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Co-Creating Community-Based Disaster Risk Reduction in Conflict Settings: Evidence from North-West Syria

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Abstract: This article examines the co-creation of a Community-Based Disaster Risk Reduction (CBDRR) framework in North-West Syria, a conflict-affected region increasingly exposed to seasonal flooding and the effects of climate change. In collaboration with the Syrian Civil Defence (White Helmets), the study combined mixed-methods risk and vulnerability analysis with a training programme for community responders between September 2024 and March 2025. Findings highlight the central role of civil society in bridging gaps between emergency response and longer-term risk reduction, particularly in contexts involving camps for internally displaced persons (IDPs). Key challenges include fragmented coordination, limited infrastructure capacity, and weak institutional memory, while opportunities emerge from strong informal early warning networks and community-level knowledge. The study contributes a scalable CBDRR framework tailored to conflict-affected settings, emphasizing early warning systems, adaptive coordination, and community-led risk governance.

Keywords: CBDRR; North-West Syria; Idlib; Aleppo; IDPs; camp management; civil defence

1. Introduction

North-West Syria represents a highly complex disaster risk environment shaped by the interaction of climate-related hazards, protracted conflict, and fragmented governance structures. In recent years, the region has experienced increasing exposure to extreme weather events, particularly seasonal flooding, while institutional capacity for disaster risk reduction (DRR) has been significantly weakened by over a decade of conflict. In such contexts, where formal state-led systems are limited or absent, civil society actors and community-based approaches may play a critical role in reducing risk and supporting preparedness, response, and recovery processes.

Between September 2024 and March 2025, the authors collaborated with the Syrian NGO the White Helmets (Syria Civil Defence) and Christian Aid to implement a combined research and training initiative across ten communities in North-West Syria. The project aimed to develop a multi-hazard and vulnerability profile, with a particular focus on pluvial flooding, while simultaneously building local capacity through a 'train-the-trainers' programme for community responders. A mixed-methods approach was employed, including household surveys, key informant interviews, climate and flood modelling, and a systematic review of academic and grey literature.

The study was conducted during a period of significant political transition. Data collection took place in late 2024, shortly before the fall of the government led by Bashar al-Assad and the establishment of an interim administration under Ahmed al-Sharaa. This shift, described as "as unexpected as it was swift" [1] (p. 22) introduces both uncertainty and potential opportunities for the development of new governance arrangements, including in the field of disaster risk management.

This paper, therefore, examines how a Community-Based Disaster Risk Reduction (CBDRR) framework can be co-developed and operationalised in a conflict-affected and institutionally fragmented setting. We utilise JC Gaillard's [2] definition of CBDRR as initiatives that "foster[s] the participation of threatened communities in the evaluation and reduction of risk (including hazards, vulnerability, capacities and resiliences)" [2] (p. 224). Gaillard goes on to highlight that CBDRR initiatives aim to empower communities with tools, programmes, and initiatives that are culturally, socially, and economically suited to the context.

Drawing on empirical findings and collaborative engagement with local actors, the study contributes both context-specific insights and a scalable approach to CBDRR in protracted crisis environments. The remainder of the article is structured as follows: Section 2 outlines the environmental and institutional context of North-West Syria and situates the study within existing literature; Section 3 describes the methodology; Section 4 presents the results and discussion, including recommendations made during the project; and Section 5 concludes.

2. Context and Conceptual Framing

North-West Syria presents a complex risk environment shaped by the interaction of climatic hazards, protracted conflict, and fragmented governance structures. In recent decades, North-West Syria has experienced an increasing frequency and intensity of climate-related disasters, including floods and heatwaves, since the year 2000, with at least 4 major flooding events, compounded by a drought and winter storm, occurring in the area since 2016 [3] (see Table 1). The Red Cross Red Crescent Climate Centre [4] characterises North-West Syria as having a climate characterised by cyclical spells of heavy rainfall and drought. The World Bank [5] also records four violent storms, two periods of intense flooding, two instances of prolonged drought, and one severe landslide between 1980 and 2020, estimating that life-threatening river floods are a one-in-ten-year occurrence.

Hydrologically the region is characterised by the watershed of the Orontes River including its two major tributaries: the Karasu/Sajur and Afrin rivers. The Orontes is heavily developed, with people in Syria using most of the water generated in its basin and use of its water is mainly governed by a transboundary water agreement, signed between Türkiye and Syria in 2002 [6]. In the 20th century, many engineering works were completed to change the course and usage of the Orontes, including the 1950 World-Bank sponsored Ghab development project that drained over 32.000 km sq of marshland to create arable farmland [7]. The river also has several dams that have serious downstream repercussions in Syria in terms of water flow rate and infrastructure inundation [8]. These historical modifications have increased both the sensitivity of the landscape to flooding and the consequences of infrastructure failure.

