POLICY BRIEF

Extreme Weather and the Role of Early Warning Systems in Yemen:

Al-Mahra as a Case Study

By Musaed Aklan

August 2, 2023

SANA'A
CENTER FOR STRATEGIC STUDIES
مركز صنعاء للدراسات الاستراتيجية

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Cover photo: The Al-Hawf Nature Reserve in Al-Mahra governorate on July 2021 / / Sana'a Center photo by Ahmed Waqqas.

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The Sana'a Center for Strategic Studies is an independent think-tank that seeks to foster change through knowledge production with a focus on Yemen and the surrounding region. The Center's publications and programs, offered in both Arabic and English, cover political, social, economic and security related developments, aiming to impact policy locally, regionally, and internationally.

Executive Summary

Yemen's growing vulnerability to extreme weather events due to climate change is increasingly evident throughout the country. Al-Mahra, Yemen's easternmost governorate, has witnessed an increasing number of climate-change-related natural disasters over the past eight years, including tropical cyclones and flash floods, which have led to losses of lives and livelihoods.

Based on a survey with 183 respondents, as well as interviews and focus group discussions with specialists, officials, and community members, this policy brief investigates the impact of extreme weather events on communities in Al-Mahra and the effects on lives, homes, and economic activity, including in the agriculture and fisheries industries. The findings reveal that Al-Mahra currently lacks a cohesive infrastructure against natural disasters, jeopardizing the lives of vulnerable communities whose livelihoods are increasingly at risk as climate change causes more frequent, extreme, and unpredictable weather.

Early warning systems have the potential to counter the effects of extreme weather by gathering observations and forecasts, providing warnings to citizens, highlighting the risks of such events and aiding authorities in planning and responding to them. While the governor of Al-Mahra sought to establish an early warning system in 2022, it remains inactive. This policy brief advocates practical recommendations for mitigating the impacts of extreme weather events in Yemen, including activating an early warning system in Al-Mahra, and strengthening the resilience of local communities to natural disasters.

Introduction

"Countries that develop policy legislative and institutional frameworks for disaster risk reduction and that are able to develop and track progress through specific and measurable indicators have a greater capacity to manage risks and to achieve widespread consensus for, engagement in, and compliance with disaster risk reduction measures across all sectors of society." [1]

In the past two decades, Yemen has experienced growing susceptibility to disasters arising from extreme weather events. Rapid population growth, unregulated urbanization, insufficient environmental regulations coupled with vulnerable populations living in areas of high risk, have resulted in an increased likelihood of calamity resulting from natural disasters, the effects of which are further exacerbated by Yemen's almost decade-long war and its ensuant humanitarian crisis.

Al-Mahra is one of Yemen's most affected governorates by climate change-related natural disasters. Open to both the Arabian Sea and the Indian Ocean, the governorate is vulnerable to extreme weather events and has witnessed a number of natural disasters in recent years. Tropical cyclones Chapala and Megh in 2015 and Sagar, Mekunu, and Luban in 2018, are just some examples of extreme climatic events that have caused the loss of both lives and livelihoods.

This policy brief investigates environmental challenges in recent years, and details local communities' responses and the prevailing government and institutional arrangements in place to react to extreme weather events, and identifies community priorities for an early warning system. It concludes with a set of recommendations for the relevant authorities and organizations on how to activate an early warning system in Al-Mahra.

[1] Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters," United Nations Office for Disaster Risk Reduction, World Conference on Disaster Reduction, Kobe, Hyogo, Japan, January 18-22, 2005, https://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf

Research Methodology

Study Area

Located in the easternmost part of the country, Al-Mahra governorate (Fig. 1) is bordered by Oman to the east, Saudi Arabia to the north, Hadramawt governorate to the west, and the Arabian Sea to the south. With an area of 67,300 square km, it is the second largest governorate in the country and boasts a coastline extending 560 km, the longest of all governorates in Yemen. Al-Mahra has nine districts, with the main urban centers located in coastal areas, including the capital city of Al-Ghaydah.[2] With coastal plains in the south, mountainous terrain with seasonal streams in the middle, and the desert of the Empty Quarter in the north,[3] Al-Mahra's climate is generally hot and dry, characterized by low rainfall and seasonal monsoons, with temperatures averaging around 30°Celsius throughout the year.[4] Al-Mahra's population, including internally displaced persons (IDPs), is estimated at 650,000,[5] with the majority living in Al-Ghaydah and coastal towns along the Arabian Sea.

Al-Mahra's economy is largely based on agriculture, fishing, livestock husbandry, and small-scale trade with neighboring Oman. Economic activities such as beekeeping, fishing, and subsistence farming are common in Al-Mahra but increasingly vulnerable livelihoods. Raising goats, sheep, cattle, and camels is essential for the Bedouins and other communities living in inland areas. However, limited arable land and scarce water resources restrict other agricultural activities. Some grains, fruits, and vegetables are grown locally. Customs revenues from border crossings with Oman also contribute to its economy.[6]

[2] Anwar Noaman, "Yemen Environmental Bulletin: The Need for Climate Change Preparedness in Al-Mahra," Sana'a Center for Strategic Studies, March 1, 2021, https://sanaacenter.org/publications/main-publications/13271

