Reduced death rates from cyclones in Bangladesh: what more needs to be done?

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Abstract Tropical storms, such as cyclones, hurricanes and typhoons, present major threats to coastal communities. Around two million people worldwide have died and millions have been injured over the past two centuries as a result of tropical storms. Bangladesh is especially vulnerable to tropical cyclones, with around 718 000 deaths from them in the past 50 years. However, cyclone-related mortality in Bangladesh has declined by more than 100-fold over the past 40 years, from 500 000 deaths in 1970 to 4234 in 2007. The main factors responsible for these reduced fatalities and injuries are improved defensive measures, including early warning systems, cyclone shelters, evacuation plans, coastal embankments, reforestation schemes and increased awareness and communication. Although warning systems have been improved, evacuation before a cyclone remains a challenge, with major problems caused by illiteracy, lack of awareness and poor communication. Despite the potential risks of climate change and tropical storms, little empirical knowledge exists on how to develop effective strategies to reduce or mitigate the effects of cyclones. This paper summarizes the most recent data and outlines the strategy adopted in Bangladesh. It offers guidance on how similar strategies can be adopted by other countries vulnerable to tropical storms. Further research is needed to enable countries to limit the risks that cyclones present to public health.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Background

Cyclones and storm surges threaten coastal communities worldwide. The World Meteorological Organization defines a tropical cyclone as "a non-frontal synoptic scale cyclone originating over tropical or subtropical waters with organized convection and definite cyclonic surface wind circulation".[1] More specifically, a storm in the south-east Indian Ocean is cyclonic when the sustained wind speed is more than 33 nautical miles per hour (> 62 km/h). The storm surge represents a major cause of death and injury during a cyclone. A storm surge is the difference between the water level under the influence of a disturbance (storm tide) and the normal level that would have been reached in the absence of the meteorological disturbance.[2] Over the past two centuries, around two million people worldwide have died and millions have been injured as a result of tropical storms, including cyclones, hurricanes and typhoons.[3] Globally, the number of cyclones has increased more than threefold (Fig. 1) from 1970 to 2006.[4] The strength and number of major cyclones may be increasing because of higher sea surface temperatures associated with global warming.[5] Tropical cyclones and storm surges are particularly severe in the Bay of Bengal region.

We review the impact of cyclones on health and livelihoods in Bangladesh, in light of the progress made and the challenges that remain. We explore cyclone-related severity and death in Bangladesh over the past 50 years, and discuss the experiences of other cyclone-afflicted countries. We also consider how we can learn from international experience to reduce the adverse health impacts of natural disasters. Finally, we recommend mitigation and adaptation strategies, and future research needs.

Cyclones in Bangladesh

Bangladesh is especially vulnerable to cyclones because of its location at the triangular shaped head of the Bay of Bengal,[6] the sea-level geography of its coastal area, its high population density and the lack of coastal protection systems. During the pre-monsoon (April–May) or post-monsoon (October–November) seasons, cyclones frequently hit the coastal regions of Bangladesh. About 40% of the total global storm surges are recorded in Bangladesh,[7] and the deadliest cyclones in the past 50 years, in terms of deaths and casualties, are those that have struck Bangladesh.[8]

The number and severity of cyclones in Bangladesh and the associated mortalities have varied greatly during the past 50 years (Table 1). The two deadliest cyclones occurred in 1970 and 1991, with > 500 000 and almost 140 000 deaths, respectively. However, during the past 20 years, Bangladesh has managed to reduce deaths and injuries from cyclones. For example, the most recent severe cyclone of 2007 caused 4234 deaths, a 100-fold reduction compared with the devastating 1970 cyclone.