The study area covered a context which, in government terms, remains highly fractured. Syria was, until the beginning of the civil war, subject to a highly centralised Baathist governance regime [1]. However, as the central Syrian state became unable to govern across Syria's landmass, ad-hoc governance structures were built by (in most cases) the major military power in each locality; including local governance councils and Sharia courts, depending on the region [9]. North-West Syria's governance status during the study period was ambiguous, with various localities being governed by Turkish-backed groupings, and the Syrian Salvation Government, as well as the local governance councils mentioned earlier [2].

DRR in a conflict-affected context poses specific challenges related to the political and socio-economic pressures arising from conflict [10–12]. Conflict and associated fragility drastically reduce the coping capacity of a society [13] and there is a strong tendency towards the co-occurrence of disasters and conflicts over time [14]. There is also the risk of disasters and conflict becoming mutually reinforcing phenomena [15]. Meanwhile, DRR efforts within high-intensity conflicts are usually within the remit of humanitarian responders [11], rather than development practitioners and agencies. Whilst in many cases humanitarian responders are able to integrate some form of risk reduction programming into their response, humanitarian organisations are necessarily more often focused on immediate relief rather than longer-term risk reduction work.

In North-West Syria, responsibility for disaster risk reduction and vulnerability mitigation has largely been assumed by civil society organisations and humanitarian actors. Shortfalls in humanitarian funding relative to need have reinforced a focus on immediate response activities. At the same time, the realities of protracted crisis have led some organisations to expand their programming across the disaster cycle, an approach often described as "resilience humanitarianism" [16]. While this represents an important adaptation, such efforts remain fragmented and unevenly coordinated. Utilising "resilience humanitarianism" as a frame through which to see humanitarian governance provided an important impetus in centering people affected by overlapping disasters in NW Syria, and guiding the research team to place equal importance on the insights gleaned from affected populations as well as professional (international) humanitarian organisations. This viewpoint is an important component of looking at humanitarian governance "from below" [17], and particularly relevant to NW Syria, which during the study period

did not have unified or cohesive regional or local governance structures linked to an overarching national governance structure. Throughout the period of active hostilities between 2011 and 2024, shifting territorial control and the presence of multiple regional authorities severely constrained the development of national DRR frameworks.

Table 1. Major disasters in North-West Syria (2000–2025).

Disaster Group	Disaster Type/Detail	Location	Year/Month
Climatological	Wildfire	Latakia, Tartous, Homs	2020–Sep
Geophysical	Earthquake (6.3)		2023–Feb
Hydrological	Flood (pluvial)	Idlib and Aleppo refugee camps (NW)	2021–Jan
Geophysical	Earthquake (5.2)	NW	2023–Feb
Meteorological	Blizzard/Winter Storm	Al Qunaytirah, Aleppo, As Suweida, Damascus, Dara, Hama, Homs, Idleb provinces	2015–Jan
Hydrological	Flood (Pluvial)	Idleb, Al Hasakeh Governate	2019–Mar
Climatological	Drought	Hasakah, Aleppo, Raqqa, Deir-ez-Zor, Homs	2021–Jan
Climatological	Drought	Damascus, Homs, Hama, Raqqah, Dayr Az Zor, Hassakeh provinces	2008
Meteorological	Sand/Dust storm (100 kph)	Dayr Az Zor, Dara provinces	2001–Feb
Biological	Bacterial epidemic (Cholera)	Aleppo, Deir-ez-Zor, Ar-Raqqa, Al Hasakeh, Hama, Latakia	2022–Sep
Hydrological	Flood (Pluvial)	Aleppo and Idleb governates	2023–Mar
Transport	Water	Zarzar lake, near Damascus	2009–Mar
Meteorological	Blizzard / Winter Storm	Afrin and Azaz district (Aleppo Governate) and Harim district (Idleb Governate)	2022–Jan
Hydrological	Flood (Pluvial)	Idlib (NW)	2024–Jan
Meteorological	Sand/Dust storm	Dayr-Az-Zor, Hama, Dara provinces	2025–Sep
Meteorological	Blizzard/Winter storm (150 kph)	Damascus Province	2004–Feb
Miscellaneous accident	Collapse (Dam)	Zeyoun, Mchit, Tell Wassat, Karkour, Jisr al-Shughur, Zic Ria (Hama)	2002–Jun
Hydrological	Flood (Riverine)	Hassakeh province	2006–Oct
Geophysical	Earthquake (7.8)	Aleppo, Latakia, Hama, Harim (Idlib) Tarous, Atmeh, Sarmada, Atareb, Kafr Takharim	2023–Feb
Hydrological	Landslide (wet)	Aleppo city (Jebel Saman, Aleppo)	2002–Oct

Through highlighting the agency of affected people, as well as local and regional civil society organisations (CSOs) via this lens, the research team was able to provide recommendations and insights that can be actioned by a range of societal and governance actors. This approach also takes in elements of supporting 'self-recovery', a process where humanitarian actors aim to provide a more supporting role to facilitate affected people, often at a household level, to complete their own actions to try and improve their immediate material conditions and recovery potential. As highlighted by Raeburn-Gibson [18] in a study on NW Syria, whilst this approach can provide the foundations for a more durable post-conflict and post-disaster recovery, it also runs into several limitations including complex and fragmented land ownership records and a lack of specialist technical support for (ie) UXO disposal. The role of local government is also key, as a gatekeeper of development permits and access. These potential issues were also borne out during the research for this project, especially considering the current political flux in building local government structures under the new Syrian national government.