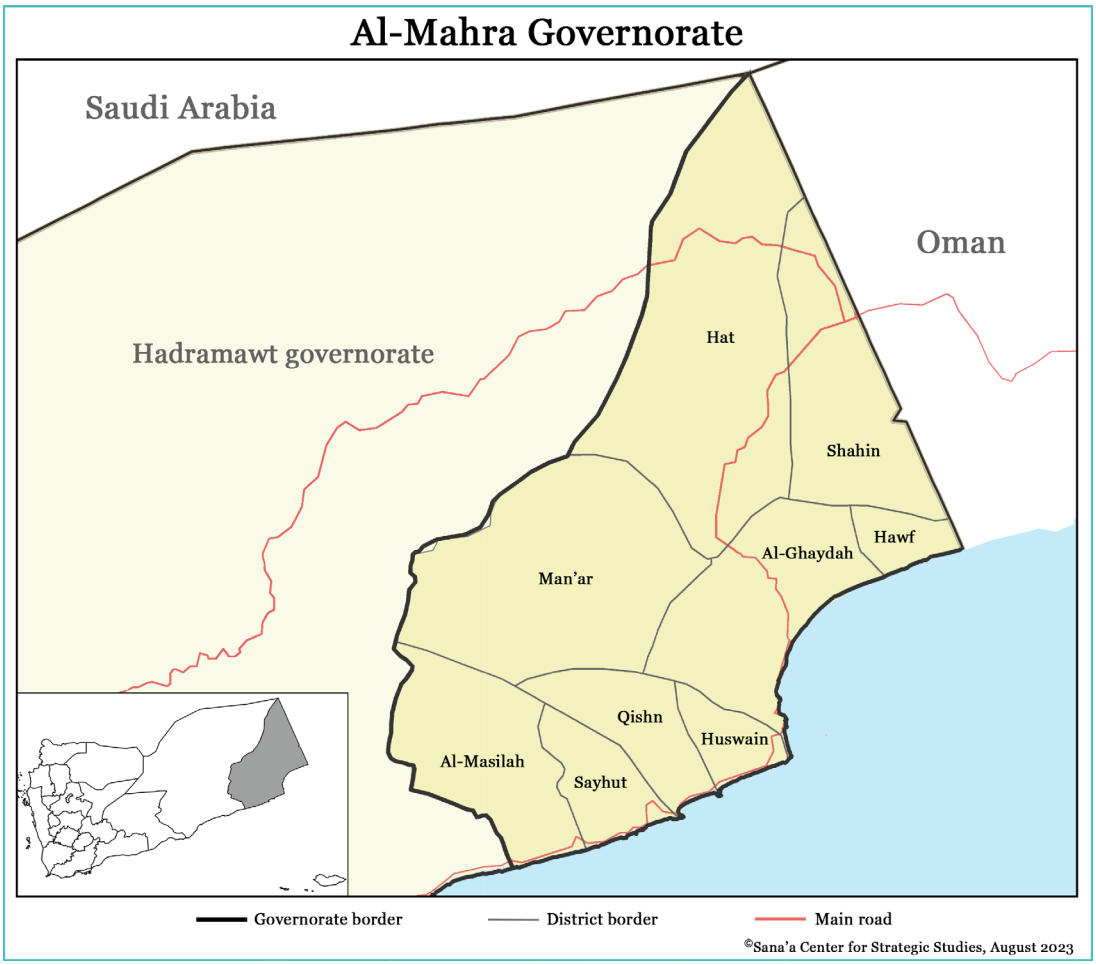
[3] Yahya al-Sewari, "Yemen's Al-Mahra: From Isolation to the Eye of a Geopolitical Storm," Sana'a Center For Strategic Studies, July 5, 2019, https://sanaacenter.org/publications/analysis/7606

[4] Anwar Noaman, "Yemen Environmental Bulletin: The Need for Climate Change Preparedness in Al-Mahra," Sana'a Center for Strategic Studies, March 1, 2021, https://sanaacenter.org/publications/main-publications/13271

[5] Yahya al-Sewari, "Yemen's Al-Mahra: From Isolation to the Eye of a Geopolitical Storm," Sana'a Center For Strategic Studies, July 5, 2019, https://sanaacenter.org/publications/analysis/7606

[6] Ibid.

Fig.1



With the advent of war and the ensuing political crisis in Yemen, Al-Mahra's economic activity underwent a shift. The conflict caused many workers to migrate from Al-Mahra, while Oman implemented flexible border policies, allowing Mahris to trade and transport goods across the border. To ensure border security, Muscat also provided development and relief aid to the population of Al-Mahra.[7] The local authorities were also able to ensure oil imports and sales could resume, providing revenues to the local authority via taxes. Overall, Al-Mahra has relied on its strategic location and close relations with Oman to sustain economic life throughout the war.[8]

Data Collection

This policy brief relies on an online survey conducted with 183 respondents from Al-Mahra governorate, complimented by a desk review, interviews, and two focus group discussions with specialists, officials, and community leaders that took place before and after the survey was done.

[7] Ahmed Nagi, "Oman's Boiling Yemeni Border" Malcolm H. Kerr Carnegie Middle East Center/Italian Institute For International Political Studies, March 22, 2019, https://carnegie-mec.org/2019/03/22/oman-s-boiling-yemeni-border-pub-78668

[8] Yahya al-Sewari, "Yemen's Al-Mahra: From Isolation to the Eye of a Geopolitical Storm," Sana'a Center For Strategic Studies, July 5, 2019, https://sanaacenter.org/publications/analysis/7606

Conducted in April and May 2023, the survey was carried out using voluntary response sampling and comprised ranking, likert scale ratings, probing, multiple choice, and open-ended and closed-ended questions. The respondents (90 men, 91 women, two undisclosed),[9] were asked about their experience in confronting extreme climate events, in addition to that of their communities and the local authorities. Questions also addressed the need, willingness, and challenges envisioned in adopting an early warning system in Al-Mahra.

One-on-one interviews were also conducted with specialists, officials, climate change activists, and community members. To analyze the data, both quantitative and qualitative analyses were used, including rated scales, weighted values, and high-impact versus no-impact analyses. This triangulation of quantitative and qualitative findings and contextual details provided a robust analysis that helped understand the scope and depth of the impact of extreme weather on Al-Mahra communities and their early warning system needs.

[9] In terms of age breakdown, the majority of respondents were between 26-35 years old (42.5 percent), followed by 18-25 years old (26.5 percent). The proportion of respondents generally declined with age beyond that, with 22.7 percent 36-45 years old, 6.1 percent aged 46-55 years old, and only 2.2 percent over 55 years old. Nearly half of the respondents had received university-level or higher education at (47.5 percent); middle or high school education represented 38.1 percent; technical institute education or a diploma after high school accounted for 13.8 percent; and 0.6 percent described themselves as able to "read and write" only.

Yemen's Environmental Predicament

> *"Yemen is living proof of the apocalyptic equation: conflicts and food insecurity go hand in hand, and when there is an overlap between climate change and conflict, famine is already on the horizon."* [10]

Located in the southwestern part of the Arabian Peninsula, Yemen's climate is influenced by factors such as the Intertropical Convergence Zone, the Red Sea Convergence Zone, anticyclones, local wind systems, as well as diverse geographical terrains, the complex interplay of which generates a climate defined by variability, ranging from torrid desert conditions to seasonal monsoonal precipitation. These natural systems, however, are now being perturbed by anthropogenic global climate change. Over the past half-century, temperatures in Yemen have risen by an average of 1.8°C, with the potential for a further 3.3°C increase by 2060.[11] This rise in temperature has been accompanied by an increase in extreme weather events such as cyclones, heavy rains, and floods. Increasing temperatures, drought, alterations in precipitation patterns, and intensifying meteorological extremes imperil Yemen's climatic equilibrium, putting it at a heightened risk of climate change.

