of households had latrines and most (43.6%) used to defecate openly (Table A1(P19 and P21)). People are now more aware of the need to clean the latrines regularly. 66.7% of households responded that they clean the latrines daily, a rate which was 0% in 2013 (Table A1(P20)). In 2016, 85.6% of households disposed of their household waste in a refuse pit. This figure was only 2.2% in 2013. Previously, they used to bury the household waste in random places (Table A1(P22)).

It is common to wash hands before eating (30.1%) in Bangladesh. After V2R, an increase was observed of washing hands after defecation (11.7%) and before cooking (8.5%) (Table A1(P23)). 93.3% of households use a soap bar and water for cleaning hands, a rate which was only 28.9% in 2013, whereas 71.1% of households usually used only water for cleaning hands (Table A1(P24)). A sharp increase is seen in awareness on cleaning hands properly and when appropriate. In addition, household knowledge and practices in safely collecting, storing and treating drinking water have led to decreases of diarrhoea and other related diseases.

The people within the community mostly used to suffer from water-borne diseases linked to frequent flooding, storm surges and less availability of pure drinking water. From 2013 to 2016, diarrhoea, pneumonia and fever reduced by 34.5%, 14.9% and 8.2%, respectively. In total, 75.8% of households confirmed in 2016 that they are not facing water-borne diseases compared to 20.4% in 2013 (Table A1(P25)). The improvement of water and sanitation services appears to have decreased the incidence of water-borne diseases. There is also a "WASH in School" component in the V2R

programme. Children going to school, the rate of which has increased by 55.2%, are good agents of change for their families and surrounding households.

For health care, more people now go to a nearby general clinic (28.9%) and public hospital (8.9%). No one now visits a private doctor, whereas 22.2% did in 2013 and fewer people now go to nearby pharmacy (11.1%) as a first point of treatment (Table A1(P26)). It is expensive to visit a private doctor and pharmacies are not reliable for getting proper treatment. In this context, it is better to visit a general clinic first and then, in case of a serious illness, one can go to the public hospital. The households are following this trend, and it proves that the household members now know where to go for treatment at a reasonable cost and are acting on that knowledge.

Household members are now able to identify signs of diarrhoea which is the most significant disease in these communities. For example, most people responded that dysentery (33.0%) and vomiting (28.0%) are the two major and initial symptoms (Table A1(P27)) of diarrhoea, while in both cases, the rates were 0% in 2013. People now know how deal with diarrhoea; for example, giving Oral Rehydration Salts (ORS) packet solutions to the patient (46.6%) or preparing ORS at home (24.4%). Previously, mostly people (62.3%) used to rely on homemade ORS/fluids (namely, a sugar, salt and water solution) which is now reduced to 31.2% (Table A1(P28)). It is safer to use ready-made ORS packages to avoid contaminated water. 88.9% of respondents in 2016 described the ORS preparation process correctly (Table A1(P29)). Previously, in 2013, most respondents (90.91%) used to get the information on health and hygiene from outreach workers, but now 86.7% get the information from the Red Crescent volunteers through the CDMCs (Table A1(P30)).

From the 2016 survey, 98.9% of households are greatly concerned about disasters within the locality and 88.9% of households were affected by disasters in the past three years (Table A1(P31 and P32)). The effects of disasters were mostly related to property damage (32.6%), loss of domestic animals (26.7%), loss of income (20.0%) and damage to agricultural products (14.8%) (Table A1(P32.1)). As part of household preparedness, people can identify safe shelters for the family (32.8%). 11.8% of households stockpile necessary food, medicine and water in safer places. 25.2% of households take their animals to safer places, compared to 0% in 2013. 9.2% of households now take actions to protect their houses, a rate that was 0% in 2013. Previously, people used to think of primarily personal safety, but now they have increased concern about their household assets without a reduction in considering personal safety. In 2013, 13.0% of households used to do nothing for household disaster preparedness, a rate which has reduced to only 0.38% (Table A1(P33)). Overall, the communities now appear to be better prepared for disasters.

Now, 98.9% of households get early warnings for multiple but mainly meteorological hazards. This figure was 73.3% in 2013 (Table A1(P34)). 48.2% of respondents said that they receive warnings from the newly established CDMCs. Some households also receive warnings from the Government of Bangladesh's cyclone preparedness program (16.1%), radio (15.3%) and mosques (8.8%). In 2013, most people (68.5%) would receive warnings from electronic media (i.e., radio, TV, and mobile phones) (Table A1(P35)). CDMCs appear to be a useful addition in playing an important role in disseminating warnings.

After receiving warnings, 73.3% households go to nearby cyclone shelters (17.8% more than 2013), 13.3% go to well-constructed public schools (6.7% more in 2013), and 13.3% take shelter in raised plinths (compared to 0% in 2013). Previously, 24.4% of people used to stay at home (now 0%) and 11.1% used to go to a relative's house (now 0%) (Table A1 (P36)). Respondents are much more aware of impending storms and where to take shelter.

4.2. Cost-Benefit Analysis

Costs are fixed and known for the V2R project implemented in these communities, while benefits can be harder to measure due to being both direct and indirect. CBA is one tool for estimating a project's efficiency. This section reports a generalized CBA applied to V2R for the two communities in Bangladesh. It considers only the measurable and direct costs and benefits from V2R; i.e., project

activity costs, households' average yearly income, savings, household assets and agricultural product values. The benefit-cost ratio (BCR) of the V2R project is calculated as follows:

$$\text{Total households in two communities (approximately)} = 900$$

$$\text{Number of households surveyed} = 90\,(\text{a } 10\% \text{ sample})$$

$$\text{Total population in surveyed households} = 194\,(\text{male}) + 187\,(\text{female}) = 381$$

$$\text{Average family size} = 381/90 = 4.23 \approx 4$$

The budget spent for V2R in Nowapara and Pashurbunia (2013–2016) is in Table 1.