In addition to the immediate death and suffering caused by such disasters, cyclones also have direct and indirect impacts on general public health, livelihoods, infrastructure, the economy and sociocultural foundations. They can affect access to food and drinking water, and increase the transmission risks of infectious diseases, such as diarrhoea, hepatitis, malaria, dengue, pneumonia, eye infections and skin diseases,[12] thus contributing to the interruption of livelihoods. Surface water, the main source of drinking water in coastal regions of Bangladesh, becomes contaminated by saline intrusion and poor sanitation systems.[13,14] Open latrines and poor sanitation are common in rural Bangladesh and coastal areas, and cyclones

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Fig. 1. **Frequency of cyclones in the world**[4]

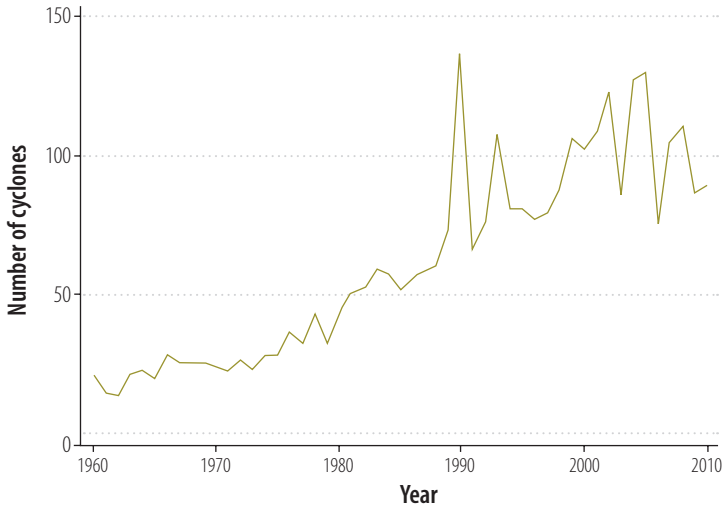

Table 1. **Cyclone severity and deaths in Bangladesh 1960–2010**[9–11]

Year	Number of death	Wind speed	Severity index
1960	8 119	210	5
1961	11 466	146	5
1963	11 520	203	5
1964	196	NA	NA
1965	20 152	210	5
1966	850	146	5
1969	75	NA	NA
1970	500 300	223	6
1973	183	122	5
1974	50	162	5
1985	11 069	154	5
1986	12	100	4
1988	9 590	162	5
1989	573	NA	NA
1990	132	102	4
1991	138 958	225	6
1994	170	200	5
1995	172	100	4
1996	545	70	3
1997	410	225	6
1998	233	112	4
2007	4 234	250	6
2008	15	80	3
2009	197	95	4

NA, not available.

make this situation worse.[13] The lack of safe drinking water may be the most important cause of the spread of waterborne diseases after a cyclone. Other causes are through indirect impacts such as damaged infrastructure, population displacement, reduced food production and the release of contaminants into the water (e.g. from storage and waste disposal sites). Childhood malnutrition is already a serious issue in Bangladesh, and the loss of crops and reduced access to fish compounds the problem. Indirect health-related impacts, such as increased suicide and crime rates, and adverse pregnancy outcomes, are clearly associated with cyclones.[15] These tend to increase in the post-disaster period, as a result of post-traumatic stress and depression. Literacy rates are low and poor knowledge of environmental health issues creates additional problems following a cyclone.

Progress and challenges

In the past 50 years, Bangladesh has learnt how to adapt to recurrent cyclones and has succeeded in significantly reducing cyclone-related deaths. This has been achieved by modernizing early warning systems, developing shelters and evacuation plans, constructing coastal embankments, maintaining and improving coastal forest cover and raising awareness at the community level.