Yemen stands today among the world's most vulnerable nations to climate change, with its effects increasingly evident throughout the country, exacerbated by an almost decade-long war.[12] With its high prevalence of poverty and food insecurity, where 43 percent of the population live in chronic poverty and 32 percent are food insecure,[13] Yemen is also poorly prepared for the effects of climate change.[14] The conflict has further hindered the country's ability to manage natural resources and be climate ready in terms of governance and economic prosperity, further compromising the health, safety, and education of its people, particularly women and young girls.[15]

[10] José Graziano da Silva, Director-General of the Food and Agriculture Organization of the United Nations (FAO), "Briefing to UN Permanent Representatives in New York on food security, migration," FAO, November 6, 2018, https://www.fao.org/news/story/en/item/1164334/icode/

[11] "Risking the Future: Climate Change, Environmental Destruction and Conflict in Yemen," Center for Civilians in Conflict, October 4, 2022, https://civiliansinconflict.org/risking-the-future-climate-change-environmental-destruction-and-conflict-in-yemen/

[12] "Yemen Socio-Economic Update," Ministry of Planning and International Cooperation, Economic Studies & Forecasting Department, October 2022, https://reliefweb.int/report/yemen/yemen-socio-economic-update-issue-76-october-2022-enar; Helen Lackner, "Climate Change and Conflict in Hadramawt and Al Mahra," Berghof Foundation, December 21, 2021, https://berghof-foundation.org/library/climate-change-and-conflict-in-hadhramawt

[13] "Climate Change Profile in Yemen," Ministry of Foreign Affairs, Government of the Netherlands, February 5, 2019, https://www.government.nl/documents/publications/2019/02/05/climate-change-profiles

[14] "Risking the Future: Climate Change, Environmental Destruction and Conflict in Yemen," Center for Civilians in Conflict, October 4, 2022, https://civiliansinconflict.org/risking-the-future-climate-change-environmental-destruction-and-conflict-in-yemen/

[15] According to the UN, 80 percent of people displaced by climate change are women. Displaced women are more vulnerable to sexual violence and also run the risk of trafficking and forced marriage. "Climate Change Exacerbates Violence Against Women and Girls," Office of the United Nations High Commissioner for Human Rights, July 12, 2022, https://www.ohchr.org/en/stories/2022/07/climate-change-exacerbates-violence-against-women-and-girls

Flash Floods

Of all the natural disasters faced annually in Yemen, floods pose the greatest threat.[16] Rainfall in Yemen is sparse, intense, and comes in short bursts, causing flash floods that in turn wreak havoc, destroying farmlands and other property, and causing loss of life.[17] Serious flooding occurred in 1986 and 1999, and devastating floods in 2008 ravaged parts of the country in the worst natural disaster in a decade. In Hadramawt and Al-Mahra, the flooding caused 73 deaths and 17 missing persons, displaced 25,000 people, and completely destroyed or partly damaged 6,500 houses. Agricultural damage in affected governorates included 22,902 acres of cultivated land and 51,455 acres of uncultivated land. Irrigation and infrastructure were significantly impacted, and 58,500 livestock (sheep, goats, camels, cattle) were killed.[18] It is estimated that over 50 percent of the population in affected areas of Hadramawt and Al-Mahra felt an impact on their livelihoods.[19] The economic costs of the flood-induced damage in 2008 amounted to 6 percent of GDP (US$1.638 billion),[20] and increased the national poverty rate from 28 to 51 percent.[21]

Over 300,000 people in 2020 and at least 240,000 in 2021 were affected by heavy rains and unexpected flash floods, leaving widespread damage to infrastructure including homes, shelters, roads, bridges, and irrigation facilities.[22] The summer of 2022 again witnessed heavy rains and flooding, and in June of that year alone, floods affected over 41,000 people in Al-Dhalea, Hudaydah, Hadramawt, Hajjah, and Taiz governorates.[23] The impact of the flooding on sanitation systems led to the spread of diseases including cholera, dengue fever, malaria, and diphtheria. [24]

Several models project higher rainfall levels for Yemen in the future, thus potentially increasing the frequency and severity of floods. The greater variability in rainfall patterns will also likely impact food security due to the increasing severity of floods and droughts.[25]

[16] "Climate Change Profile in Yemen," Ministry of Foreign Affairs, Government of the Netherlands, February 5, 2019, https://www.government.nl/documents/publications/2019/02/05/climate-change-profiles

[17]"Risking the Future: Climate Change, Environmental Destruction and Conflict in Yemen," Center for Civilians and Conflict, October 4, 2022, https://civiliansinconflict.org/risking-the-future-climate-change-environmental-destruction-and-conflict-in-yemen/

[18] "Cyclone Chapala Disaster Risk Reduction Situation Report," PreventionWeb and UNISDR, November 4, 2015, https://www.preventionweb.net/files/46530_pwsitrep20154cyclonechapala.pdf; Anwar Noaman, "Yemen Environmental Bulletin: The Need for Climate Change Preparedness in Al-Mahra," Sana'a Center for Strategic Studies, March 1, 2021, https://sanaacenter.org/publications/main-publications/13271

[19] "Damage, Losses, and Needs Assessment. October 2009 Tropical Storm and Floods. Hadramout and Al-Mahra, Republic of Yemen," A Joint Assessment of the Government of Yemen, the World Bank, the United Nations International Strategy for Disaster Reduction and the International Federation of the Red Cross and Red Crescent Societies, January 2009, https://www.preventionweb.net/publication/damage-losses-and-needs-assessment-october-2008-tropical-storm-and-floods-hadramout-and

[20] "Climate Change Profile in Yemen," Dutch Ministry of Foreign Affairs, February 5, 2019, https://www.government.nl/documents/publications/2019/02/05/climate-change-profiles

[21] "Disaster Risk - Poverty Trends in Jordan, Syria, Yemen: Key Findings and Policy Recommendations," UNISDR Regional Office for the Arab States, Cairo, May 2012, https://www.unisdr.org/files/27853_arabriskpovertypolicynotejuly2012.pdf