Table 1. Costs for implementing V2R project in Nowapara and Pashurbunia.

Project Activity	BDT Spent *
Cash for work and cash grant	3,500,000
Skill enhancement training	500,000
Workshops with government line departments (e.g., agriculture, fisheries, and livestock)	300,000
Distribution of rings and slabs for latrines	1,400,000
Water point installation and rehabilitation	840,000
Disaster resilient latrines	200,000
Water point maintenance tool kits	50,000
Awareness campaigns	500,000
School sanitation and hygiene education	100,000
Organisational capacity development for micro-groups and CDMCs	400,000
Workshop with the Union WATSAN committee	150,000
Linkages with stakeholders (government and non-governmental)	200,000
Distribution of first aid kits, early warning kits, and search and rescue kits	100,000
Awareness campaign on disaster preparedness, risk reduction and mitigation	150,000
Youth peer education in secondary schools	100,000
Workshops with local government institutions	150,000
Total cost	8,640,000

Source: British Red Cross (BRC) Dhaka Office, Bangladesh, March 2016 [17]. * The project management costs were not considered. In fact, different groups of people were engaged in V2R's implementation; i.e., international monitoring inspectors, permanent staff in Dhaka and regional offices, contractual staff, and community-level volunteers. Most of them were involved in multiple projects and were in charge of several communities. This research has focused on relevant project activity costs and direct benefits. Therefore, our CBA excludes indirect costs and benefits that were not possible to measure. We have conducted a generalized CBA to evaluate the overall project activity for achieving community resilience and SL.

Average cost per household = 8,640,000/900 = 9600 BDT. The BCR is calculated considering four different scenarios as follows:

(a) Considering household income
Average yearly income for each household = 30,532.20 BDT
BCR = 30532.2/9600 = 3.18
(b) Considering household income and savings
Average yearly income for each household = 34,582.86 BDT
BCR = 34582.86/9600 = 3.60
(c) Considering household income, savings and asset values
Average yearly income for each household = 37,266.92 BDT
BCR = 37266.92/9600 = 3.88
(d) Considering household income, savings, asset and agricultural product values
Average yearly income for each household = 44,671.92 BDT
BCR = 44671.92/9600 = 4.65

If BCR>1, then the project is economically viable [56]. Applying a discount rate to future benefits is common in CBA. Considering various uncertainties in the future (e.g., the monetary benefits

can be different with varying disaster magnitudes, changes in vulnerability, and changes in hazard parameters), the standard practice is to apply a discount rate of 12% in DRR projects [57]. In all the cases, and considering discount rates up to 20%, BCR > 1 is always found (Figure 4).

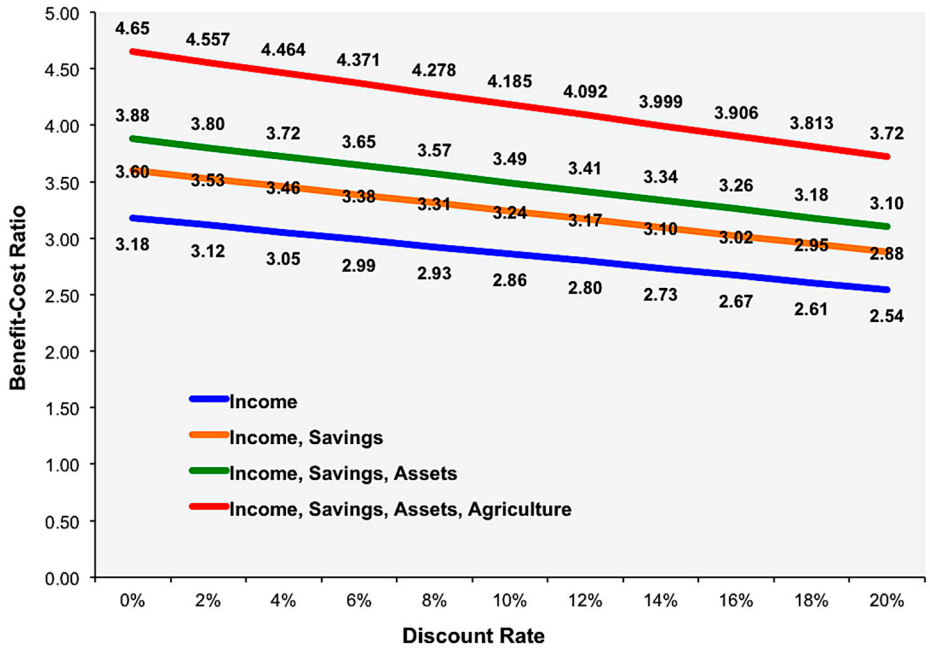

Figure 4. BCR based on different scenarios and discount rates.

In the next step, BCR is estimated over the long-term, considering a project benefit duration of 10 years, a typical value. Three different discount rates have been applied; 5%, 12% (the standard scenario for DRR [57]) and 20%. No costs are discounted, as the project cost is fixed for 2013–2016 with no costs afterwards. Assuming a 5% discount rate, BCR = 2.86 in 2026. The figure is 1.50 for a 12% discount rate. If a 20% discount rate is considered, then BCR drops below one in 2025 (Figure 5). In all the cases analysed, apart from the extreme scenario of a 20% discount rate right at the end of the project, the V2R project measures provided higher benefits than costs incurred. Other indirect and non-monetary benefits were not possible to measure, suggesting increased chances of achieving higher BCR from the V2R project intervention.