While this approach shares common ground with localisation agendas, which seek to shift decision-making authority and resources towards local actors, the CBDRR framework proposed here differs in its emphasis on community-led hazard identification, anticipatory action, and risk governance. Rather than focusing solely on the localisation of humanitarian delivery, the framework seeks to strengthen the capacity of communities themselves to identify, prioritise, and address disaster risks through locally embedded governance and information-sharing mechanisms

Throughout the study, the team as far as possible tried to ensure that data collection, analysis, and recommendations were informed by the relationship between gender and DRR theory. As is well-documented, women at the grassroots might tend to be subject to higher vulnerability to disasters due to lower socio-economic capital, lower access to resources and decision-making powers, and being overburdened by domestic and care responsibilities [19]. However, the role of women within risk reduction and post-disaster recovery in Taiwan highlights their agency, resilience, and role as core partners in especially CBDRR programmes [20], with a study looking at women's role in DRR programmes in Oman highlighted that a large majority of the volunteers working on DRR efforts, and especially those at a local and household level, were women [21]. The extent to which women in NW Syria will be able to play a fulsome role within CBDRR programming and risk governance structures in the future is still unknown, though the sparsity of woman candidates in recent national elections signal that the role of women in Syria's governance systems may remain marginal in the coming years [22].

Taken together, these environmental pressures and institutional constraints create a highly complex risk landscape in which traditional, state-led disaster risk reduction mechanisms are largely absent or fragmented. In this context, community-based and civil society-led approaches play a critical role in shaping preparedness, response, and recovery processes. The following section outlines the methodological approach adopted in this study to analyse these dynamics and to support the co-development of a CBDRR framework tailored to North-West Syria.

3. Materials and Methods

3.1. Geographical Area of Work

The study area was determined collaboratively by the WH and their regional teams, to encompass ten locations that had experienced persistent winter rainfall-related flooding in the past ten years. This selection was validated using internal WH programming records and the operational experience of first-response teams. The ten study locations included both formal and informally-settled IDP camps, formally settled villages and towns, and mixed contexts. The study focused on rural and semi-rural locations, and did not include the large urban population centres of Idlib city or Aleppo city (see Table 2).

Table 2. Study areas.

Khirbet al-Joz	Jindires
Atma	Qabasin
Samada	Shamarin
Batabu (Batabo)	Al-Kafr
Ahtimlat	Armanaz

The selection process prioritised locations that have consistently experienced severe flooding impacts, as well as those exposed to compounding risks from multiple hazards including extreme heat, winter storms and associated heavy rainfall. The chosen communities represent a diverse geographic and socio-economic cross-section of northwest Syria, intended to provide a broad understanding of disaster risks and vulnerabilities.

3.2. Data Collection and Analysis

A multi-method approach to data collection and analysis was employed to provide a wide range of data sources, facilitating more fulsome analysis. This included a survey with at least 15 participants from each of the selected ten communities, with selection (see below) to designed to ensure a diversity and wide range of perspectives, as summarised in Table 3. The target sample size was exceeded, with a total of 251 respondents. Prior to the survey and each key informant interview, participants completed an informed consent procedure. They were informed of the purpose of the study, the intended use of their data, their right to withdraw at any time, and how to contact the research team with any questions or concerns. The overall study gained ethical approval by Erasmus University Rotterdam. Enumerators used Kobo Toolbox software (2.024.25) to collect survey answers, and participants were selected by WH local teams in each study location, according to the below criteria.

Table 3. Survey Participant Diversity Criteria.

Group	Description	Example Participants	Target No. Responses per Area
Local Leaders & Authorities	Community leaders involved in local decision-making, traditional authorities, and informal governance	Local governance representatives, de facto authorities, village chiefs, religious leaders, community elders	1
NGO Representatives	Staff from non-governmental organisations providing humanitarian aid or disaster response. At least one should work for a local/regional organisation, and at least one should work for an iNGO	NGO field staff, program coordinators	4
IDPs and other Displaced People	Individuals or families displaced by conflict or disasters, including refugees	IDP household heads, refugees, displaced women, children	2
Local Residents	Individuals living in areas prone to floods or other disasters (regardless of displacement status)	Local business owners, laborers, unemployed individuals	6
Other Stakeholders	Additional key actors based on relevance to the study		2

