GUIDANCE NOTE

Early Warning Early Action (EWEA) in Secondary Cities in South Asia

Climate & Development Knowledge Network

Ministry of Foreign Affairs of the Netherlands

IDRC · CRDI

Canada

German Red Cross

Norwegian Red Cross

Climate Centre

ICLEI Local Governments for Sustainability SOUTH ASIA

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The authors would like to thank the following people (in alphabetical order) for their generous time in shaping the direction of this guidance note and/or reviewing its contents:
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Copy-edited by: Patrick Fuller
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Recommended Citation

Vahlberg, M., Khan, R., Heinrich, D., Jjemba, E., *Early Warning Early Action (EWEA) in Secondary Cities in South Asia.* Guidance Note. 2022. Red Cross Red Crescent Climate Centre.

This work was carried out with the aid of a grant from the Ministry of Foreign Affairs of the Netherlands and the International Development Research Centre (IDRC), Canada, as part of the Climate and Development Knowledge Network (CDKN) Programme. The views expressed herein do not necessarily represent those of the Ministry of Foreign Affairs of the Netherlands, or of the International Development Research Centre (IDRC) or its Board of Governors, or of the entities managing CDKN.

The German Red Cross provided additional resources to develop this guidance note. We also thank the Norwegian Red Cross and the Norwegian Ministry of Foreign Affairs for their support to develop this guidance note.

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About this guidance note

The guidance note aims to support city authorities, as well as emergency service providers and community-based organisations in secondary cities throughout South Asia, which are seeking to implement Early Warning Early Action (EWEA) mechanisms. Furthermore, the guidance intends to provide reference notes and comprehensive overviews to the city authorities and practitioners who endeavor to implement EWEA.

The guidance note outlines the building blocks of EWEA. It does so by describing what EWEA is, its core elements, characteristics and different approaches. It highlights the categories of secondary cities, the challenges they face in governance and the challenges for implementing EWEA in secondary cities particularly. It underscores the importance of increasing the resilience of secondary cities to natural hazards.

The guidance note identifies enabling conditions for EWEA and presents suggestions for enabling EWEA by city authorities in secondary cities. It outlines the existing Early Warning System (EWS) and EWEA at regional, national and city levels. Furthermore, it illustrates an EWEA process flowchart, especially for secondary cities. It contains 12 steps to present the leading questions on *what, how, who* and *when* to implement EWEA in a secondary city. The guidance note concludes with a set of Frequently Asked Questions (FAQ).

There are summary notes after each of the chapters. Moreover, the guidance note throughout demonstrates success stories and case studies from the different parts of the world.

Abbreviations and acronyms

AATF	Anticipatory Action Task Force
ACAA	Afghanistan Civil Aviation Authority
ADB	Asian Development Bank
AMD	Afghanistan Meteorological Department
BMD	Bangladesh Meteorological Department
C-FLOWS	Chennai Flood Early Warning System
CAP	Common Alerting Protocol
CCA	Climate Change Adaptation
CERF	Central Emergency Relief Fund
CEWS	Community Early Warning System
CISR	Council of Scientific and Industrial Research, India
CRED	Centre for Research on the Epidemiology of Disasters
CSO	Civil Society Organisation
DARAJ	Developing Risk Awareness through Joint Action
DDM	Department of Disaster Management, Bangladesh
DDM	District Disaster Management Committee, Nepal
DEOC	District Emergency Operation Centres, Nepal
DHM	Department of Hydrology and Meteorology, Nepal
DHMS	Department of Hydromet Services, Bhutan
DIPECHO	European Commission Humanitarian Aid Department's Disaster Preparedness Program
DMC	Department of Meteorology, Sri Lanka
DRC	Danish Red Cross
DRF	Disaster Risk Financing
DRR	Disaster Risk Reduction
EAP	Early Action Protocol
EVCA	Enhanced Vulnerability and Capacity Assessment
EWEA	Early Warning Early Action
EWS	Early Warning System
FAO	Food and Agriculture Organisation of the United Nations
FbA by the DREF	Forecast-based Action by the Disaster Relief Emergency Fund
FbF	Forecast-based Financing
FEWS	Flood Early Warning System
FFWC	Flood Forecasting and Warning Centre, Bangladesh
FOREWARN	Forecast-based, Warning, Analysis, and Response Network
GRC	German Red Cross
GLOF	Glacial Lake Outburst Flood
GLOFAS	Global Flood Awareness System
HKH-HYCOS	Hindu Kush Himalayan Hydrological Cycle Observing System
I-FLOWS	Integrated Flood Early Warning System
ICIMOD	International Centre for Integrated Mountain Development
IDP	Internally Displaced Person
IFAS	Integrated Flood Alert System

IFRC	International Federation of Red Cross and Red Crescent Societies
IHH	India Humanitarian Hub
IHMEN	Institute for Meteorology, Hydrology and Climate Change, Vietnam
INCOIS	Indian National Center for Ocean Information Services
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning System
IRCS	Indian Red Cross Society
IVR	Interactive Voice Response
JICA	Japan International Cooperation Association
MCGM	Municipal Corporation of Greater Mumbai
MHEWS	Multi-Hazard Early Warning System
MMS	Maldives Meteorological Service
MoES	Ministry of Earth Sciences, India
MRCS	Malawi Red Cross Society
NCCR	National Centre for Coastal Research, India
NDMA	National Disaster Management Authority, Maldives
NDMP	National Disaster Management Plan
NDRCG	National Disaster Response Coordination Group, Bangladesh
NGO	Non-Governmental Organisation
NIOT	National Institute of Ocean Technology, India
NRCS	Nepal Red Cross Society
NTWC	National Tsunami Warning Center, Maldives
NWARA	National Water Affairs Regulation Authority, Afghanistan
OCHA	Office for Coordination of Humanitarian Affairs, United Nations
OITWS	Indian Ocean Tsunami Warning System
PMD	Pakistan Meteorological Department
PTWS	Pacific Tsunami Warning and Mitigation System
RCCC	Red Cross Red Crescent Climate Centre
REAP	Risk-informed Early Action Partnership
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
SADMS	South Asia Drought Monitoring System
SFB	Start Fund Bangladesh
SFN	Start Fund Nepal
SOI	Survey of India
SOP	Standard Operating Procedure
South Asia FFGS	South Asia Flash Flood Guidance System
TSMS	Turkish State Meteorological Service
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations International Children's Emergency Fund
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation

USAID	U.S Agency for International Development
VNRC	Vietnam Red Cross
WASH	Water, Sanitation and Hygiene
WCI	Weather and Climate Information
WFP	World Food Programme, United Nations
WHO	World Health Organisation
WIS	WMO Information System
WMO	World Meteorological Organisation

Chapter 1: Introducing Early Warning Early Action (EWEA)

The concept of Early Warning Early Action encompasses the provision of useful and timely information which empowers people to take action designed to mitigate impacts of hazards (International Federation of Red Cross and Red Crescent Societies, n.d.). Owing to advances in science and technology, allowing us to access data ranging from global satellite images to community observations, we are well equipped to produce weather and climate warnings that are meaningful at all timescales, spanning centuries to hours (Perera *et al.*, 2020). Through weather forecasts at different timescales, city authorities and humanitarian actors are able to assess the probability of upcoming hazards and trigger early responses before the hazards unfold (Rüth *et al.*, 2017). "EWEA" is thus used as a catch-all phrase to link an early warning system with appropriate action in response to a warning. Commonly used synonyms include "anticipatory action" and "forecast-based action."

1.1 What are Early Warning Systems?

An Early Warning System (EWS) has four core components that are essential to producing and communicating meaningful information to support at-risk populations to act to mitigate risks and damage (Chaves and De Cola, 2017).

What do "early" and "warning" mean?

The definition of what constitutes "early" is relative. Generally, this is used to refer to any time before the materialisation of a shock, as both early warning and early action happen prior to the onset of forecasted hazards such as tropical cyclones, floods and heatwaves. When early actions are implemented varies between hazard types and their warning timelines. Warnings refer to information about the monitored hazard, whose threshold has to be crossed according to predetermined observation protocols (Akerkar et al., 2020).

How early warnings are communicated depend on the hazard itself and the capacity of the science to provide decision-makers with accurate enough information about what the weather will do. Slow-onset hazards, such as drought, can provide early warning of years prior to critical levels of its manifestation (International Federation of Red Cross and Red Crescent Societies, 2010). Whereas tropical cyclones and heatwaves are examples of hazards which can give hours to days of early warning. Rapid-onset hazards such as flash floods typically only provide lead times of seconds to minutes (Ibid.). The concept of "lead time" refers to the time between a forecast and/or the warning of a shock and when this shock occurs (de Wit, 2019). There is uncertainty in this hazard information, which is generally greater the farther from the hazard that the forecast is given. Uncertainty is an important variable with which decision-makers must contend when faced with a hazard prediction.

Beyond early implementation, the objective of early action also differs from traditional humanitarian action. Early actions are designed to mitigate impacts preemptively to strengthen resilience, instead of responding to a manifested emergency (International Federation of Red Cross and Red Crescent Societies, 2021).