Cyclone preparedness has improved following the launch of the Cyclone Preparedness Programme by the Bangladesh Red Crescent Society in 1970. The programme's goal is to minimize the loss of lives and property in cyclonic disasters by strengthening and developing disaster preparedness and response capacity in coastal communities, and by increasing the effectiveness of volunteers. The programme's activities include: disseminating cyclone warning signals issued by the Bangladesh Meteorological Department through an extensive telecommunication network; providing and assisting in first aid, rescue, relief and rehabilitation operations; and coordinating and building community capacity, disaster management and development activities. The Bangladesh Disaster Management Bureau also issues cyclone alerts through the national media as soon as a cyclone is detected by environmental satellites. The Bangladesh Meteorological Department has three radar stations in Dhaka, Khepupara and Cox's Bazar that transmit minute-by-minute weather updates.[16] The Department also receives information from the National Oceanic and Atmospheric Administration in the United States of America (USA) and from a Japanese satellite via the Bangladesh Space Research and Remote Sensing Organization.[16] The effective early warning system provided by the government in advance of Cyclone Sidr in 2007 enabled the successful evacuation of coastal communities resulting in fewer than expected deaths. Initia-

tives at central and local governmental, nongovernmental and community levels seem to be key for success in minimizing cyclone-related mortality.

Apart from early warning systems, other measures such as cyclone shelters and coastal embankments have contributed to reducing death rates in Bangladesh. Prior to 2007, the country had 1500 shelters, each capable of offering refuge to up to 5000 people in coastal districts. After Cyclone Sidr, the Bangladesh government initiated the construction of 2000 new cyclone shelters in 15 low-lying coastal districts, but the number and location of shelters remain inadequate for the population.[15] Bangladesh has more than 700 km of coastline. Since 1960 a series of embankments have been constructed to protect coastal regions, including around 4000 km of coastal embankments surrounding the Bay of Bengal and offshore islands.[17] Coastal vegetation was found to be protective during Cyclone Sidr when mangrove forests saved the south-western part of Bangladesh and, during a different storm, reduced the death toll from a cyclone in India in 1999.[18] Reforestation of approximately 1200 km^2 of mangrove forests in Bangladesh has been carried out to mitigate cyclone risk.[19] Under the Cyclone Preparedness Programme, Bangladesh has implemented awareness campaigns to disseminate information about cyclone warning signals and preparedness measures, using meetings, discussions, posters, leaflets, film shows and demonstration performances.[20] Although there is currently no scientific evidence regarding the precise impact of shelters, coastal embankments or awareness programmes on cyclone-related mortality, they appear to have saved millions of lives. Continued technological advances will increase preparedness and help mitigate the effect of cyclones in Bangladesh.

Despite improvements in warning systems, pre-cyclone evacuation remains a challenge. Illiteracy, lack of awareness and communication problems mean that some people do not understand or follow the warnings. Instead of moving to cyclone shelters, people in coastal areas often still believe in a wait-and-see approach.[21,22] Fear of property loss and previous false warnings also limit the numbers who evacuate to shelters.[21] Others refuse to evacuate because of the poor condition of the public cyclone shelters, attributes of the warning message, individual perceptions and beliefs, including thinking that their house can withstand a cyclone.[22] Building structures of concrete or brick prevent human loss, as people who shelter in such structures generally survive, while the death rate can be double in populations without access to sturdy shelters.[22] Maintenance of and access to cyclone shelters are important factors in enabling people to quickly find adequate protection. For example, only two out of every five shelters were usable during the 1991 cyclone, because of flooding.[23] People also had lack of access to shelters during Cyclone Sidr in 2007.

Dissemination of warning messages presents another challenge as most residents in coastal areas of Bangladesh have no access to radio or television. Some Bangladeshis rely on natural warning signs, such as unusual animal behaviour and weather and ocean patterns, to prepare for the impacts of a cyclone,[23] however these signs may be unreliable and inconsistent. In remote areas, the use of megaphones by volunteers (more than 20 000 during cyclone alerts)[22] is not always reliable due to wind direction affecting sound transmission, and batteries for megaphones and microphones may not be locally available. Significantly, households with radios had lower death rates during cyclones than those without radios.[22]

Experiences from other countries

By examining the impacts of and responses to cyclones in other countries, we can improve our understanding of effective strategies for preventing the loss of life. Cuba has significantly improved its pre- and post-cyclone early warning and evacuation systems and health services and has introduced a cyclone preparedness programme for primary school children. Universal education and the eradication of illiteracy are important to improve awareness of the risks associated with hurricanes and the understanding of government warnings. Cuba also has a population with a very high level of civil participation and a comprehensive primary health care system.[24]