[22] "Yemen Socio-Economic Update," Yemen Ministry of Planning & International Cooperation, Economic Studies & Forecasting Department, Issue 76, October 2022, https://reliefweb.int/report/yemen/yemen-socio-economic-update-issue-76-october-2022-enar

[23] "Risking the Future: Climate Change, Environmental Destruction and Conflict in Yemen," Center for Civilians in Conflict, October 4, 2022, https://civiliansinconflict.org/risking-the-future-climate-change-environmental-destruction-and-conflict-in-yemen/

[24] "Yemen Socio-Economic Update," Yemen Ministry of Planning & International Cooperation, Economic Studies & Forecasting, Issue 76, October 2022, https://reliefweb.int/report/yemen/yemen-socio-economic-update-issue-76-october-2022-enar

[25] "Climate Change Profile in Yemen," Dutch Ministry of Foreign Affairs, February 5, 2019, https://www.government.nl/documents/publications/2019/02/05/climate-change-profiles

Cyclones

Cyclones have become more frequent in recent years and their impact is largely concentrated in southern Yemen. In November 2015, cyclones Chapala and Megh hit Yemen within a week of each other. Chapala was the strongest cyclone on record to hit the Arabian Peninsula, bringing torrential rain that caused flash floods and landslides. The severe flooding damaged homes primarily in four governorates: Hadramawt, Shabwa, Socotra, and Al-Mahra. In Al-Mahra, health facilities in the main towns of Sayhut, Qishn, Al-Ghaydah, Al-Masila, and Haswayn sustained significant damage.[26] The cyclone resulted in the displacement of over 40,000 people living in coastal areas of central-eastern Yemen, claiming the lives of eight people, including three in Socotra, where 100 people were also injured.[27]

In 2018, three cyclones hit Al-Mahra – Sagar, Mekunu, and Luban. Cyclone Mekunu sank boats in Al-Ghaydah and Al-Ebri, and damaged homes and public buildings, including the Surfait port office and schools in Huswain and Khawlah. It also destroyed telecommunications towers and agricultural equipment. Cyclone Luban (Fig. 2), killed eight people, injured 33, left nine people missing, and caused extensive damage to properties, farmlands, livestock, fishing equipment, and infrastructure (roads, bridges, and powerlines to coastal districts). Over 3,000 households were displaced from Al-Masila, Sayhut, Qishn, Huswain, and Al-Ghaydah.[28] A preliminary assessment report submitted by a ministerial committee assessing the impact of the damage caused by Cyclone Luban in Al-Mahra estimated the losses and damage costs at US$700 million.[29] Cyclones will continue to pose an ongoing threat to Yemen's already vulnerable population, depriving them of livelihoods, damaging their homes and properties, and disrupting basic services, exacerbating the already dire humanitarian crisis caused by war.

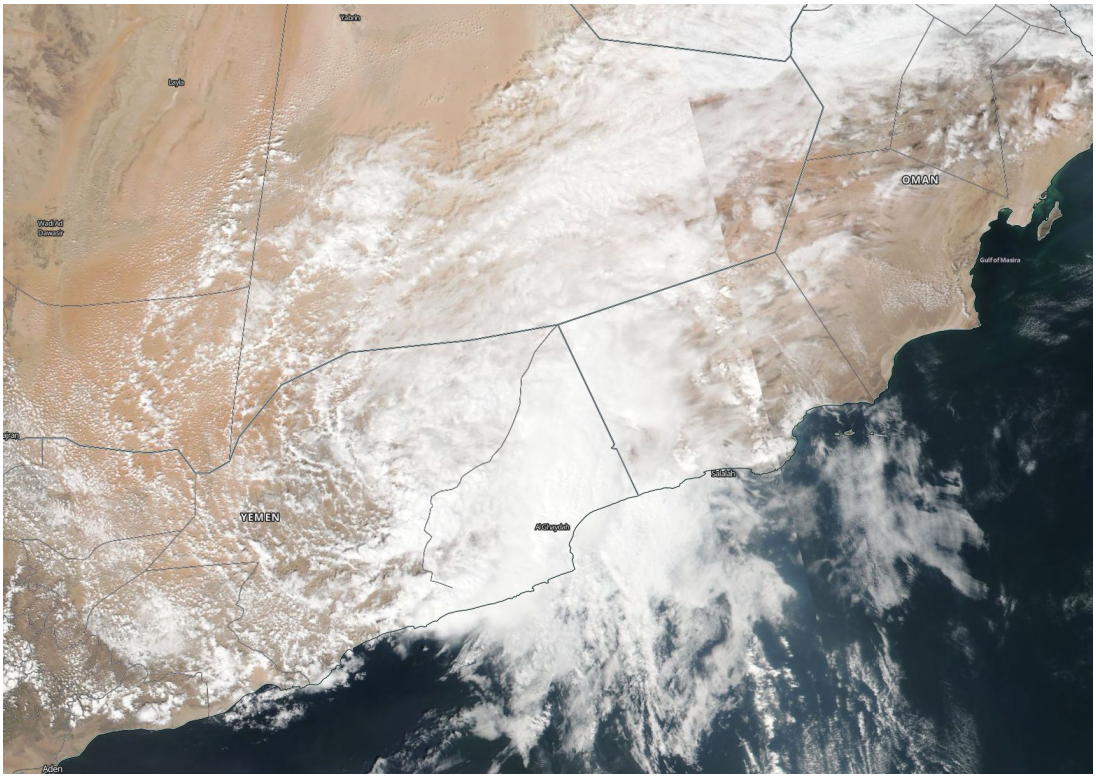
[26] Anwar Noaman, "Yemen Environmental Bulletin: The Need for Climate Change Preparedness in Al-Mahra," Sana'a Center for Strategic Studies, March 1, 2021, https://sanaacenter.org/publications/main-publications/13271

[27] "Cyclone Chapala Disaster Risk Reduction Situation Report," PreventionWeb and UNISDR, November 4, 2015, https://www.preventionweb.net/files/46530_pwsitrep20154cyclonechapala.pdf

[28] "Yemen: Cyclone Luban Flash Update Number 2," United Nations Office for the Coordination of Humanitarian Affairs, October 17, 2018, https://reliefweb.int/sites/reliefweb.int/files/resources/Cyclone%20Luban%20Flash%20Update%202.pdf

[29] According to a Yemeni official assessment report submitted by the ministerial committee for surveying and listing the impact of Luban in Al-Mahra governorate in 2018, no compensation had been paid except for the provision of shelter (tents) and food baskets.