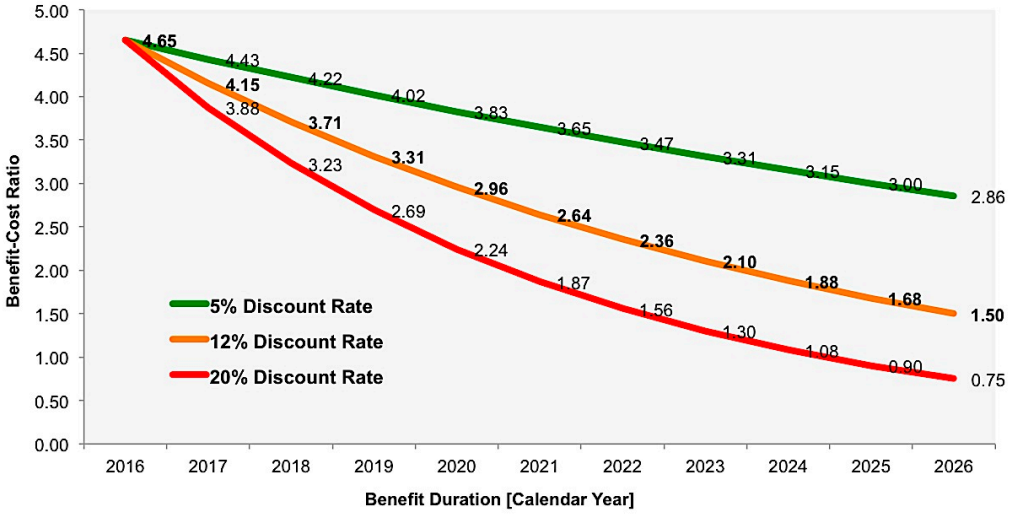

Figure 5. BCR at different discount rates for an assumed project duration of 10 years.

4.3. Achieving Resilience Characteristics and SL

During the V2R project, one part of the embankment broke and the whole study area was flooded in July 2014 (Figure 6). The people within the communities have to deal with this kind of tidal flooding along with frequent cyclones and threats of sea-level rise.

Figure 6. (**a**) Broken embankment due to tidal flooding; (**b**) inundated communities; (**c**) Nowapara's CDMC office (located about 500 m from the embankment) during the flood of 2014; and (**d**) Nowapara's CDMC office in the dry season. Sources: (**a**–**c**) Sarker Monowar Pasha, M&E Officer, V2R Project, Bangladesh, fieldwork, July 2014 [17]; and (**d**) Bayes Ahmed; fieldwork, February 2016.

The people in the communities rely heavily on this area for their SL activities, matching arguments that many Bangladeshis trade-off SL benefits with dangers from hazards [2]. Most of the population had been earning their livelihoods on a day-to-day basis with little scope to consider possibilities of disasters.

For example, the primary occupations of the heads of households are dominated by seasonal fishing in the sea (23.3%), working as wage labourers (37.8%), agricultural activities (17.8%) and retail businesses (7.8%). Only 1.1% work as full-time paid employees (Table A1(P4)). Due to the limited savings per household (Table A1(P11)) prior to V2R, the people's focus had been on daily tasks, leading to a potential discounting of the risks of future disasters, instead focusing on the day-to-day SL benefits [2]. Cyclones, storm surges and tidal floods are seasonal disasters with adverse impacts remaining for at least 2–3 months. Much of the communities' areas—or the entire location—is then under water, limiting sea fishing, wage labourers and retail businesses. Houses and animals can be washed out to sea while vast tracts of agricultural land can end up under saltwater, inhibiting its productivity. This level of livelihood fragility is the primary reason for persistent vulnerability within these communities.

To overcome this situation, sustainable secondary sources of household income can assist, so V2R focused on this issue. Now, the community people are more engaged in secondary livelihood activities (Figure 7), such as poultry farming and cattle rearing.

Previously, 74.4% of people were not engaged in secondary income sources, but now this proportion has reduced to 6.7%. Having plans for alternative income sources is useful for achieving household level resilience [27,33] and V2R has successfully implemented this activity for the two Bangladeshi communities.

Figure 7. Beneficiaries with secondary livelihood options, e.g., (**a**) backyard plants; (**b**) a small retail shop; (**c**) a clothing business; and (**d**) cattle rearing. Source: Bayes Ahmed, fieldwork, February 2016.

The project has also provided disaster resilient tube-wells and sanitary latrines along with developing the internal road network (Figure 8a–c). After tidal flooding and cyclone disasters, water-borne diseases had been breaking out because of the habit of open defecation and due to lack of availability of pure drinking water. These two problems have now been tackled. Additionally, government interventions like constructing cyclone shelters and repairing the embankment (Figure 8d,e) are helping people in the communities to take shelter safely on time while relocating cattle to protect livelihoods. Agricultural production is increasing because of reducing the intrusion of saline water (Figure 8e,f). The communities now have micro-groups and CDMCs and are better linked with external networks. Table 2 illustrates the changes in various indicators due to V2R and its implications for achieving the six characteristics of a safe and resilience community as defined by IFRC [25]. Each indicator is contributing to fulfilling the objectives of multiple resilience characteristics. A flowchart of V2R's community resilience and SL impacts is depicted in Figure 9.

Table 2. Indicators for achieving community resilience for V2R, 2013–2016.

Indicator (Household Level)	Changes (2013–2016)	Resilience Characteristics *					
		IS	EO	KH	SC	NR	CO
Micro-groups	Established				✓		✓
CDMC	Established	✓	✓	✓	✓	✓	✓
Homestead land ownership	Increased		✓				
Agricultural land ownership	Increased		✓			✓	
Children attending school	Increased	✓		✓			
Diversified income sources	Increased		✓	✓		✓	
Number of household assets	Increased		✓	✓		✓	
Value of agricultural products	Increased		✓	✓		✓	
Monthly income	Increased		✓	✓			
Monthly savings	Increased		✓	✓			