In early May 2008, Cyclone Nargis struck Myanmar with sea surges and wind speeds > 200 km/h; more than 140 000 people died or were presumed dead and almost 2.4 million people were seriously affected.[25,26] There was an international warning of the approaching Cyclone Nargis several days before its landing, but poor dissemination of information and lack of governmental responsibility were thought to have contributed to the outcome. Local authorities and populations were not proactive in their planning and response. No information on cyclone shelters in Myanmar had been published before the cyclone, and there was a lack of awareness and political will and a poor health infrastructure. Private organizations had to quickly decide how to become involved in relief distribution, with some organizations taking on relief work as a completely new task. There were delays in evacuating people and the international community was not allowed to access the most affected areas. A lack of boats also contributed to the problem. Interestingly, however, emergency projects after Cyclone Nargis opened up the way for peace building efforts in areas that had previously been difficult to access by the international community.[27]

In February 2011, Cyclone Yasi hit Queensland, Australia. The cyclone was 500 km wide with an eye of 100 km in diameter and 285 km/h wind speeds. Local and district disaster management committees initiated their disaster management plans in advance. The media played a vital role in informing the public about weather events, assistance and evacuation locations. Evacuation, including hospitals, was completed more than four hours before the cyclone struck. Aircraft were prepared for evacuations after the cyclone. Considering the magnitude of its destruction capability, not a single person died as a direct result of the cyclone. This was achieved through thorough preparedness and early warning systems.[28]

Even with public warnings before Hurricane Katrina in the USA, two-thirds of the more than 1800 fatalities were reportedly caused by drowning as a result of cyclone-related storm surges and floods.[29] The early evacuation of 1589 people from New Orleans to Oklahoma was done based on the results of a rapid needs assessment.[30] Due to the successful coordinated evacuation of hospitals in the city of New Orleans, no patient deaths or injuries were reported.[31]

Outbreaks of cholera, diarrhoea, malaria and dengue have been common after cyclones in India and in several African and Central American countries.[32–36] Careful preparation for epidemics before the arrival of a cyclone is important to ensure a rapid response and control of outbreaks. Along with high death rates, the Philippines has experienced outbreaks of leptospirosis infection caused by coastal flooding after typhoons.[37] Basic hygiene kits were distributed to affected communities following the typhoon to reduce waterborne disease. Early warning systems and evacuation programmes have recently improved, and better coordination of relief efforts was also reported to have reduced typhoon-related health injuries and increased relief distribution. In October 2010, the early evacuation of 3066 people before Typhoon Megi saved lives.[38]

Cyclones are also responsible for many indirect traumas and mental disorders in different parts of the world. A high incidence (30.6%) of post-traumatic stress disorder was reported after a cyclone that struck India in 1999,[39] and a high prevalence of post-traumatic stress disorder and major depressive symptoms have also been reported following cyclones in India, Nicaragua, Sri Lanka and the USA.[40–44] These mental-health problems might have long-term impacts on health. However, these issues have so far been neglected in Bangladesh because of limited resources and poor health infrastructure. Post-disaster psychological care services should be developed including: screening of affected populations; prioritizing interventions on the basis of risk assessment; providing trauma/grief-focused interventions; and monitoring recovery.

Cyclone-prone countries should consider investing in the construction of coastal embankments and reforestation programmes, as Bangladesh and other countries have done. Awareness-building programmes and learning from previous cyclones have saved lives in Bangladesh.

Although observational evidence from previous years does not show a clear trend in the number of tropical cyclones occurring, climate change is likely to cause an increase in the intensity of tropical storms.[45] It is crucial that countries that experience regular cyclones consider the Bangladeshi experience to minimize the loss of human lives.