The first component of an early warning system is risk knowledge, which entails producing risk information through collecting and assessing data on vulnerability, exposure, capacity and hazards (International Federation of Red Cross and Red Crescent Societies, 2010). The second is monitoring and warning which includes observing, measuring and predicting hazard events (Chaves and De Cola, 2017). The third element is dissemination and communication in which “authors” create the warning message. “Mediators” are first receivers who broadcast the message to receiving populations and “receivers”, including at-risk populations (Ibid.). Since EWS are only successful when recipients understand and act on warnings, the fourth component is response capability (Brazzola and Helander, 2019). When effective, EWSs help protect lives, livelihoods and infrastructure (United Nations Office for Disaster Risk Reduction, n.d.). They are therefore key to disaster risk reduction (DRR) and climate change adaptation (CCA), and support long-term sustainable development (Climate ADAPT, 2021).

Figure 1. ***The core components of Early Warning Systems***

1	2	3	4
RISK KNOWLEDGE	**MONITORING AND WARNING**	**DISSEMINATION AND COMMUNICATION**	**RESPONSE CAPABILITY**
Systematic collection of risk information, including hazard identification, and risk, vulnerability and capacity assessments	Risk detection and analysis, and hazard forecasting, including observation, measurement and prediction	Warnings are drafted and disseminated by various means, e. g. megaphhones, sirens, radio, SMS and billboards	Recipients need to trust, understand and act on the hazard warning, which is why simulations and drills are key

Early warning systems vary within regions and countries. They can exist at many different and overlapping scales. At the largest scale, global level early warning systems for floods, food security and health are common, most notably the Famine Early Warning Systems (FEWS), the Global Flood Awareness System (GLOFAS) (Copernicus, n.d.) and the Early Warning And Response Network (EWARN) (World Health Organisation, 2018). Early warning systems also exist at regional level, including the Pacific Tsunami Warning and Mitigation System (PTWS) which transmits warning information to member states (International Tsunami Information Center, n.d.). Often these large-scale warning systems are funneled to national governance structures and then disseminated to the public (Demeritt *et al.*, 2012; Glantz, 2003).

Countries themselves also run national-level early warning systems which monitor forecasts and conditions, and disseminate warnings to relevant agencies and citizens through different modalities. Commonly, these systems are multi-hazard, built to monitor and warn of a whole range of different hazards experienced throughout the country (United Nations Platform for Space-based Information for Disaster Management and Emergency Response, n.d.).

Although city-level early warning systems are far less common, there seems to be a trend towards their development. Examples include, early warning systems for flash floods and heatwaves developed in the cities of Guwahati and Mumbai in India (The Energy and Resources Institute, 2020; National Centre for Coastal Research, 2020) and Hanoi in Vietnam (International Federation of Red Cross and Red Crescent Societies and German Red Cross, 2018) respectively. Population density and complex community networks which characterise cities fosters informal early warning systems at community-level. These can include neighborhood communication, social media and more (e.g., Bui, 2019).

Synergies of integrated EWS efforts

As core elements of establishing community EWS (CEWS), communities conduct risk analyses, set up monitoring practices and develop response plans. When national EWS disseminate warnings, they triangulate data with the monitoring of their own indicators and deploy early action where needed. For instance, communities along rivers can inform settlements downstream, including cities, of the prospect of imminent events that their CEWS mechanism has picked up on. Moreover, data from CEWS can be sent for inclusion in national EWS (International Federation of Red Cross and Red Crescent Societies, 2013). City EWS comprise complex practices tailored to the urban setting at hand. Given a city's interconnectedness with its surrounding environment and systems, its data can complement national EWS as well as CEWS nearby (Ibid.). Certain agencies with disaster risk reduction mandates (such as National Red Cross or Red Crescent Societies) work to support the development, deployment and maintenance of these community early warning systems (International Federation ofRed Cross and Red Crescent Societies, 2020).

Table 1. *Implementing EWS at different scales*

Key factors	National EWS	City EWS	Community EWS
Design	*Based on legal mandate by government or other authorities*	*Based on need*	*Design according to need and revised by trial and error*
Human resources needed	*Technicians, specialists*	*Specialists, municipal officials, community leaders/members, volunteers*	*Volunteers and individuals delegated by local leaders*
Characteristics	*Formal staged warning*	*Formal staged warning based on information received by national nodal agencies*	*Warning when needed, based on informal observation and measurements*
Documentation	*Legislation, policies, SOPs, communication protocols, etc.*	*Policies, SOPs*	*Informally operated, which is why it is rarely documented*

Key factors	National EWS	City EWS	Community EWS
Technology	*High-tech to telephone, e.g., high frequency radios, siren, email, social media, TV, SMS*	*Telephone to traditional, e.g., megaphone, social media, radio, TV, siren, SMS*	*Telephone to traditional, e.g., megaphone, siren/ sound, social media, noticeboard*
Trigger	*Predetermined indicators, technology to observe and measure, prediction analysis*	*Predetermined indicators, warning and prediction received by regional/ provincial nodal agencies or city authority*	*Personal detection of a hazard by informal observation and measuring, or warning receipt from outside the community*
Warning process	*Systemic dissemination to "mediators", who then relay it forward among target groups*	*Systemic dissemination to "mediators" who then relay it forward among target groups, or direct systemic dissemination to target groups*	*Ad hoc, but can be systemically disseminated*
Messages	*Impersonal to the masses*	*Both impersonal and personal to account for diverse needs within targeted area/ population*	*Personal by and to the community*
Timing	*Information communicated at different stages; messages produced to share with official systems at all levels*	*Information received from the national or state nodal agencies*	*Rapid when message created by the community itself, or when adequately linked with relevant other EWS levels in the country*
Primary needs targeted	*Reduce economic loss, loss of lives and livelihoods*	*Reduce losses, provide security to the residents*	*Provide safety and emotional support, reduce stress*
Evaluation criteria	*Hazard details and lead-time provided, proportion of false warnings*	*Hazard details and lead-time provided, proportion of false warnings, actionable message*	*Timing of warning message, actionable warning message*

1.2 How do Early Warning Systems enable early action?

As previously stated, EWSs' largely build on risk knowledge production by analysing past disasters and utilising available data, technology and science to understand, uncover patterns and apply lessons learned to enhance anticipatory capacities and actions. When warnings are triggered, EWS can provide evidence for the need to take early action, but the existence of early warning information is no guarantee that action will be taken.

Actionable warnings that are disseminated in accessible ways enable EWS to instruct and support at-risk populations to take the action needed to reduce humanitarian impacts preemptively (Akerkar *et al.*, 2020). If existing, warnings activate a specifically designed early action protocol (EAP) or Standard Operating Procedure (SOP) and release funding linked to the pre-agreed early action, which supports the timely and effective implementation of said actions (Destrooper *et al.*, 2019). Early warnings are thereby designed to create a so-called "window of opportunity" for early action, which entails the time between the warning and the point of hazard materialisation (Otieno *et al.*, 2019). Depending on hazard and lead-time, examples of early action are evacuation, fortifying vulnerable structures, distribution of water, purification tablets, food or cash and volunteer mobilisation (Bischiniotis *et al.*, 2019). For example, in anticipation of a heatwave in Karachi, Pakistan, in May 2020, Start Network's Disaster Risk Financing (DRF) project released 36,000 pounds sterling to the various actors on the ground a week prior to the forecasted heatwave (Start Network, 2020). The implemented early actions included awareness-raising activities on how to identify and treat heat strokes (Ibid.).

Zambia's Early Action Protocol (EAP) for floods

In Zambia, the EAP is countrywide and targets 31 districts - 19 of which have "high risk" and 12 "very high risk" of flooding (Zambia Red Cross Society and International Federation of Red Cross Red and Red Crescent Societies, 2020). Impact analyses of past crises show that the population, livestock, crops and infrastructure are elements most at risk, particularly those located in the vicinity of riverbanks and in plains, and structures made with makeshift material such as mud, grass, and reeds (Ibid.). For this reason, the EAP centres on the country's largest rivers, namely the Chambeshi, Kefue, and Zambesi.

The forecast used in the monitoring is the Global Flood Awareness System (GLOFAS) and the trigger is built around the water discharge threshold, corresponding to a 20-year return period flood (Houston, 2021). When the daily issued GLOFAS forecast indicates that the threshold is reached in one or more monitor stations, the EAP is triggered (Zambia Red Cross Society and International Federation of Red Cross and Red Crescent Societies, 2020). That starts with a warning message issued by the Disaster Management and Mitigation Unit (DMMU), which continues to monitor the forecasts and sets into motion the relief stock prepositioning. Unless the river flow reduces by 40 per cent by the third day, early actions start to be implemented. The selected early actions span three sectors, namely shelter, food security, and water, sanitation and hygiene (WASH) and health (Ibid.).