To ensure diversity among survey participants, a set of criteria was applied, recognising that household composition, financial status, and adaptive capacity to annual flooding vary at the micro level [23]. These criteria

included residence in an area prone to, or affected by, disasters such as floods, droughts, heatwaves, or earthquakes; diversity in household status; inclusion of individuals from vulnerable groups, including people with disabilities and women- or child-headed households; and a non-clustering requirement, whereby participants were geographically distributed. Of the 251 responses, the majority of respondents were men, with 64% identifying as male, and a plurality aged between 30 and 49 years old (36%). A further plurality (32%) had lived in their current locality for between one and five years, reflecting the large number of internally displaced persons (IDPs) in North-West Syria.

In addition to the survey, 15 semi-structured Key Informant Interviews were conducted with professionals working in humanitarian affairs, disaster risk reduction (DRR), vulnerability reduction, and camp management in North-West Syria. Eight interviewees represented national Syrian NGOs and civil society organisations, including Programme Directors, a Livelihood Programme Manager, and Emergency Relief coordinators. Five interviewees were from international NGOs, including Camp Management team leaders and WASH Programme Managers, while two interviews were conducted with UN Cluster senior leaders in the Shelter and Early Recovery clusters. Further expert meetings were held with donors, academics, and other stakeholders to gather additional background and technical insights.

A climate modelling exercise was also conducted to identify trends in climate change, flood risk, and the potential for anticipatory action. Climate projections and hydrological modelling were derived from CMIP6 data provided by SMHI [24] and Aqueduct models from the World Resources Institute. Two climate scenarios were used: RCP 4.5, representing moderate warming of approximately 2–3 °C, and a worst-case scenario, RCP 8.5, with warming exceeding 4 °C. These scenarios are based on certain socio-economic assumptions which result in different trajectories of greenhouse gas emissions and associated warming rates. RCP8.5 represents a high-emission "worst-case" scenario, consistent with high population growth, continued exploitation of fossil fuels and high warming [25]. Meanwhile, RCP4.5 represents a medium-emission scenario, in which radiative forcing is stabilised, but the target of 2C warming above pre-industrial are missed [26]. Overall, the two scenarios were utilised to indicate a range of potential outcomes for NW Syria, However recent assessments of observed emissions trajectories note current emissions pathway lies well below RCP8.5 (slightly above RCP4.5) which has led to emerging consensus that the RCP8.5 scenario is becoming more implausible over time [27].

Forecasts from the Global Flood Awareness System (GloFAS) and the European Centre for Medium-Range Weather Forecasts Ensemble Prediction System (ECMWF-EPS) were used to anticipate river flood risks and assess probabilities over 2, 5, and 20-year periods. These projections were cross-referenced with historical flooding and rainfall-related disaster data from the EM-DAT database [3].

All data were further cross-referenced and synthesised with supplemental desk research, which systematically reviewed academic and grey literature on humanitarian disasters related to climatic hazards in North-West Syria. Grey literature and context-specific reports from the five years preceding the study were included, alongside academic literature from the preceding twenty years.

3.3. Limitations

While this study aims to provide insights into the applicability of CBDRR in conflict-affected settings, some limitations should be acknowledged. Firstly, this study relies on data collection carried out in one region of Syria and is therefore closely attuned to the socio-economic circumstances of people affected by disasters in North-West Syria. This may limit the transferability of some findings to other conflict-affected contexts with different environmental, political, or governance conditions.

Secondly, aside from the climate modelling aspect of this study, much of the data collected relies on communities' perceptions of their own risk, vulnerability, and hazard profiles, which can introduce recency or personal salience bias into the dataset. The research team recognises these potential risks; however, the approach undertaken, consistent with the resilience humanitarianism perspective [16], intentionally sought to centre affected communities' own recollections, experiences, and knowledge within the study.

A further limitation relates to the use of disaster databases such as EM-DAT. Missing data is a well-recognised challenge in studies utilising the database, as highlighted by Jones, Kharb, and Tubeuf [28]. Other limitations include the lack of consistent long-term data for the region and the reporting thresholds used by EM-DAT, which only records disasters above specific impact criteria [29]. During the course of this study, the research team sought to substantiate EM-DAT findings through first-hand accounts of disasters in North-West Syria collected during both the survey and key informant interview stages.

A more comprehensive technical assessment of institutional capacities, governance arrangements, and infrastructure resilience in North-West Syria would provide a useful complement to this study. Future research

could also explore the implementation of CBDRR approaches in collaboration with evolving national, regional, and local governance structures in Syria, as well as examine the applicability of the proposed framework in other conflict-affected settings.