Conclusions

Instead of developing large cyclone shelters, a dense network of small, sturdy and safe multipurpose buildings should be developed. Considering the population density, cyclone shelters should be established within a 2 km walking distance of households and villages. Geographic Information Systems and remote sensing technology should be used to determine the best locations in terms of factors such as access, road networks and population density. Schools, mosques, local government buildings or other locations where people congregate represent potential locations for these shelters. This should be given the highest priority in cyclone-preparedness programmes.

Bangladesh is now fully covered by mobile telecommunication networks; distributing cyclone warning messages via mobile phones is thus a good option. Colourful hot air balloons can be used to convey cyclone-warning messages in remote and coastal areas of Bangladesh.

The potential for the breakdown of water and sanitation systems during a cyclone should be considered carefully in the planning, design and implementation of future housing developments. This will help prevent vector- and waterborne disease outbreaks.

Initiatives to collect and store drinking water should also be considered. Harvesting rain water during a cyclone can be an option.

Coastal embankment projects should be extended to all coastal areas. Existing embankments should be repaired and maintained. Careful planning with sufficient sluice gates, especially in the south-eastern area of Bangladesh, will protect against both flash floods and storm surges during a cyclone,[46] and will also help protect cropland, fisheries and livestock.

Operational research should be conducted on the precise impacts of cyclone shelters, coastal embankments and awareness programmes on cyclone-related mortality. Additionally, research should be conducted on how to reduce drowning-related deaths during floods caused by cyclones.

The development of a 500 metre coastal mangrove forest zone will further reduce the vulnerability to cyclones, which is especially important given the likelihood of a rise in sea level and an increase in tropical storm frequency and strength due to climate change.[47]

Based on the elevation of houses/residential areas in relation to nearby streams, maps of areas at high risk of flooding can be prepared to use during evacuations ahead of cyclone-related coastal surges.

Planners, policy-makers and development practitioners should endeavour to incorporate local knowledge into environmental and adaptation strategies. The building code in coastal zones should be changed to ensure that concrete houses are raised 3 metres off the ground. More broadly, a more compact development style may be recommended.

To increase people's awareness of the severity of cyclone hazards, the Bangladesh government and nongovernmental organizations should further strengthen the existing awareness programme and initiate educational campaigns in coastal districts to ensure prompt use of public shelters during cyclones. Awareness should focus on public health and hygiene issues. The awareness programme could target primary school children, following the Cuban model, which represents an excellent example for Bangladesh. Some operational research should be conducted in this regard.

People's misconceptions about the strength of their houses, a lack of interest in moving to a cyclone shelter and other potential risk factors should be identified through qualitative research. The design and delivery of community cyclone-preparedness education should be based on these research findings. Community-based volunteer intervention programmes should be introduced without further delay.

Cyclone-related loss in terms of economic and human capital is exacerbated by poverty and poor infrastructure in coastal areas of Bangladesh. Donor agencies, politicians and planners in Bangladesh should take this into account in future planning of coastal zones.

Industrialized countries and newly emerging industrialized countries should provide financial support to vulnerable countries to help them adapt to and mitigate cyclone-related risks. At the same time, all countries should reduce their emissions of carbon dioxide and other greenhouse gases. ■

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الملخص

انخفاض معدلات الوفيات الناجمة عن الأعاصير في بنغلاديش: ما المزيد الذي يمكننا القيام به؟