Table 2. *Cont.*

Indicator (Household Level)	Changes (2013–2016)	Resilience Characteristics *					
		IS	EO	KH	SC	NR	CO
Livelihood support advice	Operating	✓	✓	✓		✓	✓
Training on SL	Increased	✓	✓			✓	✓
Borrow money from MFIs	Decreased		✓	✓			
Distance to nearest water point	Decreased	✓		✓	✓		
Drinking water problems	No	✓	✓	✓			
Availability of sanitary latrines	Yes	✓		✓	✓		✓
Open defecation	No	✓		✓	✓		✓
Knowledge on WASH	Increased			✓			✓
Refuse pit for waste disposal	Available	✓		✓	✓		
Water-borne diseases	Decreased	✓	✓	✓	✓		
Public hospital and clinics	Operating	✓	✓	✓	✓		✓
Knowledge on identifying diseases	Increased		✓	✓	✓		✓
Response to diseases	Increased	✓	✓	✓	✓		✓
Information on WASH and diseases	Available	✓	✓	✓	✓		✓
Disaster preparedness and recovery	Increased	✓			✓	✓	✓
Getting reliable early warning	Increased	✓			✓		✓
Knowledge on DRR	Increased	✓	✓		✓		✓
Improved internal road network	Done	✓	✓		✓	✓	✓
Training on safety and first aid	Done			✓			✓
Market accessibility and business	Established	✓	✓		✓	✓	✓
Leadership development	Increased				✓		✓
Advocacy on community issues	Increased				✓		✓
Participation in local government activities	Increased				✓		✓
Knowledge on adaptation	Increased				✓	✓	

* IS = Accessible Infrastructures and Services; EO = Economic Opportunities; KH = Knowledgeable, Healthy and Meet Basic Needs; SC = Socially Cohesive/Organized; NR = Managing Natural Assets; and CO = Connected.

Figure 8. (**a**) A flood-resilient tube-well; (**b**) raised sanitary latrines; (**c**) the improved internal road network; (**d**) a school and cyclone shelter in Nowapara; (**e**) an embankment protecting an agricultural field; and (**f**) increased rice production. Source: Bayes Ahmed, fieldwork, February 2016.

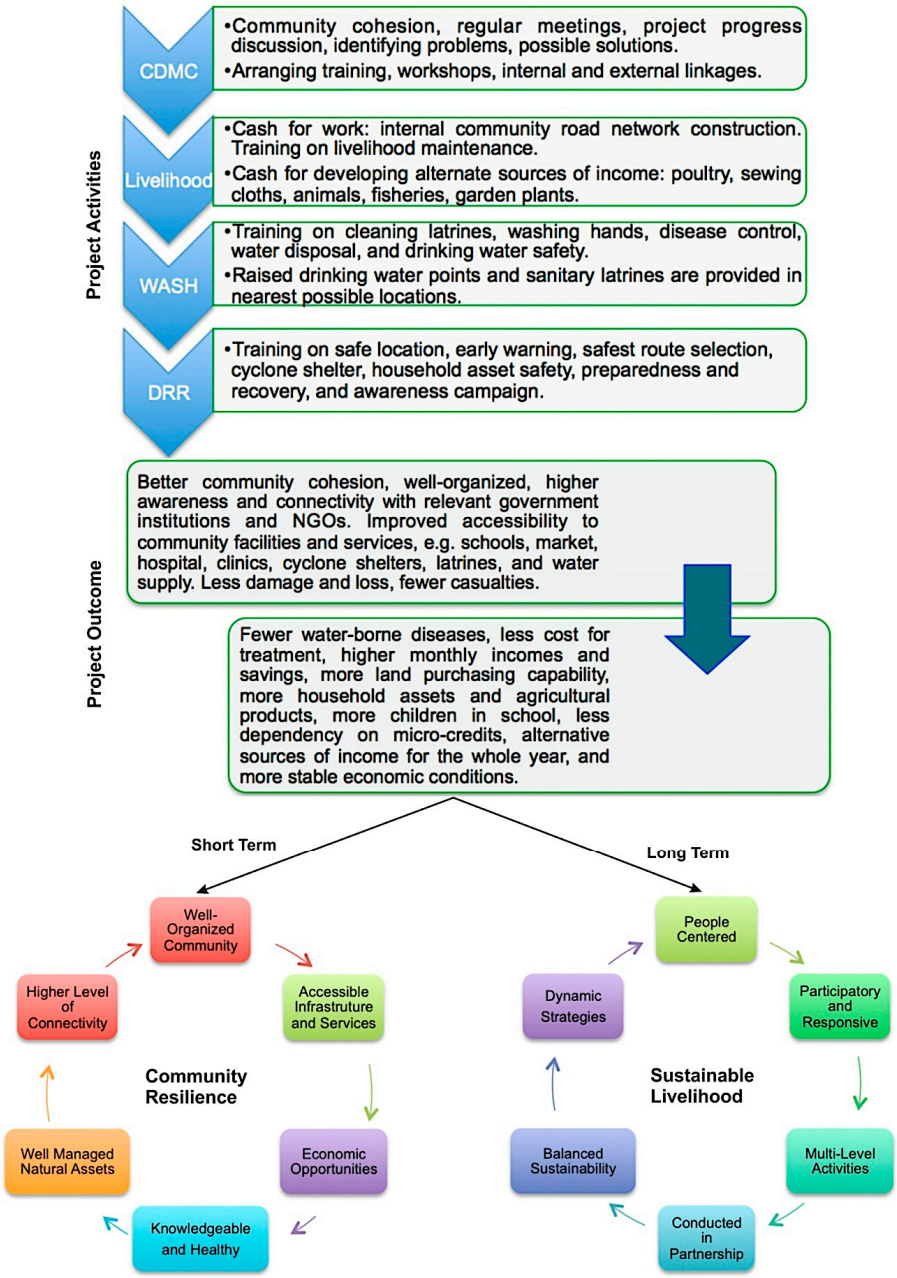

Figure 9. Flowchart of V2R's community resilience and SL impacts.