Fig.2: Tropical Cyclone Luban[30]



Global Call for Early Warning Systems

As climate change causes more frequent, extreme, and unpredictable weather, early warning systems support communities in countering its effects by better preparing citizens, highlighting coming risks, gathering observations and forecasts, and aiding authorities in planning and responding to climatic events. Effective early warning systems rely on monitoring technologies, predictive modeling, and physical safeguarding, making use of satellite monitoring and weather stations. These systems utilize a number of different approaches that are adaptable and consider the local context, including the infrastructure in place. Communication channels might include mobile alerts, broadcasts, designating warning officers, the use of megaphones or microphones in mosques, as well as other alternative channels where communication infrastructure is limited or in areas with low technology adoption. Advancements in forecasting have now enabled accurate predictions of weather phenomena and their potential impact. At-risk areas can, for instance, install drainage systems, flood and coastal barriers, and evacuation routes to mitigate loss of life and damage to property. More importantly, early warning systems empower communities to avoid crises, reduce harm, and build resilience against extreme weather events by equipping citizens with the knowledge, and the authorities with the means, to mobilize decisively against hazards.

The World Meteorological Organization notes that investing in early warning services and supporting infrastructure yields high returns. It estimates that a total of US$1.5 billion needs to be invested over the next five years to improve the quality of these services and related infrastructures, particularly in developing nations.[31]

[30] NASA Worldview, Earth Observing System Data and Information System (EOSDIS)/NOAA, https://blogs.nasa.gov/hurricanes/tag/luban-2018/

[31] Lottie Limb, "Early Warning Systems Will Protect Everyone On Earth in 5 Years, UN Announces," Euro News Green, March 29, 2022, https://www.euronews.com/green/2022/03/23/early-warning-systems-will-protect-everyone-on-earth-in-5-years-un-announces

The United Nations concurs, noting that enhancing early warning systems amounts to only 50 cents per capita annually. Countries with inadequate early warning systems, notes the UN, suffer disaster mortality up to eight times higher than those with EWS coverage, a stark improvement. In developing countries like Yemen, the mortality rate from catastrophic events is immense relative to more developed countries due to underdeveloped early warning capabilities.[32] Upgrading monitoring technologies, forecasting models, and warning dissemination in vulnerable developing countries could cost around €800 million per year and avoid €3-16 billion in losses, according to the Global Commission on Adaptation.[33] Continued progress in early warning systems promises to limit loss of life and damage to property in the face of growing environmental challenges. In the context of Al-Mahra, the ability to anticipate and avoid crises through early warning systems has the potential to build security and adaptation of its community to a destabilizing climate – at a fraction of the cost of failed response and recovery.

[32] Joshua Askew, "COP27: New UN Early Warning System Could Save Billions and Many Lives," Euro News Green, November 7, 2022, https://www.euronews.com/green/2022/11/07/cop27-new-un-early-warning-system-could-save-billions-and-many-lives

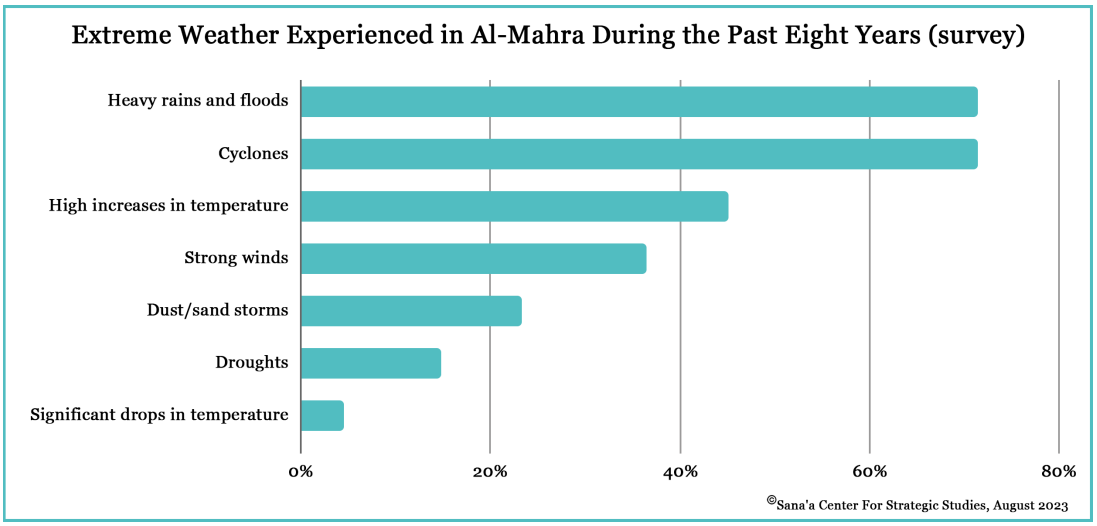
[33] Ibid.

Findings and Discussions

The Impact of Extreme Weather Events on Mahris' Lives

Citizens in Al-Mahra have faced increasing environmental challenges that have directly impacted their lives. In a survey on extreme weather in the governorate over the past eight years, respondents cited heavy rains and floods (71.4 percent) and cyclones (71.4 percent) as having a significant impact on their lives (Fig. 3). Some 45.1 percent cited a high increases in temperature, signaling a warming trend in the governorate. A significant number of respondents also reported experiencing strong winds (36.6 percent) and nearly one quarter (23.4 percent) witnessed dust and sand storms, echoing studies suggesting the region is vulnerable to desertification and land degradation.[34]

Fig.3



Respondents described the direct impact of extreme weather on their lives as "moderate", but the impact on their homes and properties was rated "high" and "very high", with 33 percent and 25 percent respectively **Fig. 4.** Participants noted that many homes, especially in valleys, including Wadi al-Masila, Wadi al-Jazaa in Al-Ghaydah, and Wadi Ghaboori in Qishn, were completely or partially damaged by extreme weather.

Communities in Al-Mahra rely heavily on agriculture and fishing,[35] both of which have been affected by extreme weather, with the highest impact being on farmland. Some 56 percent of survey participants rated the impact on farmland as "very high". Damage to agricultural land, especially for communities that are reliant on farming, has far-reaching consequences for stability, food security, and livelihood. Respondents noted how climatic events washed away many agricultural lands in Al-Ghaydah, Ma'nar, and Al-Masila.