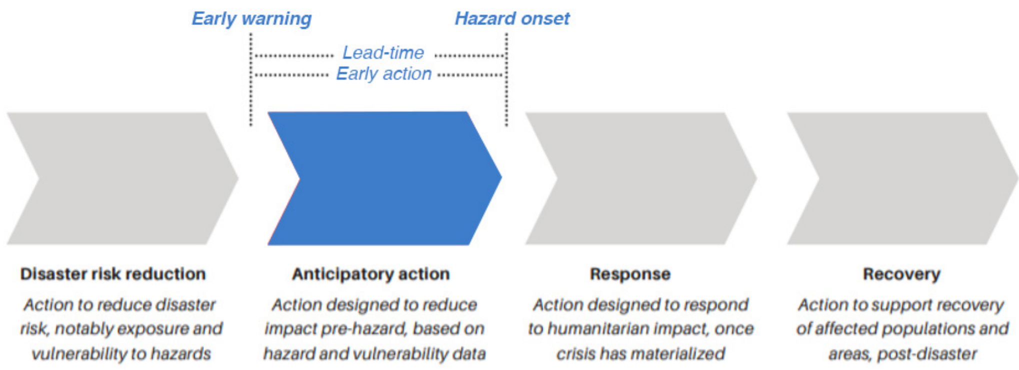
Early actions – Shelter:
- *Dissemination of weather information and actionable messages to communities.*
- *Assessment of the status of evacuation routes and evacuation centres.*
- *Prepositioning and distribution of non-food items.*
- *Community mobilisation to dig embankments and trenches to divert flood water.*
- *Procurement and distribution of water-resistant bags to protect key documents.*

Early actions - Food security:
- *Dissemination of information regarding early harvesting of crops threatened by flood, and food storage and preservation.*
- *Prepositioning and distribution of food storage bags.*

Early actions – WASH and Health:
- *Dissemination of actionable information on hygiene and sanitation.*
- *Prepositioning and distribution of WASH items.*
- *Distribution of information, education and communication materials on WASH.*
- *Assessment of pre-detected sanitation facilities and water sources near the evacuation centre.*

The Zambia Red Cross Society is the implementing actor, which is receiving financial support from their Partner National Society, the Netherlands Red Cross (Ibid.). The early actions are designed to assist 1,000 households and 6,000 people in total. The EAP has a budget of 249,955 Swiss francs, of which 61,280 Swiss francs were allocated for readiness purposes upon EAP activation and 98,161 Swiss francs are to be allocated once the trigger is met (Ibid.).

Figure 2. ***Anticipatory action in the disaster risk management continuum***[1]



1.3 Different approaches to anticipatory action

To support early action, the International Red Cross and Red Crescent Movement has led the development of the Forecast-based Financing (FbF) approach since 2007, including Forecast-based Action (FbA) by the Disaster Relief Emergency Fund (DREF). FbF entails that a hazard of a chosen magnitude is forecasted to exceed a probability threshold, requiring an action by a designated actor. All of this is predetermined in an Early Action Protocol (EAP) or Standard Operating Procedure (SOP) (Coughlan de Perez *et al.*, 2015). Rather than acting once disaster is a fact, as per traditional disaster management, the FbF approach is aimed at reducing impacts of hazards on at-risk populations by enabling funding for and implementing early action (Lopez *et al.*, 2018). Actions are informed by data about the forecasted hazard and at-risk populations, in order for interventions to be designed and implemented efficiently. Undertaking early action provides the possibility of avoiding disaster altogether.

Community Early Warning Systems (CEWS) is another approach focused on anticipatory action. This type of system is people-oriented, meaning it operates for, or with community members actively involved in at least one of the EWS core elements (International Federation of Red Cross and Red Crescent Societies, 2012). In contrast with national EWS, CEWS is notably characterised by an informal and scarcely documented framework, hazard triggers assessed by individuals and personalised hazard information and warnings (see Table 1).

The Office for Coordination of Humanitarian Affairs (OCHA), World Food Programme (WFP) and Food and Agriculture Organisation (FAO), are actors within the UN system who operate anticipatory programmes. OCHA leads a pilot programme throughout Africa and Asia funded by the Central Emergency Response Fund (CERF) (CERF, n.d.-a; OCHA, 2021), for which OCHA has developed an Anticipatory Action framework (OCHA, n.d.). WFP has run Forecast-based Financing programmes since 2015 and currently hosts them in 15 countries (World Food Programme, 2019). The anticipatory action programmes led by FAO are financed by their Anticipatory Action Window fund within the organisation's Special Fund for Emergency and Rehabilitation Activities (Food and Agriculture Organisation of the United Nations, 2021).

1 Tozier de la Poterie (2021)

Anticipatory action programmes that the Start Network offers include the Start Fund Anticipation and Forecast-based, Warning, Analysis, and Response Network (FOREWARN). The former was established in 2016 as the first NGO-led funding mechanism to enable early action. Since its implementation it has been activated to release funding totaling more than six million pounds sterling in anticipation of 26 crises in 21 countries (Start Network, n.d.-a). FOREWARN is a community that helps predict and act early on hazards and advocates for systemic shift within the humanitarian sector to make anticipatory action the norm (Ibid.).

Anticipation Hub

At the Anticipation Hub, hosted by the German Red Cross (GRC), Red Cross Red Crescent Climate Centre (RCCC) and International Federation of Red Cross and Red Crescent Societies (IFRC), you will find an interactive map through which you can browse the anticipatory action programmes housed by approximately 60 countries. The platform gathers partners across sectors – the International Red Cross and Red Crescent Movement, universities and research centres, governments, donors and international NGOs – to facilitate knowledge exchange, collective learning, and advocacy related to anticipatory action.

Learn more at the Anticipation Hub at https://www.anticipation-hub.org/. Find the map and country profiles by clicking the "Experience" tab, then "Anticipatory action in the world."

Summary

- **Early warning early action is a key component of disaster risk reduction.**
- **Early warning systems, when effective, are meant to enable action in anticipation of a hazard.**
- **Early warning early action systems exist at different scales: from the global to the national to the hyper-local.**
- **There exist many different approaches to EWEA with certain common characteristics and components.**

Chapter 2: EWEA and secondary cities

2.1 What is a secondary city?

Defined as a primary city, a nation's leading city tends to be considerably larger than others in the urban hierarchy (Roberts, 2014). While primary cities attract the limelight and are allocated the most resources, secondary cities are growing the fastest and are increasingly recognised as having the potential to shape our urban future (Cities Alliance, 2021). Unlike its larger counterpart, the definition of secondary cities is contextual in the sense that classification can depend on a city's population size; economic, logistical or administrative function; its historical, academic or political significance; or its role as a centre for health, community and security services (Roberts, 2014).

Secondary cities are divided into three spatial categories

- *Economic trade corridors exist in the form of growth centres that are developing adjacent to key transport corridors, such as along national highways or important railroad networks (Roberts, 2014). Examples include Jalalabad in Afghanistan and Kaduwela in Sri Lanka.*
- *City clusters surround major urban metropolitan areas that are linked to satellite and new town cities. These cities help decentralise industrial and economic centres from primary cities (Ibid.). Navi Mumbai in India is one such city example.*
- *Sub-national cities are centres of industry, agriculture, mining, tourism, and local government. These are the most common secondary cities, many of which were founded to serve as development hubs by previous dynasties or colonial powers (Ibid.). Examples include Addu City in the Maldives and Phuntsholing in Bhutan.*

Although some can be smaller, as a general rule secondary cities' populations range from between 10 and 50 per cent of a primary city's (Roberts, 2014). Numbers vary between nations across South Asia, from tens of thousands of people in the Maldives and Bhutan to several million in Pakistan, India and Bangladesh. Solely based on population size, it is estimated that there are more than 2,400 cities in the world which could be described as secondary cities, approximately 60 per cent of which are situated in Asia and Africa (Ibid.). As the world urban population increases from today's 3.5 billion to a projected 6.2 billion in 2050 (Earle, 2016), secondary cities in these regions are expected to experience the greatest growth rates. Cities of this category are described as catalysts and hubs of development, community, economy, information and services on sub-national to global city systems (Hohmann and Roberts, 2020). By virtue of their growing numbers, secondary cities are projected to be drivers that unlock nations' prospective economic development (Roberts, 2014).

2.2 Challenges faced by secondary cities

In spite of their potential, socioeconomic discrepancies between secondary and primary cities commonly limit the former's capacities to manage urban development (Roberts, 2014). Secondary cities tend to be neglected as a result of many countries emphasising investments in their capitals where economic growth and job creation are concentrated. Consequences include growing poverty, employment and income gaps between the two city tiers (Cities Alliance, 2021). As many secondary cities often struggle with raising capital, they also face challenges in building human and physical infrastructure, vibrant communities and profitable enterprises – factors essential to improve livelihoods, generate and retain jobs, and foster diversified and lively economies (Roberts, 2014).

Secondary cities' scarce resources may affect their capacity to respond to needs and reduce risks linked with climate change and extreme weather events. Notably, it can affect the ability of city authorities and municipalities to invest in risk reducing measures, particularly when it comes to prospective risks when already manifested needs demand their attention and capital today (Dickson *et al.*, 2012). City authorities, particularly in secondary cities, may also lack sufficient and current data on exposure and hazard as a result of limited technological infrastructure, and technical and financial capacity (Ibid.). Moreover, second tier cities which have established local bodies for disaster management often lack independence and sufficient implementation power to revise laws and ensure adequate budget allocation (Ibid.).

In secondary cities, vulnerability and exposure to natural hazards can stem from poverty, lack of basic services, discrimination and informal settlements or unregulated housing. Internally displaced peoples (IDPs), undocumented immigrants and refugees, the majority of whom tend to relocate to cities, face more disadvantages than those of other at-risk populations (United Nations Refugee Agency, 2016). Additional urban populations at risk of, for instance, extreme heat, include outdoor laborers who are exposed to direct sunlight. This group includes street vendors and construction workers, as well as persons with disabilities who may experience limited mobility and access to cooling centres (Singh *et al.*, 2019). Moreover, children living in urban settings who lack access to basic hygiene and sanitation services face extreme risks induced by climate change in countries such as Pakistan, Bangladesh, Afghanistan and India (United Nations Children's Fund, 2021). Poor children in cities are the first to be affected by flooding-induced sewage in city streets and extreme heatwaves (Ibid.).