4. Results and Discussion

4.1. Building a Hazard, Vulnerability, and Existing DRR Profile for NW Syria with Insights from the Survey, Interviews, Literature Review, and Climate Data

This data was synthesised to develop a multifaceted profile for NW Syria, highlighting major hazards and the impacts of climate change, the social conditions relevant for vulnerability and risk profiling, and potential avenues for (CB)DRR-related initiatives. This section highlights empirical findings from the surveys and interviews carried out, substantiated with observations gleaned from existing literature.

To characterise various hazards that are present within the region, the authors triangulated EM-DAT data with the survey responses. Considering the recency of the last large earthquake in the region (in 2023), it is perhaps unsurprising that 25% of respondents referred to earthquakes as a disaster that "generally affects this community". 22% of respondents highlighted heatwaves, with 20% noting flood-related events. A smaller but still significant 15% pointed to droughts as a regularly-presenting hazard. Considering changes to the water table and river network in NW Syria, and the high potential for climatic warming in the region, the data suggest that NW Syria is likely to experience multiple extreme heat (and knock-on events such as drought) events in the coming years. Surface-level rainfall (pluvial) flooding is more likely to occur in places that have seen significant desertification or prolonged hot and dry weather [30] and survey findings triangulated with operational data from the White Helmets, indicate that much of the annual flooding within NW Syria is rapid-onset, occurring within one day (56% of respondents). These respondents were generally paired with answers saying that rainwater flooding events most affected their community.

The most common response pattern was flooding taking place "at least once per year", this flooding being a combination of "rainwater-based" combined with "drain overflow". This also triangulates with the responses given by humanitarian and DRR professionals given during the interviews: that there is a winter 'peak' of rainfall-related flood risk. This was particularly the case for study areas where a high proportion of respondents lived in camp settings, including in Atma and Azaz—both of which have high proportions of residents living in IDP camps both formally managed and informally settled. Hazard mitigation (per interviews carried out) activities are both sparse and uncoordinated. For example, within IDP camps, the Shelter Cluster is responsible for in-camp activities including increasing flow rates for drainage, gravelling, and public safety provisions such as lighting, however the Early Recovery Cluster is responsible for rehabilitating access roads. Within formally-settled areas, a mosaic of CSOs were at work to complete hazard mitigation activities that mainly included covering culverts for drainage and weather-proofing roads through increasing drainage cambers, but all of the organisations interviewed highlighted a lack of capacity, funding, and in particular access to heavy equipment, with most requiring partnership with the White Helmets to access said equipment.

NW Syria's vulnerability to disasters, including various forms of flooding, is both wide ranging and deep-seated. The conflict-related economic crisis across Syria nationally resulted in a 54% reduction in GDP from 2010–2021 [5]. The North-West Syrian economy is strongly based in the agricultural sector, with the influence of climate change and oscillating extreme weather trends evident in the huge variances in wheat production year-on-year, whilst a longer term neglect of the agricultural sector is evidenced by crop-producing lands on the Syrian side of the border with Türkiye having an average yield of between 8.8–11.5% lower than their Turkish equivalents [5]. Furthermore, Northwest Syria's continuing drought, combined with ongoing conflict-related damage to land and infrastructure, has drastically reduced the coping capacity of the agricultural and pastoralist sectors both to changing weather patterns [31].

In terms of infrastructure, a decade of conflict has seriously damaged water infrastructure in Syria, to the extent that an estimated 1.9 billion USD needs to be spent on dam rehabilitation alone [32]. Similarly, social service infrastructure capacity has been heavily reduced due to the intersection of various hazards, with the Omran Institute [33] demonstrating the widescale destruction in Idleb and Aleppo provinces of 433 schools, 73 health facilities, and a total of 1863 buildings destroyed. This has drastically reduced the coping capacity of social service infrastructure in the region to annual shocks, for example winter flooding. At the household level, 74% of all households lacked sufficient income to meet basic needs [34], rising to 84% of woman-headed households, and 85% in IDP households, with a lack of relative economic power also linked to the volatility of the Turkish Lira; a replacement currency for many households in the region [35]. Within the survey undertaken for this project, the question "how do other disasters increase the risk of floods or worsen their impact?" had a high majority of

respondents (144/251) saying that other disasters damage critical infrastructure, demonstrating the high need for infrastructure rehabilitation in NW Syria to help mitigate water related hazards.

The high number of internally-displaced people in NW Syria is also a key component of vulnerability within the 10 communities studied for this project. The IDMC [36] estimated that of the 7.2 million internally-displaced people in Syria in 2024, 52% live in the Aleppo and Idlib governates, with extreme weather events and associated flooding causing a consistent trend of 'onward displacement'. For example, the flooding and winter storm events that took place in February 2023 triggered an estimated 9300 onward displacements [36]. it is also important to note the high number of IDP camps, and the vast differences in the organisation, built specification, and formality of these camps. The CCCM Camp Cluster estimated that more than 2 million people lived in an IDP camp in Q3, 2024, during the study period [37].