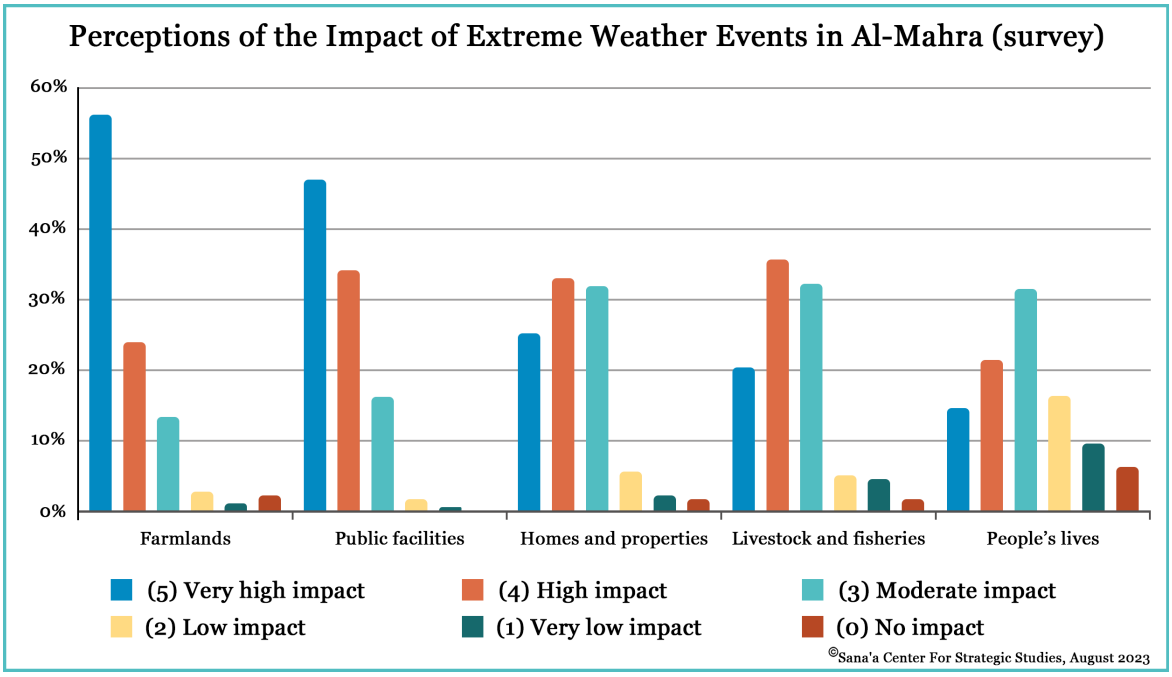
[34] Helen Lackner, "Climate Change and Conflict in Hadramawt and Al-Mahra," Berghof Foundation, December 21, 2021, https://berghof-foundation.org/library/climate-change-and-conflict-in-hadhramawt

[35] 40 percent of the estimated 250,000 tons of fish caught annually in Yemen reportedly comes from Al-Mahra; "Economy of Yemen", Fanack (Chronicle of the Middle East and North Africa), June 21, 2020, https://fanack.com/yemen/economy-of-yemen/

Livestock and fishery resources have also been affected by climate events, with 36 percent and 32 percent of respondents rating the impact as "high" or "very high", respectively. Cyclones have caused damage to fishing boats, equipment, infrastructure, and ports, resulting in a loss of income for fishing communities and making it difficult for fishermen to access the sea. Additionally, cyclones and heavy rainfall have caused flooding in several towns, including those on the coast, damaging fishing facilities.

Second highest, after farmlands, came the impact on public facilities, such as roads, water and electricity infrastructure, and health and education facilities. Some 47 percent of respondents rated the impact as "very high", and 34 percent rated it as "high", noting how climatic events over the past years disrupted the functioning of public facilities, making it difficult for people to access essential public services. Given that damaged infrastructure disrupts the delivery of essential services while hindering recovery efforts, respondents voiced the need for better infrastructure in Al-Mahra, such as better roads and improved drainage systems, to better deal with climate events.

Fig.4



Responses to Climatic Events at the Community and Local Government Level

The findings from both the survey and interviews reveal that Al-Mahra lacks pre-established local protocols or defined measures to face climate disasters. When asked about the common response to extreme weather events, the majority of respondents said it was "spontaneous and unorganized". The second most common approach was to "seek help from community members", while "contacting local authorities" was the last resort chosen by the survey participants. Some respondents felt that precautions were taken by the authorities during extreme weather events, which included the establishment of emergency response teams, setting up committees to respond to tropical storms and cyclones, including responsibility for the provision of shelter locations for residents, and clearing of drainage systems. But others noted that responses from official authorities were typically late, inadequate, did not cover all affected areas, and did not reach those most in need.

Respondents were found to be aware of the risks involved in building in flood-prone areas and willing to take measures to reduce those risks. Many expressed the view that building in locations far from flood channels is the most effective means for avoiding or mitigating the damage that comes from extreme weather events, in addition to evacuating to safe areas and stockpiling food and water. Respondents stressed that the government authorities should provide emergency shelters (69.1 percent), supplies of food and water (75.3 percent), and build outlets for flood waters (77.8 percent). Additionally, 65.4 percent of respondents indicated that medical assistance should be provided by government authorities during and after extreme weather events, especially in areas where there may be limited medical infrastructure.

To better support communities during and after extreme weather events, survey respondents also suggested that the authorities should develop an early warning system and emergency response plans; build infrastructure such as flood walls and sea barriers; educate the public about climate risks and ways to reduce them; provide aid and compensation to those impacted; establish trained and well-equipped rescue teams; involve the community in planning and implementation; and improve waste management practices to prevent environmental degradation. These measures would ensure effective disaster management and provide immediate and long-term assistance.

Institutional Frameworks in Place for Disaster Risk Reduction

Presently, the local authority, local councils, and Civil Defense Authority in Al-Mahra are responsible for coordinating relevant climate information and alerts. These, in turn, rely primarily on the Aviation Authority office in the governorate, which extracts information from aviation authorities in Sana'a and Aden. In parallel, a number of amateur weather enthusiasts active on social media share news, in addition to information coming in from local authorities in Hadramawt and Oman.