تشكل العواصف المدارية، مثل الأعاصير الحلزونية، والأعاصير المصحوبة بأمطار، والزوابع تهديداً جسيماً لسكان المجتمعات الساحلية. وقد لقي حوالي مليوني شخص حتفهم، وتعرض الملايين للإصابات طوال القرنين الماضيين نتيجة للعواصف المدارية. وتعد بنغلاديش على وجه الخصوص سريعة التأثر بالأعاصير الحلزونية المدارية، حيث وقعت فيها 718000 وفاة في الخمسين سنة الماضية. إلا أن الوفيات الناجمة عن الأعاصير الحلزونية في بنغلاديش تراجعت بمقدار يفوق مئة ضعف خلال الأربعين سنة الماضية، فقد تراجعت من 500000 وفاة عام 1970 إلى 4234 وفاة عام 2007. والعوامل الرئيسية المسؤولة عن انخفاض الوفيات والإصابات هي تحسن مستوى التدابير الدفاعية، وذلك يشتمل على نظم الإنذار المبكر، وملاجئ للحماية من الأعاصير الحلزونية، وخطط الإخلاء السكاني، وإقامة السدود الساحلية، ومخططات إعادة زراعة الغابات، وزيادة الوعي والاتصالات. وبالرغم من تحسن نظم الإنذار المبكر، إلا أن إخلاء السكان قبل حدوث الأعاصير الحلزونية مازال يُعد تحدياً، يزيده صعوبة المشاكل الكبرى كالجهل، وقلة الوعي، وسوء الاتصالات. وبالرغم من إدراك كم المخاطر المحتملة للتغير المناخي والعواصف المدارية، لا يوجد سوى القليل من المعارف العملية حول كيفية إعداد الاستراتيجيات الفعالة للحد والتخفيف من تأثيرات الأعاصير الحلزونية. وتلخص هذه الورقة العلمية أحدث المعطيات وتستعرض الاستراتيجية التي تبنتها بنغلاديش. وتقدم الورقة توجيهاً حول استراتيجيات مماثلة يمكن تبنيها من قبل البلدان الأخرى السريعة التأثر بالعواصف المدارية للحد من مخاطر الأعاصير الحلزونية على الصحة العمومية.

摘要

孟加拉国气旋死亡率降低:还需做些什么?

诸如气旋、飓风和台风等热带风暴是沿海社区面临的主要威胁。在过去的两个世纪里,世界上约有两百万人因热带风暴死亡,数百万人受伤。孟加拉国特别容易受到热带气旋的攻击,在过去的五十年里约有718,000例因气旋造成的死亡。然而,在过去的四十年里,孟加拉国与气旋相关的死亡率已经下降了一百多倍,从1970年的500,000例死亡下降到2007年的4,234例。死亡和受伤人数减少的主要原因是改进防御措施,包括预警系统、气旋避难所、疏散计划、沿海堤防、重新造林方案以及提高认识和增加交流。尽管警报系统已经得到改善,但气旋发生之前的疏散仍然是一个挑战,主要问题在于无知、缺乏认识和沟通不畅。尽管有气候变化和热带风暴的潜在风险,但如何制定有效战略以减少或减轻气旋影响的经验知识仍然很少。本文总结了最新数据并概述了孟加拉国采取的战略。旨在为容易受到热带风暴攻击的其他国家采取何种战略提供指导。对于如何使各国能够限定气旋对公众健康影响的风险,尚需进一步研究。

Résumé

Les taux de mortalité liés au passage de cyclones sont en diminution au Bangladesh: quelles mesures supplémentaires envisager?

Les tempêtes tropicales, comme les cyclones, ouragans et typhons, constituent une menace majeure pour les populations côtières. Près de deux millions de personnes dans le monde ont trouvé la mort et des millions d'autres ont été blessées à cause du passage de tempêtes tropicales au cours des deux siècles derniers. Le Bangladesh est tout particulièrement vulnérable aux cyclones, ces derniers ayant causé 718 000 décès au cours des 50 dernières années. La mortalité liée aux cyclones au Bangladesh a toutefois été divisée par plus de cent au cours des 40 dernières années, passant de 500 000 décès en 1970 à 4234 en 2007. Les principaux facteurs de cette diminution du nombre des personnes décédées ou blessées sont de meilleures mesures de défense, notamment les systèmes d'alerte rapide, des abris capables de résister aux cyclones, les plans d'évacuation, les digues littorales, les programmes de reboisement et une sensibilisation et une communication accrues. Bien que les systèmes d'alerte aient été améliorés, évacuer avant un cyclone demeure un défi. D'importants problèmes résultant en effet de l'analphabétisme, du manque de sensibilisation et d'une mauvaise communication. Malgré les risques potentiels liés aux changements climatiques et aux tempêtes tropicales, il existe peu de connaissances empiriques sur le développement de stratégies efficaces réduisant ou atténuant les effets des cyclones. Le présent document résume les données les plus récentes, et présente la stratégie adoptée au Bangladesh. Il donne des indications sur la façon dont des stratégies similaires peuvent être adoptées dans d'autres pays vulnérables aux tempêtes tropicales. Des recherches supplémentaires sont nécessaires afin de permettre aux pays de limiter les risques que les cyclones font courir à la santé publique.