Key challenges in secondary cities

Some of the typical challenges that secondary cities encounter include:

- *Many secondary cities are still in the transitional phase of urbanisation. Basic infrastructures of the urban system and utilities such as water supply and sewerage are in the process of development. These cities are frequently facing challenges to keep up with the pace of rapid urbanisation.*
- *Where available resources are limited, skilled human resources and financial capacity are the biggest concerns. Many secondary cities are facing challenges around raising capital and collecting revenues in the form of taxes or levies.*
- *Infrastructure in secondary cities can be very old. Retrofitting is not always the best-suited solution, mainly due to the unplanned development of the cities.*
- *Often connectivity, logistics and governance limitations can bottleneck development opportunities, equity and dynamic economies in secondary cities.*
- *Many city authorities have not streamlined the stakeholder engagement process in their planning and developmental activities. As a result, these city authorities miss out on opportunities to leverage local knowledge and forge partnerships with local research organisations such as universities.*

2.3 Why is EWEA important for secondary cities?

Secondary cities often have limited human resources and capital investments to build robust anticipatory mechanisms and simple governance structures. However, most secondary cities still house natural habitats such as forests and swamps that can be harnessed for disaster risk mitigation, for instance flood risk management and heat risk reduction. Moreover, most secondary cities are still developing systems which make it easier to build a culture of disaster preparedness as cities grow. With relatively low populations compared to primary cities, secondary cities can use EWEA to protect lives and livelihoods from extreme weather events.

Beyond enabling a faster response, research shows that anticipatory action, including EWEA, is more cost-effective than traditional emergency-oriented response (Lopez *et al.*, 2018). Meerkat *et al.* (2017) and Rüth *et al.* (2017) state that return on investment of resilience-building measures has a rate of over 2:1. In other words, for every one US dollar invested, more than two dollars is saved. EWSs, specifically, have a 5:1 median benefit to cost ratio (Ewbank *et al.*, 2019).

Challenges for implementing EWEA in secondary cities

Some of the key challenges around implementing EWEA in secondary cities include:

- *Limited risk education and awareness among communities and city authorities.*
- *Gaps in interdepartmental coordination for DRR and resilience building.*
- *Early warnings are mostly issued by the nodal agencies of the national government (e.g., the Indian Meteorological Department), and they are generally issued for the entire province or district. In the same region or province, there might be districts or areas with different geographical topography. Furthermore, the pattern of risks could also differ due to local topography. For instance, the risks of landslides due to moderate rainfall in a hilly area is higher, whereas in the foothills, flood risk for average rainfall can be insignificant and landslide risk is minimal. Consequently, the generalised risk perception and approach for the entire region or province might adversely impact the risk assessment, risk communication, mobilisation of resources and emergency relief provided by the government.*
- *The public may have difficulty reading, interpreting and understanding warnings and their impacts and risks. City authorities may also have difficulty translating warnings into actionable messages.*
- *Constrained capacity among city authorities to design, plan and implement EWEA projects. External experts, such as consultants or humanitarian actors often need to support cities and their municipalities.*
- *Limited awareness about climate change and its impacts among the communities and service providers. Climate resilience planning and development are not mainstreamed in many cities.*
- *Many city authorities do not adequately prioritise investment in DRR. There is a degree of investment for undertaking preparedness measures around disaster responses but not for anticipatory actions.*
- *Buy-in from the city authority is critical. The EWEA mechanism will not be sustainable unless the respective city authority owns it.*
- *Interdepartmental coordination for DRR or EWEA might not be streamlined.*
- *Financial constraint discourages many city authorities to take fruitful preparedness and early action measures. Often funding, albeit limited, is available for developmental work, which can be used for climate issues. Still, city authorities at times find it challenging to link development and climate to one another and thereby miss out on funding opportunities. Furthermore, delays in transferring the funding for DRR activities by national or state government might also discourage city authorities from early actions.*
- *Communities tend to assess risk based on their perception and historical evidence. They are often reluctant to take early actions, such as transferring to demarcated shelters, unless the local and provincial government conducts extensive sensitisation measures or, the risk is predicted to be extremely high.*
- *Inconsistency and perceived limitations in accuracy in the forecast system demotivate communities and local city authorities to act early.*

- *The mechanism to estimate disaster loss and damages or assess the loss and damages for possible disaster events needs to be endorsed by the local authorities or municipality. Often lead time is not sufficient for fruitful actions as there are limitations on available human and financial resources.*
- *Dissemination of early warning related information needs to be streamlined at the local level. For instance, in India, the District Disaster Management Authority (DDMA) is the nodal agency for DRR at the local level. There is an established channel of information sharing from national nodal agencies or IMD to DDMA. However, the dissemination of information from the district level to the municipality level needs to be developed further.*

Anticipatory action expands the lead-time for the implementation of support actions, saving significant capital. It is important to note that it also decreases needs and costs associated with disaster response logistics and long-term disaster recovery (Ibid.). In anticipation of floods in Malawi in 2019, the Malawi Red Cross Society (MRCS) mobilised National Response Teams, CEWS teams, and Community Disaster Response Teams to disseminate warning information and instruct on recommended early actions, including how to protect personal assets and evacuate (Anticipation Hub, n.d.-c). In other anticipatory interventions based on cash and non-food item distributions to herder households prior to the extreme winter season in Mongolia, animal mortality rates reduced while offspring survival rates increased, proving the positive effects that acting early can have on supporting livelihoods (Gros *et al.*, 2020). Because at-risk populations receive support prior to the materialisation of a crisis, strengthening their preparedness to deal with the shock by their own account, anticipatory action crucially also enables more dignified aid (Central Emergency Response Fund, n.d.-b).

As such, EWEA is key to the needed paradigm shift in the contemporary humanitarian system as well as government disaster risk management, from classical emergency-oriented response to anticipatory approaches rooted in resilience, humanitarianism and disaster risk reduction (Hilhorst, 2018). With accelerating climate change increasing the unpredictability, frequency and intensity of hazards, implementing EWEA is imperative to protect lives and prevent escalated suffering (International Federation of Red Cross and Red Crescent Societies, 2014). Not least when considering that the amount of people faced with climate-related crises in need of international assistance could double by 2050 (Ibid.). Urban populations' exposure to extreme heat has already increased by about 200 per cent in the past 33 years, mainly due to rapid urbanisation such as that experienced in secondary cities in South Asia (Tuholske *et al.*, 2021). Implementing more cost-effective and dignified disaster risk management in such cities can be an effective way to invest scarce resources.

South Asia is already home to successful EWEA mechanisms. Ranked as one of the world's most disaster-prone nations, Bangladesh has reduced its cyclone- induced mortality rates more than 100-fold in 40 years – from about half a million casualties in the 1970s, in the world deadliest weather-related disaster, Cyclone Bhola - to 4,234 in the 2007 Cyclone Sidr (Haque *et al.*, 2012). Since Cyclone Sidr, the strongest recorded cyclone to hit Bangladesh was the 2020 Cyclone Amphan which caused 26 deaths (Niu, 2021). Beyond the EWS, cornerstones to the country's preparedness include; having established cyclone shelters with provision of first aid and installation of lights to increase night time safety; evacuation plans for people and livestock; coastal embankments; reforestation programmes; food, water and cash distributions and a general increase in risk awareness among the public (Anticipation Hub, n.d.-b; Haque *et al.*, 2012). Bangladesh's cyclone EWEA mechanism could act as a beacon of possibilities for South Asia and its rapidly growing secondary cities.

Summary

- **Investing in early warning early action principles and programmes can drastically increase the resilience of a secondary city to natural hazards.**
- **EWEA can be an effective way for cities to invest scarce resources towards reducing risk posed by hazards to its citizens.**
- **Many challenges exist around embedding EWEA in secondary cities, but there are solutions to each of these.**
- **South Asia is home to many successful and flagship EWEA mechanisms which can provide support, networks and ideas for secondary cities in the region.**

Chapter 3: Streamlining EWEA in secondary cities

3.1 Elements which make EWEA different in urban contexts

Urban settings are pluralistic, meaning that definitions vary and depend on their respective context. Cities moreover, differ in size and shape (Campbell, 2016). Three concepts put forth by Ramalingam and Knox Clarke (2012) define the nature of cities as diverse, dense and dynamic. Cities differ from rural contexts in the diversity of their landscapes and communities, their density of population and built-environment, and their rapid evolution and dynamism (Urban FbF Brief, 2021).

3.1.1 Diversity

Cities are composed of a multitude of actors and infrastructure and a diverse makeup of individuals and communities adhering to various nuances within social categories such as class, religiosity, ethnicity, sexuality, gender, age, and physical ability (Campbell, 2016). Diversity moreover extends to livelihood, culture and linguistics among urban inhabitants. Since cities are densely populated, one may find great diversity in a small locality (German Red Cross, 2019). To adequately account for urban heterogeneity, assessing risks requires particular methods and foci. One example is the urban risk assessment approach, combining assessments of hazard, institutional, and socioeconomic factors (Dickson *et al.*, 2012). Urban diversity calls for high resolution local forecasts to ensure precise predictions with adequate lead-time (Vietnam Red Cross and German Red Cross, 2019a). Access to climate and early warning information also differs in urban settings. Levels of access to mobile phones and internet are generally higher in cities, which enable rapid dissemination of early warnings (International Telecommunication Union, 2020; Bahia and Delaporte, 2020). In informal settlements, however, phones and internet are accessed to a lesser extent, which is why such areas may require communication measures including megaphones on mobile trucks and other rigorous public systems (Bauer *et al.*, 2020). The need for accessible information is magnified when considering that especially vulnerable persons, such as internally displaced populations (IDPs) and individuals living in extreme poverty, tend to be concentrated in informal settlements (Alcayna and Al-Murani, 2016). Because of cities' vast diversity, warning communication should be tailored to accommodate a multifaceted set of needs.