This results in significant variation in the quality of shelter and infrastructure across camps. Some camps are built on prepared ground with drainage systems, 'dignified shelters' for more, see: [38,39], and road access that is maintained during harsh winter weather. Other camps, especially those that have been informally settled, may be situated on unsuitable ground with little drainage, on exposed land increasing their vulnerability to storms, or next to rivers or on an intermittent stream/gulch that can quickly become flooded or waterlogged in heavy rain.

Whilst efforts have been made by members of the CCM Cluster to provide more 'dignified shelters', the vast majority of IDP camp residents continue to live in tents or temporary shelters, which are more vulnerable both to extreme weather, or accidents such as fires from cooking or heating [38,40]. IDP camps are often situated on land considered 'lower value', and indeed land that has not been properly prepared to host people: whether this is at a lower elevation (so more exposed to run-off water in heavy rains), on soil that has poor drainage, or in a remote area with only one access point from the nearest settlement. There are several administrative hurdles to reducing vulnerability to climatic shocks through improvement of camp infrastructure, including problems and delays with receiving permission from landowners that may be absent from their land [41].

The NW of Syria has a large number of active Civil Society Organizations (CSOs), and via the key informant interviews the authors identified a number of key themes around ongoing (CB)DRR efforts that can provide a useful basis for any future joined-up agenda. The majority of training, preparation, and risk reduction activities that have taken place have been focused on mitigating conflict-related hazards, such as airstrikes.

> *"We have a lot of good examples in terms of risk reduction activities in terms of schools. So, we have a lot of training for the teachers training for the kids. Evacuation plans, evacuation lines are also drawn on the floor for each school. Emergency kits, of course, like fire rescue [training for] teachers and first aid kits and other things. You know, this is some activities that we do in the in the schools in order to prepare for any shelling or risk or something to happen."* (Interview, 18 November 2024)

All of the organisations interviewed highlighted a significant lack of funding for DRR and disaster risk management (DRM) activities, with most funding being put towards immediate response work. The vast majority of ongoing DRR and DRM activities were also technical or physical in nature, focusing on gravelling, clearing drainage, moving tents and shelters, or road and access rehabilitation. Only two of the organisations interviewed mentioned any non-technical preparatory activities such as training, creating emergency protocols, or hazard identification. Most of the activities are also subject (due to funding shortages) to heavy prioritisation:

> *"We have levels to decide on this. The first one is it's if the impact of the flood or the area of the IDP sites are strongly impacted [by] the flood, we send our recommendation to the cluster and to the beneficiaries in living in the city besides, you have to transfer to more safe area because you will get flood during the winter. And this will strongly impact on your shelters, your children, your family. The second one: our intervention, it's, over 70% [calculated risk]. To mitigate the flood, we intervene in technical solution engineering solution for the flood. We establish a drainage channel around, sometimes around the site, sometimes inside the sides to collect, the rain and make the water not enter to the IDP side and not to affect the tents or the shelters."* (Interview, 19 November 2024)

Various interviewees also indicated that in some situations, they are able to utilise donor funding flexibility to carry out smaller ad-hoc DRM work including rehabilitating or covering drainage culverts, especially following combined fundraising calls for 'winterisation'. Two initiatives bear focus for their scalability potential: a religious and public giving-funded organisation, Molham Team, (Interview 19 November 2024) is able to consistently 'upgrade' camps that it works in via its funding flexibility: firstly, by being able to negotiate ground purchase or stable lease and setting up a basic camp, then by returning to provide basic infrastructure, 'upgrading' housing from temporary, to semi-permanent, and finally permanent dwellings. The organisation then continues by building a full spectrum of social and health facilities.

Meanwhile, World Vision (interview 20 November 2024) utilise a 'community council' model in camps that they manage, which carries out rehabilitation and development assessments. This provides a double benefit of also providing opportunities for employment for displaced people that may lack opportunity or experience boredom whilst they are living in an IDP camp. The interviewee also highlighted the high technical qualification levels of many displaced people in Syria, meaning that in many cases the proposed improvements from the 'community council' were technically sound and appropriate.

Particularly useful learnings from the interviews and survey included identifying the information streams used for early warning (or emergency alerts) within the study area, with the majority of respondents indicating that they received warnings or emergency information via social media (including WhatsApp groups), as well as by 'word of mouth', and via SMS alerts primarily used for warning of incoming military activity by CSOs such as the White Helmets/civil defence.

These informal and semi-formal information networks provide the basis for development of more comprehensive automated early warning systems for natural hazards, including annual extreme weather and flooding. The survey also revealed that there is a high degree of flood literacy at the household level within NW Syria, with 60% of respondents saying that they took some form of anticipatory mitigation action once they had heard of heavy rainfall predictions. Much of this included moving personal property to higher ground, and evacuating households to higher ground, however there were also reports of communities building 'vernacular barriers', digging extra drainage channels, or other floodwater flow management infrastructure. As mentioned, the lack of heavy equipment available to many communities limits the amount of work that can be done at a household or community level.