4.4. Resilience Characteristics—Field Validation

Just after the V2R project conclusion date on 30 April 2016, Cyclone Ruanu made landfall on the southern coast of Bangladesh on 21 May 2016. At least 30 people were killed and 700,000 people were affected as the storm surge and heavy rainfall (150–300 mm) damaged or destroyed around 80,000 houses and submerged paddy fields and standing crops [58,59].

The local people from the two study communities here reported that Cyclone Ruanu caused the water level to rise by 1.5–2.0 m. About 46 m of the embankment in Nowapara broke and caused high tide water to flow into the study area. It flooded some households and the vast agricultural field (Figure 10). The people managed to evacuate their households to the nearby cyclone shelters or other safer places by 8 p.m. on the day before the cyclone hit following warnings provided by the BDRCS. No deaths or injuries were reported and only a few thatched houses were destroyed, although most

houses required some minor repairs. The communities were waterlogged for several days due to heavy rainfall and flooding from the Rabnabad Channel. The high tide did not wash away the sanitary latrines or damage the tube-wells, nor did it cause harm to cattle and poultry.

Figure 10. (**a**,**b**) Flooded houses; (**c**) the broken embankment; and (**d**) inundated agricultural field in Nowapara after the Cyclone Ruanu in May 2016. Source: Md. Atiq Ullah Tusar, BDRCS-V2R Project, fieldwork, May 2016 [17].

After a few days, people returned to their houses and continued their livelihoods. The ample supply of drinking water continued, as did the usability of the sanitary latrines. As the agricultural fields were inundated by saltwater, the farmers and day labourers are not yet able to continue cultivating the land. They are instead shifting livelihoods to fishing, as this is high time (rainy season) for sea fishing. To recover from the damage, they are focusing on repairing the embankment and damaged houses while providing support for growing rain-fed lowland rice in tidal saline water.

In 1970 and 1991, cyclones of similar strength killed more than 300,000 and 100,000 people, respectively, in Bangladesh. Then, over the last decade, two cyclones of similar strength, Sidr and Aila, hit Bangladesh's coast, each killing two orders of magnitude fewer people than the earlier storms, many of whom were fishermen out at sea who did not return to land in time [59]. Damage and losses from Cyclone Ruanu were substantially less than these earlier events. It is argued that this dramatic reduction in loss of human lives was possible due to an extensive DRR programme across the coastal region of Bangladesh [59] to which V2R contributed amongst the myriad of local endeavours along the coast.

The two communities in this study have shown strong resilience characteristics through V2R supporting SL. The community people including the fishers evacuated safely before the cyclone struck, an action possible because of being highly connected to external organizations for warnings while being internally cohesive for coordinated, effective response. They received warnings in time, had completed associated training evacuating along safer routes to shelter, knew when to come back from sea while fishing, and were able to manage their properties before and after the evacuation.

Due to V2R, after the cyclone, the communities could access safe drinking water, sanitary latrines, and other community necessities. All the households now have secondary sources of income, so some temporarily shifted livelihoods while rebuilding their primary income sources. In addition, it is expected that rice cultivation will soon start again, as a crop that can withstand the salinity and monsoon along the coast is available. V2R was tested soon after it finished, demonstrating community resilience and SL through connecting with DRR.

4.5. Critical Reflection

This article covers only community resilience as defined by the V2R implementers, IFRC [25]. As per Figure 11, resilience functions at multiple levels [25] and various traits and definitions are not always fully accepted or explored in research or practice [11,24,27,60]. Local government or policies undertaken by the national government can influence resilience at individual, household and community levels. For example, delays in embankment re-building can seriously affect community resilience and community resilience building. As well, the Government of Bangladesh plans to start constructing a new seaport (the *Paira Bandar* seaport in Kalapara Upazila) at Rabnabad Channel. Therefore, some people in the two studied communities might experience forced eviction which would significantly change their livelihood patterns and undermine the work completed by V2R.

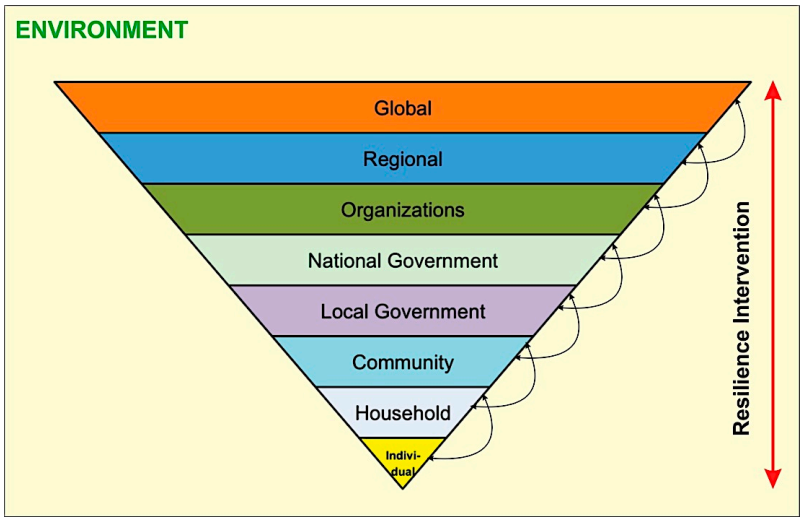

Figure 11. Resilience at multiple levels (from global to individual).

These multi-scalar processes and changes over which the communities have little control are a major limitation of V2R and IFRC's resilient community characteristics. Although far from being exclusively created externally, vulnerabilities are often imposed from outside [11–13] with little notice and little opportunity to counter them. Conversely, resiliences are not exclusively an intra-community matter, because national and international support systems are frequently assumed to exist and to be an inevitable part of a community dealing with disaster, such as remittances [61] and national social safety nets. V2R and IFRC's resilient community characteristics will not necessarily capture all such dimensions, depending how extensive the work is.