3.1.2 Density

People and infrastructure are commonly densely concentrated in cities. This urban density enables quick dissemination of information by word of mouth or use of mobile phones, for instance via social media and texts (Campbell, 2016). Because information reaches many in a small locality, municipality and humanitarian actors can easily reach vast numbers of people. One of the downsides is that hazard-induced infrastructure damage in populous areas can result in severe impact for people and livelihoods as well as challenges in accessing people in tall building complexes (Ibid.). Another is that dense populations are at greater risk of disease, rumor and misinformation spread (Sanderson, 2019). The density of urban stakeholders, who may operate with overlapping responsibilities and at multiple scales, can complicate stakeholder mapping and coordination.

3.1.3 Dynamism

Some of the main urban characteristics are that cities constantly evolve in physical form, human makeup, population, governance, economics and culture - often unpredictably and swiftly (Campbell, 2016). These changing dynamics that no single actor is in charge of make the city a complex setting to work in, not least when it comes to endeavoring to predict outcomes of actions (Alcayna and Al-Murani, 2016). Since urban contexts are interconnected with themselves and other spaces, livelihood opportunities and hazards govern the actions of relocating urban dwellers and people from the rural vicinity (Campbell, 2016). The fast-paced urban dynamics require city authorities and humanitarian actors to regularly revise early actions and undertake rigorous monitoring and evaluation systems (Sanderson, 2019).

3.2 What makes EWEA work in cities

While cities are complex spaces, their diverse and dynamic stakeholders are key to urban risk management (Sanderson, 2019). Local actors and institutions act as first responders to warnings and hazards. These include city authorities and municipalities, different levels of government, civil society organisations, community leaders, social workers, neighborhood committees, local development councils, media institutions, faith-based organisations and religious leaders, sports and leisure groups, women's groups and more (Ibid.). Together they create vast networks throughout cities that support effective dissemination of risk information and hold vital contextual knowledge. Effective communication between stakeholders and actors is key to ensure that at-risk populations are reached with the necessary information and recommended early actions to prevent suffering. The importance of community early warning systems and informal networks of social capital are particularly important in cities. Importantly, local leaders can also help build trust among vulnerable populations and thereby engender risk mitigating action proposed by city, municipality or humanitarian actors (Campbell, 2016). Social capital is suggested to play a central role in urban resilience of rapidly growing cities in the Global South and understanding its role is key to urban actors' effective response to risks and being able to harness the possibilities presented by densely populated urban areas (Mpanje *et al.*, 2018).

City Learning Lab

A 'City Learning Lab' is an approach that brings together diverse stakeholders to prioritise a challenge of common interest and discuss potential solutions. It is an inclusive process that leverages the complimentary skills and experiences of each stakeholder to achieve positive outcomes (Koelle et al., 2019).

The critical goal of the approach is the co-exploration of 'priority issues' and climate change information or science needed for national or city-level decision making. This co-exploration process leverages the diversity of stakeholders who bring knowledge from various disciplines and organisations towards a common vision or solution (Arrighi et al., 2017).

In Lusaka, Zambia, 'City Learning Labs' transformed the ways stakeholders worked together. Creating a strong relationship to be able to address complex challenges in the city. The learning labs also produced a range of policy briefs, reflecting the diverse knowledge in the city, offering practical policy solutions (McClure, 2018).

Due to cities' evolving character, there is a foundation of adaptability present within them that is worth recognising (Campbell, 2016). Other urban factors which contribute to building resilience include the populations' skill, knowledge, innovation and the density of technology stemming from the presence of universities and other educational institutions, research centres, startups, social entrepreneurship and other businesses and financial hubs (Resilient Cities Network, n.d.). Developed infrastructure and essential services in the urban setting can also provide systems on which city authorities can build and scale up anticipatory action (Campbell, 2016). Heavily populated urban areas can even be viewed as beneficial for crisis response, as actions and information reach many people quickly (Sanderson, 2019).

Common Alerting Protocol (CAP)

The Common Alerting Protocol is a standard format for warnings and emergency alerts. When alerting the public, the information must reach vast numbers of people, which is why it also requires multiple dissemination methodologies. However, it is key that all recipients access the same key warning facts. According to CAP, alert communications must include the following nine elements: Sender name, Sent, Identifier, Status, Message type, Scope, Category, Message Template, and Priority (OASIS, 2010; Global Disaster Preparedness Center, n.d.).

The nine elements of CAP

Sender name

- *State the alerting authority (e.g. city authority, domestic or international hydrometeorological institution)*
- *Include an email for further contact and clarifications*

Sent

- *State the date of the message*
- *State the time of the message*

Identifier

- *Provide a unique identifier for each CAP message (e.g. ID number)*

Status

- *State the message status:*
  - *Actual: actionable by all message recipients*
  - *Exercise: actionable by all exercise participants*
  - *System: messages to support alert network internal function*
  - *Test: technical test, to be disregarded by recipients*

Message type

- *State the message type:*
  - *Alert: initial information that requires recipients' attention*
  - *Update: updates and that supersedes referenced message*
  - *Cancel: cancels referenced message*

Scope

- *State the scope of the message to denote the intended distribution:*
  - *Public: dissemination to the general public*
  - *Restricted: dissemination limited to users with particular requirements*
  - *Private: dissemination to specific addresses*

Category

- *Provide an alert category:*
  - *Geo: geophysical*
  - *Met: meteorological, including floods*
  - *Safety: emergency and public safety*
  - *Security: military, law enforcement, local and private security*
  - *Rescue: rescue and recovery*
  - *Fire: fire rescue and suppression*
  - *Health: public health*
  - *Infra: telecommunications, utilities, and other infrastructures*
  - *Other: other events*

Message template

- *Provide a headline, including hazard and alert area*
- *Give a description of the risk information*
- *Provide an instruction or call to action for targeted recipients (e.g.evacuate)*

Priority

- *State the priority of the alert:*
  - *Urgency: Immediate, Expected, Future, Past or Unknown*
  - *Severity: Extreme, Severe, Moderate, Minor or Unknown*
  - *Certainty: Observed, Likely, Possible, Unlikely or Unknown*

3.3 Enabling contexts for EWEA

3.3.1. Enabling contexts for developing EWEA systems

- Political recognition for the benefits and need to foster anticipatory systems.
  - Needs to be reflected in disaster risk management policies, legislation and planning, as government ownership is key to institutionalisation (World Meteorological Organisation, 2011).
  - Increases the likelihood of sufficient and long-term resource allocation (Ibid.).
- The presence of and access to financial, human and technological capital.
  - A skilled workforce that understands and can effectively develop the core elements of EWEA (United Nations Environment Programme, 2015).
  - Stakeholder involvement throughout the process of developing EWEA is central to fostering public trust and understanding, and ensuring relevance according to at-risk populations' needs (Sneddon, 2021; Akerkar *et al.*, 2020). Utilising respected community workers can help facilitate this.
  - Investment in monitoring and forecasting is crucial to improving data quality and accuracy of risk mapping, thereby expanding the possibility of increased lead-time of warnings (Ibid.). Offsetting knowledge gaps can also be done through forming strong partnerships and triangulating data (Sneddon, 2021).

Case study:
Improved Weather and Climate Information (WCI) in Nairobi, Kenya and Dar es Salaam, Tanzania

Before the Developing Risk Awareness through Joint Action (DARAJA) project was implemented in Nairobi, Kenya and Dar es Salaam, Tanzania, weather and climate information (WCI) systems did not account for the complexity, interconnectedness and dynamism of their vast diversity of city actors (Sen et al., 2020). Importantly, WCI systems did not interact sufficiently with stakeholders to ensure that target groups could access the information, understand its implications and be able to act on it, nor did they have systematised feedback loop mechanisms (Ibid.). DARAJA was initiated to enhance access to and use of WCI systems by residents in the cities' informal settlements, notably through collaboration – to co-explore needs, and co-design and co-deliver solutions (Ibid.).