The governor of Al-Mahra sought to establish an early warning system unit in 2022 (as per government decree no. 15), composed of a representative of the Meteorological Department of the Ministry of Transporation and two representatives from the Civil Defense Authority and the Joint Operations office, a governmental body attached to the Al-Mahra local authority. However, despite receiving some training and equipment from the World Food Programme (WFP), it has yet to become active.

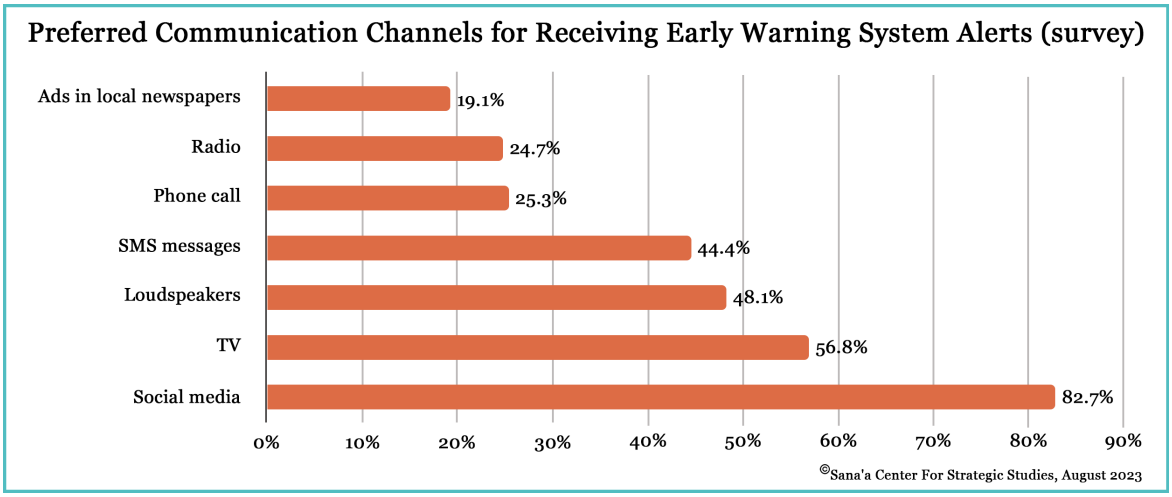
Respondents noted that warnings come from multiple sources, are often inconsistent, and are issued only during the occurrence of a natural disaster, which does not allow for sufficient time to prepare for the impact of extreme weather events. According to the respondents, there is currently no single official authority that is primarily responsible for handling data or issuing early warnings. Generally, there is limited public awareness and education regarding climate disasters in Al-Mahra. Nearly 60 percent of the respondents had no prior knowledge about early warning systems for extreme weather events and only 22 percent of respondents had received training on how to prepare for such events despite the governorate's susceptibility.

The Community Perspective on an Early Warning System

Across the board, participants in the study categorically agreed on the need to establish an early warning system in Al-Mahra, describing it as a way of safeguarding human lives, minimizing material damages and losses, and preserving the environment and natural resources. The response shows an awareness among Mahri communities of the interdependence of environmental, social, and economic factors in addressing climate change.

When asked about the desired means of receiving alerts from early warning systems, social media was selected by 82.7 percent of respondents. TV was the second most popular response (56.8 percent), followed by the use of loudspeakers, such as those on mosques (48.1 percent), followed by SMS messages (44.4 percent). Thus, a multi-channel approach for early warning alerts may be the most effective way of reaching Al-Mahra's diverse and widespread population. Only 24.7 percent of respondents selected radio, and 19.1 percent selected newspaper ads (Fig. 5), indicating that traditional media channels are likely less accessible and effective channels for reaching communities in Al-Mahra. However, the results could also reflect the age of survey participants, the majority of whom are younger and have better access to communication technologies.

Fig. 5



Other suggestions included developing neighborhood committees to disseminate information among communities; using influential community figures to disseminate information and build trust; improving the capacity stations capable of monitoring weather patterns at Al-Ghaydah International Airport, the agriculture center in Al-Ghaydah, and the weather station in Hawf; using other official communication channels to reach the community (press releases, news reports, newsletters, official websites); and activating the role of specialized authorities (the Meteorology Department, local councils, the Civil Defense Authority, and Joint Operations office) in disseminating information and coordinating response efforts.

Overall, most respondents were confident that an early warning system in Al-Mahra would be successful in mitigating the effects of extreme weather, with only a small minority expressing a lack of confidence.[36]

[36] Some 50.6 percent of respondents said they would be "very confident" in the effectiveness of an early warning system, 41.0 percent reported being "somewhat confident", and only 8.4 percent expressed a lack of confidence.

Among the challenges identified with activating an early warning system were limited resources and capabilities, such as the lack of qualified personnel and specialized equipment; the remoteness of some areas of Al-Mahra, specifically mountainous and desert regions that lack access to communications networks, electricity, and satellite TV; the high cost of establishing an early warning system; the lack of awareness among the public about the importance of an early warning system; and the absence of a dedicated team with the necessary expertise. Respondents further pointed to the current political situation in Yemen as a fundamental challenge, citing a lack of seriousness among decision-makers, corruption, and administrative inefficiencies, and the infrequent, unpredictable nature of extreme weather events, which could lead to a gradual neglect of the system.

Conclusion

Al-Mahra is one of the most vulnerable governorates to extreme weather. The findings presented in this study suggest that Al-Mahra has experienced an increase in extreme weather events in the past years, with heavy rain and floods, cyclones, and higher temperatures reported by survey respondents. Respondents reported that extreme weather events have had a devastating impact on their lives, causing extensive damage to their homes, properties, and livelihoods (the majority of which are dependent on agriculture and fishing) and restricting their access to essential public services. The findings indicate that Al-Mahra lacks a cohesive infrastructure to manage climate disasters. Respondents said that responses to extreme weather occurrences were spontaneous in nature and lacked organization, and thus most residents were forced to seek assistance and support from other community members. While some noted that precautions were taken by the authorities during extreme weather events, others faulted them for responding late and inadequately, leaving most affected areas and vulnerable communities without sufficient aid.

The findings underscore the need to urgently adapt to and mitigate the effects of climate change on Al-Mahra. Respondents unanimously agreed on the need for better disaster management and the development of an early warning system. Modern communication channels such as social media and SMS messaging, traditional media channels like TV, and local communication channels such as loudspeakers were proposed by Mahri communities as the most effective way to deliver alerts. Using a variety of communication channels is important, ensuring that early warning alerts and information are accessible and inclusive for all. Establishing neighborhood committees, tapping influential community figures to build trust in contingency plans, as well as activating the role of specialized authorities in the governorate were also suggested as measures that could mitigate the current impact of extreme weather events.