Meanwhile, other hazards and hazard drivers such as climate change, sea-level rise and tsunamis—along with social factors such as geopolitical unrest, economic recession, discrimination, inequality and corruption—continue to affect local vulnerabilities and resiliences. Although relocation is generally not preferred by the inhabitants, coastal Bangladesh will be seriously affected by climate change over the next decades, with elevated air and sea temperatures, sea-level rise, and more intense cyclones all threatening livelihoods and lives [40,62,63]. Meanwhile, a devastating earthquake could easily strike across Bangladesh at any time, even before sea-level rise's main effects are

witnessed [64,65]. In addition, population movements, geopolitical unrest, and inadequate governance have the potential to trigger various urban disasters [66–68]. Therefore, achieving community resilience through SL in rural Bangladesh can be treated as a tool for urban governance and urban resilience as well.

In fact, achieving resilience at one level does not necessarily reduce vulnerability at other levels or overall. Building resilience and reducing vulnerability are iterative processes which cross scales [11,12]. The complementarity of these actions was reflected in V2R and in the analyses, showing that vulnerability and resilience are not construed as being opposites in this work, instead expressing overlapping but different tracks of a community aiming to deal with disaster and disaster risk. Thus, the case studies and analysis here provide further empirical evidence and operational experience to overturn the viewpoint that vulnerability and resilience are opposite sides of the same coin. Despite the high vulnerabilities and multiple hazards along the coastal regions of Bangladesh, these locations also provide ample SL opportunities and demonstrate substantial resiliences [69,70]. This mixed situation suggests that focusing at the local level only could not account for the complete picture of the community's vulnerabilities and resiliences. Failure to achieve resilience at national and global levels (Figure 11) would seriously hamper activities and projects at the community level, such as V2R.

V2R and the IFRC characteristics of a resilience community do not explicitly indicate at which scales efforts should most be focused or how to balance the cross-scalar characteristics of vulnerability and resilience. V2R does provide a solid baseline for understanding local contexts to ensure that at least the local scales of vulnerability and resilience are understood and addressed. Scope exists to apply V2R at other scales and to connect scales, perhaps then realising the potential of many suggestions regarding resilience which aim to close the theory-practice gap [24,27–29].

5. Conclusions

The aim of this article was to evaluate the implementation of V2R in two coastal communities: Nowapara and Pashurbunia in Patuakhali district, Bangladesh. The three objectives of this study were met. The first objective was to measure whether the selected communities have achieved the community characteristics set out by V2R. The communities achieved the six characteristics of resilient communities as defined by IFRC [25]. The community is now well-connected with external entities, they have better infrastructure services (e.g., access to sanitation and water supply), they are economically solvent, they are working as a team (representing social cohesiveness), they are trained and have adequate knowledge to tackle the upcoming disasters and they are managing the natural assets. The second objective was to conduct a cost-benefit analysis for the V2R intervention. In almost all the scenarios, the BCR was calculated to be greater than 1. It was estimated that the V2R project would generate benefits to the communities for at least the coming decade without any serious disruption (considering the 12% discount rate which has been standard for DRR interventions, but a conclusion also emerging for a wide range of discount rates).

The third objective was to analyse V2R's impact on the communities in terms of DRR and SL. The people in the communities are now engaged with secondary livelihood activities (e.g., poultry and livestock rearing, retail business, courtyard plants, and selling home-made cloths) alongside the primary occupations (i.e., sea fishing and farming). This trend was almost absent in the past. Here, V2R used SL as the primary tool for achieving resilience in the communities, prompting DRR based on SL—exactly as the theory suggests [12,13,70].

DRR is long-term process and it is not possible to eliminate disaster risks entirely. Yet DRR can be addressed and achieved gradually, particularly through SL. By securing community SL that are not easily disrupted or damaged by various hazards, by having access to diverse resources and connections, and by ensuring proper natural resource management, DRR and SL can be linked through IFRC's characteristics of a resilient community.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BCR	Benefit-cost ratio
BDRCS	Bangladesh Red Crescent Society
BDT	Bangladeshi taka
BRC	British Red Cross
CBA	Cost-benefit analysis
CDMC	Community disaster management committee
DRR	Disaster risk reduction
FGD	Focus group discussion
GDP	Gross domestic product
IFRC	International Federation of Red Cross and Red Crescent Societies
MSL	Mean sea level
NGO	Non-government organization
SL	Sustainable livelihood
V2R	Vulnerability to resilience
WASH	Water, sanitation and hygiene

Appendix A

Table A1. Percentages generated from questionnaire surveying.

P1. Gender	**2013 (%)**	**2016 (%)**
Male	46.4	47.6
Female	44.1	45.8
No. of children (<5 years)	9.6	6.6
P2. Land ownership	**2013 (%)**	**2016 (%)**
Own house	18.9	18.9
Own house and Land	47.8	42.2
Own house with land for farming	17.8	22.2
Own house without Land	15.6	16.7
None	0.0	0.0
P3. School going pupil	**2013 (%)**	**2016 (%)**
One	72.0	66.7
Two	22.0	11.1
Three	6.0	22.2
Four or more	0.0	0.0
P4. Main earning source of HH head	**2013 (%)**	**2016 (%)**
Self-employed (business)	7.8	7.8
Agriculture/farming	16.7	17.8
Poultry rearing	0.0	0.0
Large livestock rearing	0.0	0.0
Small livestock rearing	0.0	1.1
Fishing	24.4	23.3
Handicraft	1.1	3.3
Small business	5.6	7.8
Agricultural day labour	5.6	4.4
Non-agricultural day labour	38.9	33.3
Full time paid employee	0.0	1.1
Others	0.0	0.0