Implemented activities:

- *Mapped information flows, including communication channels and actors, through gathering already established stakeholders in the WCI system and those deemed crucial to include. This helped identify key actors and build partnerships.*
- *Discussions and workshops were held to reach a common understanding of the WCI system, identify challenges and explore and design solutions.*
- *Stakeholders collaborated to reconstruct communication systems and plan awareness campaigns, designed for both dissemination and feedback. This facilitated access to WCI by those most vulnerable.*
- *Co-designed piloted solutions which include producing descriptions of technical WCI terms, drafting forecast messages for community leaders to disseminate within their respective communities, conducting daily weather broadcasts via local media, offering training to local journalists in understanding, interpreting and broadcasting, communicating WCI and more.*

Project results:

- *A more accessible, inclusive and intricately woven information ecosystem that both supports improved WCI dissemination and feedback mechanisms e.g., through using more communication channels. It also harnesses the multitude of actors present in the cities for disseminating WCI and early warnings.*
- *Improved WCI emphasising weather impacts and centering target groups e.g., through outlining consequences that weather events may have on affected areas and by including visual illustrations to facilitate interpretation.*
- *Having created communication channels between informal settlement residents, other city stakeholders and NHMS granted the former greater agency, increased their trust in weather agencies and enhanced their responsiveness to WCI.*
- *Improved information ecosystem and feedback mechanisms enabled city stakeholders to inform and thereby improve the weather agencies' WCI.*

3.3.2. Enabling contexts for hazard monitoring and warning communication

- A functioning EWEA system must be integrated within government structures.
  - It must operate with a clear framework, notably within disaster management planning at all levels (International Federation of Red Cross and Red Crescent Societies, 2014). Roles and responsibilities of key actors must be clarified and coordination mechanisms outlined (World Meteorological Organisation, 2011).

- Coordinating activities by public actors under an umbrella agency can improve the links between monitoring, warning dissemination and capacities to respond. This may also facilitate coordination of training programmes in risk awareness, hazard recognition and response drills and simulations (World Meteorological Organisation, 2011).

- Active involvement of at-risk populations is crucial to the maintenance, sustainability and effectiveness of the EWEA as it strengthens community ownership (Brazzola and Helander, 2019). Moreover, this helps build a foundation of trust (International Federation of Red Cross and Red Crescent Societies, 2014).

- Indicators monitored for the EWS should be predictable, objective and consistent (International Federation of Red Cross and Red Crescent Societies, 2014).
  - To provide adequate lead-time, indicators must be able to detect deviations from normal trends early and trigger warnings to invoke early actions (Ibid.).
  - For floods, indicators can include rainfall data such as quantity, distribution and duration of rainfall (Ibid.). For heatwaves, indicators may include temperature and relative humidity (Vietnam Red Cross and German Red Cross, 2019a).

- As it is necessary that stakeholders feel ownership of the indicators, if and when possible, indicators should be jointly owned (International Federation of Red Cross and Red Crescent Societies, 2014). Producing them could start with gathering stakeholders who act in the same area in consortia to discuss (Ibid.).

- Warnings produced, communicated and disseminated by the EWS should be diverse and abundant (Akerkar *et al.*, 2020).
  - To cover the diversity of city inhabitants and be contextually appropriate, warning communication requires a multitude of messages that vary in degree of detail and language and mode of dissemination (International Federation of Red Cross and Red Crescent Societies, 2014).
  - All warning messages should encompass clear explanations of hazard severity, trend, timing and the degree of confidence of the forecast (Ibid.).

- Warnings must be actionable and timely. They must outline impact assessments and which actions beneficiaries should take, and reach at-risk populations at a time that allows them to act before a critical stage of hazard onset (Dinnissen *et al.*, 2020).

    - Warning messages underpinned by social and behavioral theories can help foster actionable communication, increasing the likelihood of early action (Akerkar *et al.*, 2020).

- At-risk populations must be provided regular and tailored training to build response capacity and create response plans (Meechaiya *et al.*, 2019).

- Preemptively securing funding for selected early actions is fundamental for their timely implementation, as this removes obstacles during the often-narrow window of opportunity between a warning and hazard onset (United Nations Environment Programme, 2015; Risk-informed Early Action Partnership, 2021).
    - Funding should be contingent on specific triggers for the respective hazards monitored (Anticipation Hub, n.d.-d). Once a trigger is reached, funding should be released automatically.
    - When triggers cannot be decided in advance, the funding still needs to be released and mobilised swiftly, following the analysis of available evidence (International Federation of Red Cross and Red Crescent Societies, 2014).
    - Funding must be supplementary to regular programme funding and linked to wider financing strategies (Ibid.).

Suggestions to enable EWEA by the city authorities in secondary cities

- *Pass a resolution for developing an EWEA protocol in the municipal board or council meeting.*
- *Integrate the EWEA mechanism in the city disaster risk management policies or planning and city developmental planning processes.*
- *For the human or technological resources, and effective communication and monitoring for enabling EWEA, leverage the available resources with the central and provincial government.*
    - *Collaboration and coordination*
        - *Hire external experts or consultants.*
        - *Form partnerships with the local university or research bodies.*
        - *Collaborate with civil society organisations (CSO).*
        - *Coordinate with the local nodal agencies for disaster preparedness and response such as district/ provincial or national disaster management authority.*
        - *Form a core team or task force in the municipality that will lead the EWEA process; engage them in different training sessions to build their capacity.*
    - *Stakeholder engagement*
        - *Form a stakeholder expert committee and take the role of convener for the coordination meetings (to be held on a regular basis) and be responsible for the dissemination of information.*
        - *Identify community level champions and youth groups for warning communication and dissemination and monitoring of the indicators.*
        - *Form city volunteer groups and recognise them by integrating with the EWEA and DRR system in the city. Organise training and mock drill programmes for them regularly.*

- *Delegate responsibilities among different stakeholders and groups pragmatically for the management of the entire process.*
- *Harness local knowledge and perspectives through consultation processes with communities and local stakeholders. This is particularly crucial when access to critical technologies is limited. nvolve communities and stakeholders in setting up the indicators and for early actions. It is crucial to engage at-risk populations and involve a diverse set of stakeholders to inform the EWEA mechanism of the full range of needs on the ground.*

- *Knowledge exchange and capacity-building*
  - *Learn from the experience in setting up early warning systems and early action from other mega-cities in the region such as Mumbai, Chennai, Karachi and Dhaka, and develop a tailored approach as per the local context. Peer exchange can sometimes be more beneficial than formal training or capacity building initiatives.*
  - *Development of a continuous capacity-building process for the personnel or volunteers involved in the EWEA mechanism is essential. Examples of such activities include training, workshops, campaigns, public ward-level meetings, etc. The latter moreover presents a platform for local actors and municipalities to exchange experiences and form partnerships.*
- *Effective communication*
  - *Establish effective communication with the respective national agency that publishes the early warnings for different hazards, such as the Indian Meteorological Department (IMD).*
  - *Early warnings would be more impactful if they are shared by respective local authorities such as the municipality. This will facilitate trust-building for weather information among communities. The respective authority can map out community communication networks and design a communication system to reach out to the vulnerable population especially.*
  - *Use social media platforms (e.g., Facebook and WhatsApp), local TV, and radio channels to communicate with communities.*

3.4 Barriers to developing effective EWEA faced by secondary cities

- Secondary cities' limited resources may result in poor infrastructure conditions and limited urban planning (Cities Alliance, 2021). In conjunction with rapid urbanisation, this can lead to the development of informal settlements that concentrate disadvantaged populations (United Nations Human Settlements Programme, 2015).
  - Residents of informal settlements are disproportionately vulnerable and exposed to hazards (Brazzola and Helander, 2019). The limited data on their demographics and needs magnify the risks they face, as they often lack involvement in developing and implementing the core elements of EWEA and are rarely offered training in early warning early action elements (e.g., response mock drills) (Ibid.).
  - Limited ownership of mobile phones and barriers of linguistic dimensions can present further risks for these populations. They may be unable to access early warning information and act upon it; they may not speak the language the warning is presented in or lack sufficient interpretation skills of warning messages (United Nations Environment Programme, 2015; Rana *et al.*, 2021; Noori and Sherzad, 2020).

- Cities' variety and exchange of people can make it challenging to meet everyone's needs.