Резюме

Снижение смертности от циклонов в Бангладеш: что еще нужно сделать?

Тропические бури – циклоны, ураганы и тайфуны – являются серьезной угрозой для прибрежных общин. За последние двести лет около двух миллионов человек погибли, и миллионы получили травмы в результате тропических бурь. Бангладеш особенно уязвима перед тропическими циклонами: за последние 50 лет они унесли жизни около 718 тыс. человек. Тем не менее,

в этой стране за последние 40 лет смертность, связанная с циклонами, снизилась более чем в 100 раз – с 500 тыс. смертных случаев в 1970 году до 4 234 в 2007 году. Основными факторами, способствовавшими этому снижению смертности и травматизма, являются: улучшение мер защиты, включая системы раннего оповещения, сооружение укрытий от циклонов, планы эвакуации, возведение набережных, схемы лесовосстановления, повышение информированности и улучшение связи. Хотя системы оповещения были усовершенствованы, эвакуация населения до начала стихийного бедствия остается вызовом и осложняется серьезными проблемами, обусловленными неграмотностью, слабой информированностью и плохой связью. Несмотря на потенциальный риск тропических бурь и изменения климата, имеется мало практического опыта в области разработки эффективных стратегий сокращения или ограничения воздействия циклонов. В этой статье обобщаются новейшие данные и излагаются основные положения стратегии, применяемой в Бангладеш. Предложены рекомендации по применению аналогичных стратегий в других странах, уязвимых перед тропическими бурями. Необходимы дальнейшие исследования, чтобы дать возможность странам ограничить создаваемый циклонами риск для общественного здоровья.

Resumen

Tras la reducción de las tasas de mortalidad por ciclones en Bangladesh: ¿qué otras acciones son necesarias?

Las tormentas tropicales, como los ciclones, huracanes y tifones, suponen una amenaza importante para las comunidades costeras. Durante los dos últimos siglos, unos dos millones de personas de todo el mundo han perdido la vida y varios millones han resultado heridas como resultado de las tormentas tropicales. Bangladesh es especialmente vulnerable a los ciclones tropicales, causantes de aproximadamente 718 000 muertes en los últimos 50 años. No obstante, la mortalidad relacionada con los ciclones en Bangladesh se ha reducido más de cien veces en los últimos 40 años, pasando de 500 000 muertes en 1970 a 4234 en 2007. Entre los principales factores que han contribuido a esta reducción en el número de muertes y heridos se encuentran unas mejores medidas defensivas, incluyendo los sistemas de alarma anticipada, los refugios anticiclónicos, los planes de evacuación, los muros de contención costeros, los esquemas de reforestación y el aumento de la concienciación y la comunicación. Aunque los sistemas de alarma han mejorado, la evacuación antes de un ciclón sigue constituyendo todo un reto cuyos mayores problemas son el desconocimiento, la falta de concienciación y las dificultades en la comunicación. A pesar de los riesgos potenciales del cambio climático y de las tormentas tropicales, existen pocos conocimientos empíricos sobre cómo desarrollar estrategias eficaces para reducir o mitigar los efectos de los ciclones. Este documento resume los datos más recientes y describe la estrategia adoptada en Bangladesh. Además, proporciona orientación sobre cómo otros países vulnerables a las tormentas tropicales pueden adoptar estrategias similares. Es necesario seguir investigando para permitir que los países limiten los riesgos que los ciclones suponen para la salud general.

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