Table A1. *Cont.*

P5. Secondary earning source	**2013 (%)**	**2016 (%)**
Self-employed (business)	0.0	1.1
Agriculture/farming	5.6	13.3
Poultry rearing	2.2	34.4
Cattle rearing	3.3	27.8
Fish culture	0.0	2.2
Fishing at sea/river	3.3	3.3
Handicraft	2.2	3.3
Small business	0.0	0.0
Agricultural day labour	3.3	1.1
Non-agricultural day labour	4.4	6.7
Not applicable	74.4	6.7
Others	1.1	0.0
P6. Ownership of agricultural land	**2013 (%)**	**2016 (%)**
Owned	20.0	27.0
Lease	3.3	4.0
Govt. reserved land	0.0	0.0
Mortgage	1.1	2.0
None	75.6	67.0
P7. Total value of agricultural product (in BDT)	**2013 (%)**	**2016 (%)**
0–10,001	85.7	51.7
10,001–20,000	9.5	34.5
20,001–30,000	0.0	3.4
30,001–40,000	0.0	0.0
40,001–50,000	0.0	0.0
50,001–60,000	0.0	0.0
60,001–70,000	4.8	0.0
70,001–Above	0.0	10.3
P8. No of the household asset	**2013**	**2016**
	Number (%)	**Number (%)**
Cows/buffalo	(25) 3.8	(77) 3.8
Solar panel	(15) 2.2	(65) 3.2
Goat/sheep	(37) 5.5	(86) 4.3
Chicken/duck	(523) 77.1	(1598) 80.0
Pigeon	(50) 7.4	(77) 3.8
Sewing machine	(4) 0.6	(10) 0.5
Sanitary latrine	(23) 3.4	(80) 4.0
Fisherman safety equipment	0.0	(5) 0.2
Others	0.0	0.0
Total	**678 (100)**	**1998 (100)**
P9. Total value of household asset (in BDT)	**2013**	**2016**
	Amount (%)	**Amount (%)**
Cows/Buffalo	(397,000) 36.6	(1,259,000) 36.0
Solar Panel	(374,400) 34.5	(1,305,600) 37.3
Goat/Sheep	(89,500) 8.2	(241,000) 6.9
Chickens/Ducks	(151,950) 14.0	(336,600) 9.6
Pigeon	(3,600) 0.3	(6,600) 0.2
Sewing Machine	(21,000) 1.9	(60,300) 1.7
Sanitary Latrine	(57,500) 5.3	(211,500) 6.0
Fisherman Safety Equipment	0.0	(14,500) 0.4
Others	0.0	(65,500) 1.9
Total	**1,084,950 (100)**	**3,500,600 (100)**
P10. Average monthly income (in BDT)	**2013 (%)**	**2016 (%)**
0–3,000	31.1	2.2
3,001–6,000	60.0	46.7
6,001–9,000	8.9	40.0
9,001–15,000	0.0	11.1

Table A1. *Cont.*

P11. Average monthly savings (in BDT)	2013 (%)	2016 (%)
0–500	100.0	54.4
501–1,000	0.0	32.3
1,001–1,500	0.0	0.0
1,501–2,000	0.0	13.2
P12. Where do you seek help/advice related to livelihood	**2013 (%)**	**2016 (%)**
Government line department (Agriculture, livestock, fisheries etc.)	4.4	63.3
Local vendors (seed, fertilizer, pesticides)	18.9	3.3
Trained (self)	0.0	25.6
No facility for help/advice	24.4	0.0
Don't seek help/advice	51.1	7.8
Others	1.1	0.0
P13. Do you borrow money from any micro-finance organization	**2013 (%)**	**2016 (%)**
Yes	62.3	25.0
No	37.7	75.0
P13.1. If yes, then from how many micro-finance institutions	**2013 (%)**	**2016 (%)**
One	85.4	90.9
Two	12.2	9.1
Three	2.4	0.0
Four or more	0.0	0.0
P13.2. Purpose of using the money		**2016 (%)**
Servicing debts		18.3
Investing in business		44.1
Family maintenance		24.7
Food		1.1
Education		3.2
Health		7.5
Buying non-productive asset		0.0
Others		1.1
P14. Distance to nearest water supply in dry season (m)	**2013 (%)**	**2016 (%)**
0–200	57.8	77.8
201–400	0.0	4.4
401–600	42.2	15.6
601–800	0.0	1.1
801–1,000	0.0	1.1
P15. Duration to collect water on both-ways in dry season (Minute)	**2013 (%)**	**2016 (%)**
0–4	17.8	2.2
5–10	48.9	55.6
11–15	0.0	14.4
16–20	0.0	13.3
21–25	0.0	0.0
26–30	33.3	12.2
31–35	0.0	2.2
>35	0.0	0.0
P16. Distance to nearest water supply in wet season (m)	**2013 (%)**	**2016 (%)**
0–200	57.8	78.9
201–400	42.2	4.4
401–600	0.0	14.4
601–800	0.0	2.2
801–1,000	0.0	0.0
P17. Duration to collect water on both-ways in wet season (Minute)	**2013 (%)**	**2016 (%)**
0–4	15.6	0.0
5–10	42.2	35.6
11–15	0.0	15.6
16–20	0.0	11.1
21–25	0.0	4.4
26–30	42.2	16.7
31–35	0.0	1.1
>35	0.0	15.6