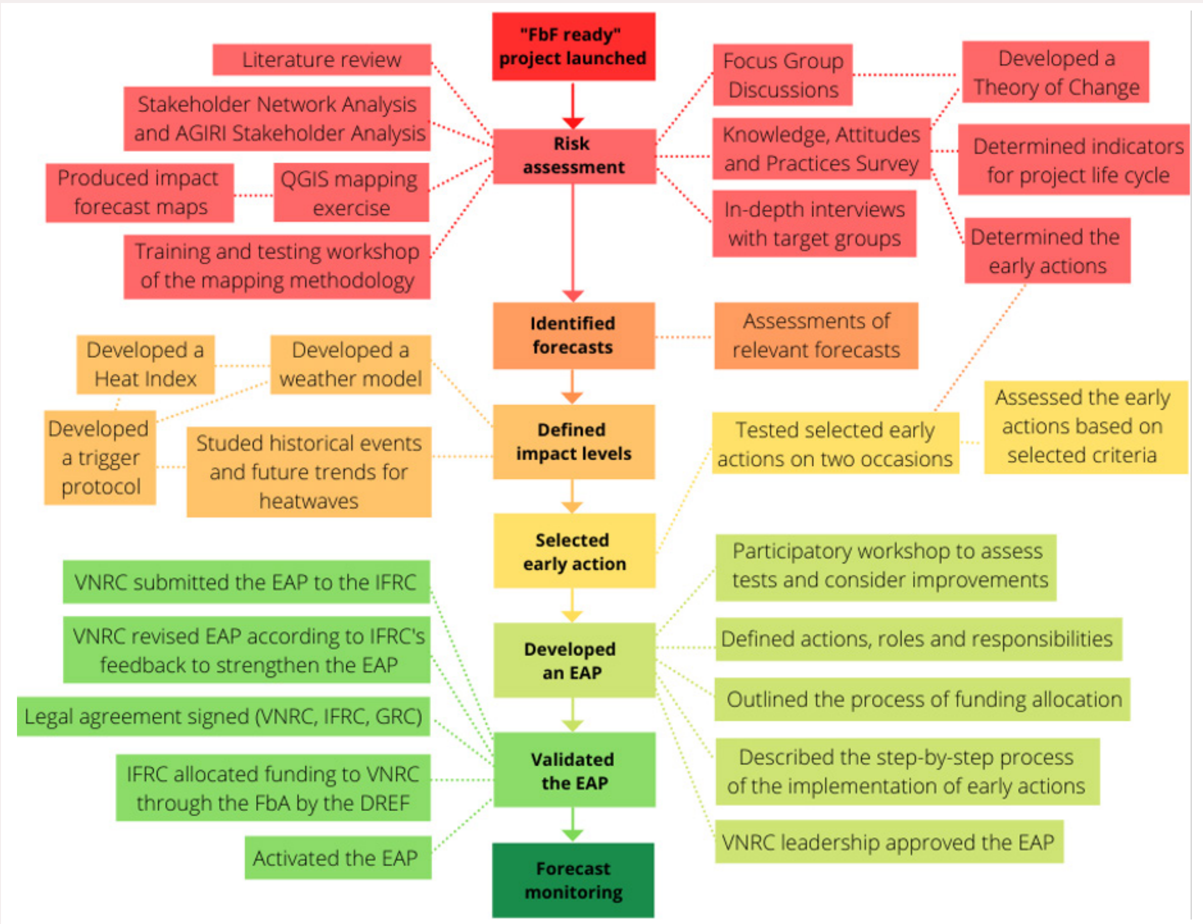
- Inadequate investment in technological infrastructure and the workforce's technical abilities directly challenges EWEA development and functioning (Brazzola and Helander, 2019). Consequences include the risk of gaps in data and limited lead-time which leaves a narrow window for early action (Tanner *et al.*, 2019).

- EWEA development is often limited by lack of policy investments in secondary cities, including the institutional framework for EWEA (Risk-informed Early Action Partnership, 2021; United Nations Development Programme, 2018).
  - This creates barriers in timely translation from early warning to early action (Ibid.).
  - There is a risk of fragmenting knowledge production and decision-making on warning thresholds as well as distorting the cohesive narrative of what EWEA is meant to achieve (Anticipation Hub, n.d.-d).
  - Structures on all levels still mostly gravitate towards relief activities (Tanner *et al.*, 2019). Risk avoidance culture reinforces reactive response models (Ibid.). This constrains possibilities of pre-allocating funding for early action.

Case study:
Implementation of FbF in Hanoi, Vietnam

In 2018, The Vietnam Red Cross (VNRC) and German Red Cross (GRC) launched their "FbF Ready" project, initiating the seven steps to implement the country's first forecast- based financing (FbF) programme (Vietnam Red Cross and German Red Cross, 2018a). The early actions they selected includes establishing cooling centres in facilities, buses and tents for people to rest, cool down, rehydrate and receive first aid as well as information on heat-related health effects; equipping housing in informal settlements with cooling systems and fans; and distributing cash to support poor households with paying utility bills (VNRC and GRC, 2019a). The programme reaches over 25,000 people when activated (Anticipation Hub, n.d.-a).

Figure 3. ***Flowchart of FbF implementation in Hanoi***



2 Vietnam Red Cross and German Red Cross, 2018a; Ibid., 2018b; Ibid., 2019a; Ibid., 2019b; Ibid., 2019c; Ibid., 2019d; Ibid., 2019e; Ibid., 2019e; Ibid., 2019f; German Red Cross, 2020; de la Poterie *et al.*, 2020

Summary

- The dynamism, density, and diversity of urban contexts have significant implications for early warning early action, and must be taken into account.

- Enabling contexts for the development of early warning early action systems in cities include:
  - existence of a functional and skillful early warning system by the national or state nodal agencies, with warnings interpreted for local contexts and language including the integration of actionable messages.
  - constructive partnerships with local stakeholders and experts, and effective communication mechanism for stakeholder coordination.
  - risk education and awareness generation among communities and emergency service providers.

- Similar conditions which make communities living in urban environments particularly vulnerable to certain hazards can also be barriers to the development of EWEA systems.

- Examining the (somewhat rare but robust) examples of recent EWEA development in urban contexts can be a good first step in applying these principles in other cities.

Chapter 4: Setting the scene for EWEA in South Asian cities

In South Asia, Early Warning Systems and Early Warning Early Action are developed at many geographic scales, ranging from regional to national and city-level.

4.1 Regional-level Early Warning Systems

Between 2000 and 2019, seven of the top 10 countries with the most absolute deaths from natural hazards, were located in Asia, including the South Asian countries of Sri Lanka, India and Pakistan. (Center for Research on the Epidemiology of Disasters and United Nations Office for Disaster Risk Reduction, 2020). South Asia in particular is the world's most exposed region to floods and second-most exposed to cyclones (Bhatt *et al.*, 2019). More than 45 per cent of the people in South Asia were affected by climate hazards during the 2000's (Amarnath *et al.*, 2017). 72 per cent of these people were located in India, 12 per cent in Pakistan and Bangladesh respectively and the remaining four percent scattered across Bhutan, Sri Lanka and Nepal (Ibid.). In approximately 30 years, cyclone-prone urban areas in the region will be home to 246 million people as rapid urbanisation will increase the number of exposed people (Ibid.). EWS in the region are thus crucial to reduce the pronounced disaster risks as they provide evidence for inciting life-saving early action.

Table 2. ***Examples of regional-level EWS in South Asia***

Regional EWS	Description
Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)	*Multi-hazard approach of hydro-meteorological events. In South Asia specifically, heads of national hydro-meteorological services collaborate through the South Asia Hydromet Forum, which WMO and the World Bank supports, as they foster climate resilience through the development of hydro-meteorological services.*[3]
Indian Ocean Tsunami Warning System (IOTWS)	*Monitors sea-levels and seismic measurements. Various work groups lead risk assessment and reduction; hazard detection, warning and dissemination and awareness and response.*[4]
Hindu Kush Himalayan Hydrological Cycle Observing System (HKH-HYCOS)	*Flood Early Warning System (FEWS) enabling transboundary coordination of data and knowledge between Bangladesh, Bhutan, China, India, Nepal and Pakistan. The FEWS has strengthened the capacity of each nation's hydrometeorological services across the region's 38 stations.*[5]
South Asia Flash Flood Guidance System (South Asia FFGS)	*The South Asia FFGS provides flash flood guidance and forecasts, and is able to provide risk warnings up to 24 hours in advance of forecasted flash floods. It can provide threat warnings six hours prior to the onset of flash floods.*[6]
South Asia Drought Monitoring System (SADMS)	*The system provides weekly drought condition maps which build on the Integrated Drought Severity Index, Standardised Precipitation Index and soil moisture data.*[7]

3 Aguirre-Ayerbe *et al.*, 2020; RIMES, n.d.

4 Schiermeier, 2011; Hettiarachchi, 2018

4 Singh, 2018

6 World Meteorological Organisation, 2020

7 United Nations Platform for Space-based Information for Disaster Management and Emergency Response, n.d.; International Water Management Institute, n.d.

4.2.1 Afghanistan

While Afghanistan has a legal framework and disaster-related policies and plans that recognise EWS as key to mitigate disaster risks, the country currently lacks a systematic network of national-level EWS (Noori and Sherzad, 2020). The National Water Affairs Regulation Authority (NWARA) and Afghanistan Meteorological Department (AMD) forecast flood risks and disseminate warnings and the former has snow monitoring capabilities. However, warnings remain at provincial level and lack enough local level detail to inform risk reducing activities (Ibid.). In recent years, the Government and supporting organisations have endeavored to address this. A prominent example is the ongoing project between the AMD, Turkish State Meteorological Service (TSMS) and World Meteorological Organisation (WMO) who are collaborating to strengthen the technical capacity of the workforce and existing hydrometeorological services in the country (United States Agency for International Development *et al.*, 2018). Key achievements so far include 24/7 access to weather and climate information for the authorities and public, providing the possibility to disseminate warnings over a 12 hour period prior to severe weather events. 70 ADM staff have also been trained (Ibid.).

In February 2021, the World Bank Board granted over 222 million US dollars for the Early Warning, Early Finance and Early Action project which will be implemented by the Ministry of Finance and Ministry of Rural Rehabilitation and Development until 2024. The project will invest in piloting new, and scaling up existing disaster risk financing instruments and systems that enable better response to drought risks, including EWS (Financial Protection Forum, 2021).

4.2.2 Bangladesh

Bangladesh is known for its Cyclone Preparedness Programme that is regularly put to test and has helped reduce the country's cyclone-induced mortality from hundreds of thousands in the 1970's to some dozens of people in the 2020's (Haque *et al.*, 2012). It has done so through rigorous investment in public education and awareness raising, early warning broadcasting, facilitation of evacuation and disaster relief and rescue (Mannan, n.d.). The early warning institutional mechanism responsible for risk knowledge and monitoring of cyclones, storms, drought, and cold and heatwaves is the Bangladesh Meteorological Department (BMD), which also houses the National Tsunami Warning Center. Responsible for floods, including both riverine and flash floods, is the Flood Forecasting and Warning Centre (FFWC) (Ibid.). The mandate and authority holder for warning dissemination lies at the DDM, which is specialised in disaster preparedness, disaster action planning at local level, contingency planning, awareness raising, training and drills and facilitating enhanced disaster information flows (Quader, 2020).