4.2. Carrying Out Targeted Training

As part of this project, author RM carried out a 'train the trainer' programme for 43 civil defence staff. This was split over two days, with the first day dedicated to exploring the concepts of 'Hazard', 'Risk', 'Vulnerability', 'coping capacity', and so on; and the second day an exercise into building community-level CBDRR frameworks and programmes. This exercise focused on community-owned and managed low-cost or 'frugal' interventions that could be maintained by communities without access to heavy equipment or specific technical expertise. The civil defence staff that joined the training were also in many cases affiliated to other voluntary groups, community committees, or CSO's.

The training began a programme of community-based hazard identification and mitigation training led by the civil defence staff, with the intention that each civil defence trainee then carried out a community-based training session in one of the study areas. Whilst the programme was carried out with live translation, the authors were informed after the training had taken place that the differences between 'Hazard' and 'Risk' in particular are somewhat complicated to describe in (Syrian) Arabic; and as is well documented [42], the concept of 'Vulnerability' is also very hard to translate: necessitating further explanation using diagrams and scenarios, and posing a further learning point for practitioners carrying out similar initiatives.

Although systematic monitoring of post-training outcomes was beyond the timeframe of this study, feedback from participating civil defence staff indicated strong interest in applying the training materials within their own communities and organisations. Several participants highlighted the practical relevance of community-level hazard identification and low-cost mitigation measures for areas exposed to recurrent flooding.

Carrying out a targeted training exercise as part of this project enabled the authors to triangulate professional viewpoints gleaned during interviews and expert literature with experiences of day-to-day practitioners, working at a much more local level and with an (even) stronger understanding of local specificities. It confirmed, for example, the use of early warning and coordination systems based on existing social networks, as well as the potential for expanded 'local council' governance models, that to greater and lesser extents were already in place within these social networks. It also further confirmed the high degree of technical, hydrological, and engineering knowledge present within affected communities in North-West Syria.

4.3. Climate Patterns and Modelling

Climate modelling carried out for this study emphasised several trends that require proactive management in NW Syria in the coming decades. The first is that since the1960s, the intensity, length, and frequency of heatwaves across the Eastern Mediterranean has increased and continues to do so [43], and future temperature predictions (under a worst-case scenario) will likely result in average daily temperatures increasing by between 4 and 7 degrees centigrade by the end of the century. This would likely to be associated with a 10–20% reduction in rainfall. With strong emissions reductions (RCP2.6), temperatures are predicted to rise by 1–2 degrees centigrade compared to

2023, with no strong signal of change in rainfall. Due to a general climatic heating across the Eastern Mediterranean, annual water discharge into NW Syria from surrounding countries may reduce by up to 75% [44].

There is also a high likelihood of peak summertime temperatures topping 56 degrees Celsius, and in a worst-case scenario over 50% of days annually could experience heatwave conditions [45]. Knock-on effects of this include the greater likelihood of drought conditions and a spike in groundwater abstraction, with serious challenges posed to agricultural viability. Whilst there is no strong signal for increasing overall rainfall, higher temperatures will increase moisture-holding capacity of air, exacerbating short-term heavy rainfall events. Coupled with increasing changing urbanisation, water infrastructure interventions, and changing land use, it is likely that exposure to flood risk during NW Syria's typical winter extreme rainfall season will increase. Projections suggest that, in a worst-case scenario, between 200,000 and 300,000 people will be exposed to flooding conditions by 2080.

4.4. Recommendations for a CBDRR Framework in the Short, Medium, and Long Terms

Drawing on the data collected and collaborative exchanges with partners, a set of recommendations was developed for White Helmets and other organisations in the region. The aim was to advance a more resilient and risk-informed system for better climate change and disaster preparedness. These recommendations were made assuming that the geopolitical milieu of NW Syria would not drastically change, and as such more may be possible as the new Syrian government take office and sets up regional governance mechanisms.

The recommendations are designed in a scalable manner, structured across short, medium, and long-term timeframes, with each stage building on preceding efforts. This phased approach enables the progressive strengthening of institutional capacity, coordination mechanisms, and risk reduction interventions, while allowing flexibility in response to changing contextual conditions in North-West Syria.