In the long run, developing an active early warning system for Al-Mahra promises to limit losses of life and damage to public and private property in the face of growing environmental challenges. This study echoes the advice of the World Meteorological Organization and the UN, which have presented clear economic arguments for investing in early warning systems that can save millions of lives by strengthening the resilience of communities at risk.[37] Such a system becomes even more critical in the context of Yemen, a country with a high prevalence of poverty and food insecurity, where extreme climatic events are likely to have an even more devastating effect on communities, especially those most vulnerable, such as women and others living in rural areas.

[37] Lottie Limb, "Early Warning Systems Will Protect Everyone On Earth in 5 Years, UN Announces ," Euro News Green, March 29, 2022, https://www.euronews.com/green/2022/03/23/early-warning-systems-will-protect-everyone-on-earth-in-5-years-un-announces; Joshua Askew, "COP27:New UN Early Warning System Could Save Billions and Many Lives," Euro News Green, November 7, 2022, https://www.euronews.com/green/2022/11/07/cop27-new-un-early-warning-system-could-save-billions-and-many-lives

Recommendations

The establishment of an effective early warning system (EWS) in Al-Mahra requires a comprehensive, multi-stakeholder approach that leverages a range of tools and technologies, engages with local communities, and provides accessible and inclusive information and communication channels. By implementing the following policy recommendations, directed at national and governorate level authorities, Al-Mahra can establish a sustainable and resilient EWS that is responsive to the needs of the community and effectively communicates critical information during extreme weather disasters.

At the National Level:

- Designate a single official authority responsible for weather monitoring, forecasting, and issuing early warnings.
- Unify and coordinate various climate change and early warning studies undertaken by international organizations, and align them with a national strategy aimed at mitigating the effects of extreme weather events and climate change.
- Issue a decree that limits residential or commercial building in valleys deemed vulnerable to flooding, and task security forces with preventing illegal construction.
- Approve the establishment of a Risk and Disaster Management Fund, which could draw on loss and damage funds approved at the COP27 climate summit in Sharm El-Sheikh, Egypt, in 2022.
- Direct the relevant ministries to conduct a nationwide public awareness campaign on disaster-risk prevention to promote a culture of preparedness and early action to enable communities to better cope with extreme weather events.

At the Governorate Level:

- Develop partnerships and coordination mechanisms on emergency responses in Al-Mahra. The establishment of an EWS requires coordination and collaboration among different stakeholders, including government agencies, national non-governmental organizations, community-based organizations (CBOs), and the private sector. Partnerships and coordination mechanisms would facilitate information sharing, resource mobilization, and joint planning and response efforts. This could involve establishing a multi-stakeholder platform or a committee that brings together different actors working on disaster risk reduction and emergency response planning.
- Develop a comprehensive strategy and action plan that outlines the roles and responsibilities of different stakeholders in an EWS, the resources and funding required, and the monitoring and evaluation mechanisms needed to measure the effectiveness of the system. This could involve conducting regular drills and simulations to test the system and identify areas for improvement, as well as investing in capacity building and training programs for relevant stakeholders.
- Conduct community outreach programs. Such programs can promote disaster preparedness and response measures and identify the specific needs and vulnerabilities of marginalized or at-risk populations. This would entail working with local leaders, NGOs, and CBOs, as well as using mobile outreach teams to reach remote and hard-to-access areas. Outreach via schools and mosques, as key community institutions, can also help foster a culture of preparedness and timely response to early warnings, thereby enhancing the overall effectiveness of the early warning system.

- Develop awareness-raising materials on emergency responses to extreme weather events. These can provide information on types of extreme weather events and preparedness measures for emergency responses. The materials need to be accessible and user-friendly, with clear instructions and visual aids. They should also be distributed widely, through various communication channels as well as via community outreach programs, schools, and local government offices.
- Implement a multi-channel EWS that combines both traditional and modern communication tools. A multi-channel approach for alerts should be adopted that includes social media, TV, SMS messages, and loudspeakers (notably those on mosques). This will ensure that emergency alerts are effectively communicated to all members of the community, regardless of their access to technology or geographic location.
- Invest in mobile phone networks and SMS messaging coverage with local service providers. A mobile alert system can be used to send SMS messages or push notifications to community members, including those in hard-to-access areas, in the event of extreme weather events.
- Establish an EWS for Al-Mahra in two phases.
    - Phase I would focus on utilizing existing capacities and resources to establish the foundation for an EWS and supporting it with an adequate number of qualified personnel and necessary equipment. The initial phase would entail:
        - Providing the required infrastructure (hardware, software, websites, etc.) to connect the early warning unit with satellites, and national and international weather observation centers, in addition to establishing a hotline with related authorities in Hadramawt and the Oman Early Warning Center.
        - Supporting the EWS unit with at least two qualified personnel capable of operating the system, correctly analyzing incoming data, and broadcasting early warning messages.
        - Involving amateur weather enthusiasts in the EWS. These individuals could be formally incorporated and trained to work in an institutional capacity with relevant organizations to unify data and designate a single authorized entity for issuing early warning messages.
        - Surveying existing weather stations to assess their current condition and feasibility for inclusion in the short- or long-term plans for an EWS.
        - Developing an early warning website. Such a website could serve as a central hub for information and updates on extreme weather events in Al-Mahra. The website should be accessible and easy to navigate. It could also provide links to other resources and tools, such as relevant social media pages, mobile applications, and maps that can help communities prepare for and respond to natural disasters.
        - Building a social media platform. The platform can be used by the responsible authorities to provide real-time updates on extreme weather events and emergency response plans. The platform can also be used to engage directly with local communities and answer questions or concerns.
    - Phase II would focus on expanding the early warning system by conducting necessary field studies and establishing relevant field stations. This phase would entail:
        - Conducting a meteorological, hydrological, and hydraulic study that combines historical data, risk assessment maps, and current sensors/station data to develop a model for forecasting extreme weather events and providing timely alerts. This should include the determination of a sensor network and weather monitoring stations to handle and transfer data to a control room.
        - Expanding the EWS based on vulnerability and risk assessments, and the learnings and outcomes from earlier phases. This phased implementation approach will facilitate continuous improvement and incorporation of lessons learned.

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