Table A1. *Cont.*

P18. Problem with water supply	**2013 (%)**	**2016 (%)**
No	42.2	82.2
Travel long way to collect water	37.8	13.3
Unavailable during dry season	20.0	0.0
Water source out of order	0.0	0.0
Platform flooded by high tide or flash flood	0.00	4.44
P19. Sanitary latrine ownership	**2013 (%)**	**2016 (%)**
Yes	45.3	87.8
No	54.7	12.2
P20. Latrine cleaning frequency	**2013 (%)**	**2016 (%)**
Daily	0.0	66.7
Twice a week	4.4	19.8
Once a week	20.0	7.4
Once a month	11.1	0.0
It is clean enough	0.0	4.9
Never cleaned it	17.8	1.2
Others	46.7	0.0
P21. Household sharing a latrine	**2013 (%)**	**2016 (%)**
Yes	11.1	16.7
No	88.9	83.3
P22. Where do you dispose of your household waste?	**2013 (%)**	**2016 (%)**
Refuse pit	2.2	85.6
Bush	8.9	6.7
Burn	0.0	0.0
Bury	88.9	7.8
Others	0.0	0.0
P23. Importance of hand washing	**2013 (%)**	**2016 (%)**
Before eating	36.6	30.1
After eating	0.0	5.4
Before praying	0.0	2.0
Before breastfeeding	33.9	3.8
Before cooking	6.2	14.7
After defecation	16.1	27.8
After handling child's faeces	4.4	9.4
When my hands are dirty	2.7	4.7
After cleaning toilet	0.0	2.0
Before handling water containers	0.0	0.3
Others	0.0	0.0
P24. Ways of hand washing	**2013 (%)**	**2016 (%)**
I don't wash my hands	0.0	0.0
Water with Bar soap	28.9	93.3
Water only	71.1	0.0
Ash	0.0	6.7
Mud/sand	0.0	0.0
Others	0.0	0.0
P25. Diseases you face	**2013 (%)**	**2016 (%)**
Diarrhoea	36.7	2.2
Jaundice	0.0	2.2
Acute respiratory illness/pneumonia	20.4	5.5
Malaria	0.0	0.0
Fever	22.4	14.3
No Illness	20.4	75.8
Others	0.0	0.0

Table A1. *Cont.*

P26. First point of treatment	**2013 (%)**	**2016 (%)**
General clinic	2.2	31.1
Community health worker	4.4	0.0
Pharmacy	24.4	13.3
Private doctor	22.2	0.0
Public hospital	46.7	55.6
Mobile clinic	0.0	0.0
Nurse	0.0	0.0
Traditional healer	0.0	0.0
P27. Signs of diarrhoea	**2013 (%)**	**2016 (%)**
Dysentery	0.0	33.0
Vomits	0.0	28.0
Thirst	51.5	6.8
Sunken eyes	27.3	17.2
Dry mouth and tongue	0.0	7.7
Lethargy or loss of consciousness	1.5	6.33
Skin losing elasticity	4.6	0.4
Not able to drink	0.0	0.4
Little or no urine	0.0	0.0
Muscles cramps	1.5	0.0
Other Specify	13.6	0.0
P28. Diarrhoea measure	**2013 (%)**	**2016 (%)**
Give ORS packet	30.4	46.6
Homemade ORS with sugar, salt and water	53.6	24.3
Increased homemade fluid (thin gruel of rice, maize, potato, coconut juice)	8.7	6.9
Continue breast feeding	0.0	3.2
Zinc treatment	0.0	5.8
Take to the doctor	5.8	6.9
Rehydrate, give water	1.4	0.0
Give medicine (to stop diarrhoea, or antibiotics)	0.0	2.6
Home remedies	0.0	3.7
Others	0.0	0.0
P29. ORS preparation knowledge	**2013 (%)**	**2016 (%)**
Described correctly	80.0	88.9
Described incorrectly	20.0	11.1
P30. Source of info about health, personal and household hygiene	**2013 (%)**	**2016 (%)**
Friends and Neighbours	6.8	1.1
Community health worker/outreach workers	90.9	2.2
Clinics and hospitals	0.0	4.4
School teacher or children	2.3	0.0
Religious leaders	0.0	0.0
Mass media (TV/radio)	0.0	1.1
Newspaper	0.0	0.0
Books/posters/brochures	0.0	0.0
Water and sanitation committee	0.0	3.3
Red Crescent volunteer	0.0	86.7
No body	0.0	1.1
Others	0.0	0.0
P31. Disaster consciousness		**2016 (%)**
Great concern		98.9
Little concern		1.1
No concern		0.0
I don't know/no answer		0.0

Table A1. *Cont.*

P32. Households affected by a disaster in the past 3 years	**2016 (%)**	
Yes	88.9	
No	11.1	
P32.1. If Yes, what was the effect	**2016 (%)**	
Evacuation	4.4	
Property damage	32.6	
Agricultural products damaged	14.8	
Loss of domestic animal	26.7	
Disruption or loss of income	20.0	
Serious injury or death	0.0	
Minor injury	1.5	
Others	0.0	
P33. Household preparation	**2013 (%)**	**2016 (%)**
Identify safe shelter for family	33.3	32.8
Identify safe route to shelter	38.9	11.1
Stockpiled food in safe place	3.7	9.2
Stockpiled medicine in a safe place	0.0	1.2
Stockpiled water in a safe place	1.8	1.5
Protect important docs	7.4	5.3
Took animals to safer area	0.0	25.2
Have monetary/financial savings	0.0	4.2
Took action to protect your home	0.0	9.2
Other	0.0	0.0
Do nothing	13.0	0.4
Not sure	1.8	0.0
P34. Early warning info	**2013 (%)**	**2016 (%)**
Yes, always for all disasters	73.3	98.9
Yes, sometimes for all disasters	26.7	1.1
Yes, but only for cyclones	0.0	0.0
No	0.0	0.0
P35. How do you receive information on early warning	**2013 (%)**	**2016 (%)**
Indigenous knowledge	12.3	7.3
Existing CDMC committee	0.0	48.2
Radio	12.3	15.3
TV	21.9	1.5
Mobile phone	34.2	2.2
NGOs	9.6	0.0
Union Parishad (local govt.)	0.0	0.7
Mosque/religious leader	0.0	8.8
Cyclone preparedness program (Govt.)	9.6	16.1
Others	0.0	0.0
P36. After getting early warning	**2013 (%)**	**2016 (%)**
Cyclone shelters	55.6	73.3
Public school building	6.7	13.3
Neighbours/relatives house	11.1	0.0
Mosque/temple/church	0.0	0.0
My house is strong enough, no need to evacuate	24.4	0.0
Don't go anywhere	2.2	0.0
Killah (raised plinth)	0.0	13.3
No place to go	0.0	0.0
Others	0.0	0.0

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