Short term recommendations (0–2 years) are designed to strengthen coordination mechanisms and build foundational capacity:

- Strengthening the leadership role of national civil defence organisations within response clusters, to better integrate relief and rehabilitation efforts
- Establishing a parallel, nationally coordinated CSO-led knowledge-sharing and joint planning forum
- Developing a centralised repository for community-reported flooding events, contributing to improved institutional memory
- Expanding training for community members and civil defence staff to support small-scale hazard identification and localised risk profiling
- Developing community-level heatwave action plans, in collaboration with camp management authorities and community councils, including measures such as cooling centres, secondary roof shading, and rainwater harvesting for small-scale agriculture

Medium-term recommendations (2–5 years) focus on scaling community-based approaches and improving anticipatory capacity:

- Scaling the 'community committee's model, supported by targeted training, to enable localised hazard identification and resource-constrained DRM actions
- Integrating existing conflict-related early warning systems with community reporting mechanisms to deliver geo-targeted flood warnings
- Leveraging longer-term weather forecasting and early warning systems to provide advance notice of extreme heat events

Long-term recommendations (5–10+ years) emphasise structural improvements and institutionalisation:

- Partnering with organisations with flexible funding streams to invest in drainage systems and climate-resilient infrastructure in camps and urban/semi-urban areas
- Integrating regional learning into a national CBDRR framework, including community committees, training systems, and resource-conscious interventions
- Establishing a national disaster and hazard database, incorporating recorded events and DRM actions to improve coordination and planning

The phased recommendations outlined above reflect both the constraints and opportunities identified across the study sites. While immediate actions focus on strengthening coordination and community-level capacity, medium- and longer-term measures emphasise the progressive institutionalisation of CBDRR approaches and investment in more resilient infrastructure systems. Taken together, these recommendations provide a structured pathway for transitioning from reactive disaster response towards more anticipatory and risk-informed approaches in North-West Syria.

4.5. Potential Limitations to the Recommendations

Whilst the recommendations provided as outcomes of this study are intended to provide multiple options for marginally reducing disaster risk that can be achieved at various governance levels within NW Syria, an overall DRR-programme for the region requires buy-in and action by a multitude of stakeholders. As discussed, risk reduction work within the region has historically suffered from a lack of funding, especially over the course of the active conflict. With a new Syrian national government, there are possibilities for more focused funding streams, however it is reasonable to expect multiple pressures on (regional) state budgets in the coming years. Whilst community-level planning requires only minimal funding, it does require the support of (local) government structures in fostering further CSOs and community committees. Several interviewees also highlighted the complexity and incomplete land ownership records within the region as being limiting factors to DRR work in the past, and these may continue to complicate work in the future. Finally, whilst conflict-related early warning systems are operational and have been used reliably throughout the period of active conflict, coordination and management issues may limit the speed with which they can be pivoted to provide early warning for climatic hazards.

5. Conclusions

Building resilience and reducing vulnerabilities through targeted community-based and owned DRR/M programming is complicated within conflict and fragile contexts, as evidenced by the widescale destruction and limited rehabilitation of infrastructure and governance systems in NW Syria. This study worked with a range of data sources and stakeholders to propose sustainable and community-based interventions that can try to reduce the damage and destruction caused by annual rainfall-related flooding events in Aleppo and Idlib governates in Syria, working primarily with the Syrian White Helmets and other humanitarian and civil defence organisations.

While years of conflict and a changing climate have significantly increased exposure and vulnerability, particularly among internally displaced populations, the findings also highlight several pathways for strengthening a (CB)DRR approach. North-West Syria has a dense and active civil society landscape, alongside well-established formal and informal information-sharing networks that can be leveraged to support early warning systems. In addition, high levels of technical capacity and locally embedded knowledge of hazards provide a strong foundation for community-led approaches, such as the ‘community council’ model for hazard identification and mitigation.

At present, DRR/M initiatives in the region remain fragmented and are largely focused on technical and short-term interventions. However, improved use of data, particularly meteorological information, combined with expanded training and coordination, offers significant potential to reduce exposure to climate-related hazards. The findings of this study suggest that strengthening community-based mechanisms, enhancing early warning systems, and improving coordination across actors are critical steps towards building a more coherent and effective DRR framework in North-West Syria.

Beyond its practical recommendations, this study contributes to the growing literature on disaster risk reduction in conflict-affected settings by demonstrating how CBDRR approaches can be co-produced through partnerships between civil society organisations, humanitarian actors, and affected communities. The findings also extend discussions on resilience humanitarianism by illustrating how community knowledge, informal governance structures, and locally embedded warning systems can support anticipatory and risk-informed action in contexts where formal state institutions remain fragmented. While grounded in North-West Syria, these lessons may be relevant to other protracted crisis environments facing overlapping climate and conflict-related risks.

Author Contributions

R.M., T.A. and D.M. have contributed to the conceptualisation, methodology, writing, and editing of this work. All authors have read and agreed to the published version of this manuscript.

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Institutional Review Board Statement

This study was conducted according to the guidelines of the Declaration of Helsinki, an approved by the Ethics Committee of the International Institute of Social Studies (ISS) of Erasmus University Rotterdam (EUR), with the decision number ETH2425-0221 on 24 October 2024.

Informed Consent Statement

Informed consent was obtained from each study participant prior to their participation.

Data Availability Statement

Data are contained in the article.

Conflicts of Interest

The authors declare no conflicts of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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