Future plans to develop Bangladesh's EWS include expanding upon DDM's hazard mapping, making their website more dynamic in terms of distribution of warning information and extending its hazard dissemination activities to encompass hazards beyond cyclones and floods (Ibid.). Ambitions have also been declared regarding, for instance, increasing lead-time, possibly by investing in seasonal forecasting; introducing a multi-hazard EWS; and strengthening the human resource and technical and technological capacity of the National Disaster Response Coordination Group (NDRCG), BMD and FFWC (Mannan, n.d.).

Since 2015, Bangladesh Red Crescent Society (BDRCS) and the World Food Programme (WFP) and German Red Cross (GRC), with support from the Red Cross Red Crescent Climate Centre, have been addressing flood, heatwave and cyclone risks through anticipatory action (Anticipation Hub, n.d.-b). The Early Action Protocols (EAPs) have been activated four times. Early actions implemented include installation of lights at shelters to enhance safety at nighttime; evacuation of at-risk population, assets and livestock with the assistance of tractors; and distribution of foods such as rice and energy bars as well as drinking water (Ibid.). In 2020, the BDRCS, GRC, RCCC and BMD began exploring opportunities to develop a Forecast-based Financing (FbF) programme for heatwaves in Dhaka, piloted in 2021 (Rahaman, 2021).

In 2017, Start Network established the Start Fund Bangladesh (SFB) (Start Network, n.d.-c). The fund holds 10 million pounds sterling for timely emergency response, to be released within 72 hours following an alert, and is accessible to local and international actors operating in the country. Since its founding, until December 2020, SFB has been activated 29 times in anticipation of hazards like floods, cyclones and heatwaves and in response to established crises (Ibid.).

Launched in 2021, an updated landslide EWS is now installed in Chittagong Metropolitan Area and Cox's Bazar (Bhasin, n.d.). The EWS consists of Tipping Rain Bucket gauges, and data loggers and solar panels which disseminate SMS as precipitation thresholds are met (Ibid.). Moreover, the warning system builds its landslide predictions on the use of satellite imagery, meteorological data and rainfall levels, enabling a lead-time of five days to take early action to mitigate risks of at-risk populations in, for instance, informal settlements (Climate Adaptation Platform, 2021).

Dhaka's Interactive Voice Response (IVR)

In the city of Dhaka, the Disaster Management Bureau has implemented an Interactive Voice Response (IVR) system to support information and hazard warning dissemination (International Organisation for Migration, 2020). The IVR mechanism enables the public to call an assigned telephone number to access information regarding the weather and early warning information throughout the city authorities' different stages of emergency response (Department of Disaster Management, 2011). The IVR was used prior and throughout landfall of the 2020 Cyclone Amphan, when at-risk populations could call the designated telephone number to identify shelter, livelihood, and sanitation and hygiene opportunities to meet their needs (International Organisation for Migration, 2020).

4.2.3 Bhutan

On a national level, Bhutan hosts a flood EWS – the country's top hazard in terms of number of deaths (World Meteorological Organisation, 2020a). Since Bhutan's most devastating glacial lake outburst flood (GLOF) disaster from Lake Luggye in 1994, the government of Bhutan has invested incrementally in GLOF risk mitigation (Shrestha *et al.*, 2016). Today, the country hosts 28 flood monitoring stations which measure river water level and rainfall data, that are jointly run by the Department of Hydromet Services (DHMS) and the Japan International Cooperation Association (National Center for Hydrology and Meteorology, n.d.).

In 2016, the DHMS presented their plans to strengthen the EWS infrastructure to enable the most high-risk locations throughout the country to be covered by an integrated EWS which operates 24/7 (Ibid.). This includes investments in the development of 70 automatic weather stations, 25 automatic water-level sensors,eight devices monitoring landslides and 35 pieces of integrated early warning systems.

4.2.4 India

The 2004 Indian Ocean tsunami was one of India's deadliest disasters, prompting the country's investments in EWS (United Nations Development Programme, 2014). In 2007, the Indian Tsunami Early Warning System (ITEWS) was established by the Ministry of Earth Sciences and is subsequently run by the Indian National Center for Ocean Information Services (INCOIS). ITEWS monitors tsunamis through Bottom Pressure Recorders, tide gauges, a network of seismic stations and a round the clock operational warning centre focused on detecting earthquakes. It also produces and communicates warning information for at-risk populations which provides a lead-time of 10-20 minutes for the vicinity of the Andaman and Nicobar Islands and a few hours for the mainland (United Nations, n.d.).

Beyond its tsunami EWS, India has a multi-hazard EWS (MHEWS) that includes monitoring of heavy rainfall, dust storms, strong winds, thunderstorms, heatwaves, cold waves, cyclones, sea state, frost and fog (India Meteorological Department, 2021). When warnings are triggered at different forecasting stations across the nation, they are sent to the IMD that disseminates the warning message through fax, email, SMS, Global Telecom System (GTS), WMO Information System (WIS), Interactive Voice Response System (IVRS), traditional and electronic media including, FM and community radio, TV, social media, along with warnings on the India Meteorological Department (IMD) website (Ibid.).

Start Network is the founder of India Humanitarian Hub (IHH), which aspires to act in ways that are new to the current humanitarian architecture (Start Network, n.d.-d). One of its three main pillars is new funding and financing mechanisms and future plans include establishing a mechanism of fund-pooling aimed at local donors (Ibid.). To enable more anticipatory action in the face of floods, the Indian Red Cross Society (IRCS) is currently developing an Early Action Protocol (EAP). This will establish the pre-agreed funding mechanism necessary for the implementation of FbA by the DREF (International Federation of Red Cross and Red Crescent societies, 2021).

In 2013, Ahmedabad implemented a warning system and preparedness plan for heat, the first Indian municipality to do so (National Resource Defense Council, 2013). Beyond warnings for extreme heat, the Heat Action Plan provides training to community outreach and medial workers; heat-health trainings for at-risk populations such as outdoor workers and school children and awareness raising campaigns among the general public.Its framework outlines the coordination mechanism for response activities as heatwaves strike (Ibid.). The Plan outlines early actions to undertake in anticipation of heatwaves, such as establishing cooling centres (Ibid.). Between 2015 and 2020, the Government supported 23 states and more than 100 cities throughout the nation to develop and implement their own Heat Action Plans, examples among which include Hyderabad, Nagpur, and Bhubaneswar (National Resource Defense Council, 2020). Ahmedabad's Heat Action Plan was a model built to scale, and the country is still expanding the implementation of Heat Action Plans to more cities exposed to extreme heat events (Ibid.; Padmanaban, 2021).

Flood is another key hazard in urban settings in India. Many cities have implemented Flood Early Warning Systems (FEWS), including Kolkata, Bangalore, Chennai, Surat, Guwahati, Shimla, Gangtok, Madurai and Mumbai (Karanth *et al.*, 2013; Avinash *et al.*, 2018; National Centre for Coastal Research, n.d.-a; The Energy and Resources Institute, 2020). In Kolkata, the FEWS can inform city authorities how to manage traffic and communities how to plan responses (Asian Development Bank, 2018).

Flood Early Warning System (FEWS) mechanisms in Chennai and Mumbai, India

In Chennai and Mumbai, city authorities have developed FEWS to manage the risks related to the cities' increasing frequency of urban floods.

The Chennai Flood Early Warning System (C-FLOWS) is hosted and developed by the National Centre for Coastal Research (National Centre for Coastal Research, n.d.-b). C-FLOWS is a decision support tool for the Tamil Nadu government in mitigating flood risks and managing relief operations. It does so through six modules, including: collection of meteorological, ocean state, satellite, discharge and flow data; a GIS database for city management and planning; 3D visualisation of flooding scenarios throughout the urban landscape; and flood vulnerability analysis based on a data library of previous flooding events, from which the module identifies past scenarios similar to current forecasts and conditions (NCCR, n.d.-c).

The Integrated Flood Early Warning System (I-FLOWS) in Mumbai is developed by the Ministry of Earth Sciences (MoES) and Municipal Corporation of Greater Mumbai (MCGM) (Press Information Bureau, 2020). Similar to C-FLOWS, I-FLOWS supports the Government of Maharashtra in decision making regarding flood risk mitigating activities (Ibid.). The system operates through seven modules, including: collection of weather, land use, infrastructure, population, lakes, creeks and river bathymetry data; a GIS database for city planning and management; and hydrodynamic models which analyse hazard impacts on the city (National Centre for Coastal Research, n.d.-a). I-FLOWS can provide flood warnings of up to 72 hours in advance.

4.2.5 The Maldives

The Maldives were also heavily influenced by the 2004 Indian Ocean tsunami and subsequently established an elaborate disaster risk management programme through the financial support of the German government (Shadiya, 2018). This included the establishment of EWSs and emergency response capacity development, as well as the development of institutional frameworks such as a disaster management policy (Ibid.). To monitor seismic activity, the Maldives Meteorological Service (MMS) instituted a National Tsunami Warning Center (NTWC).

While the Maldives has not established an MHEWS per se, the country does have the communication framework and necessary coordination mechanisms between MMS and the National Disaster Management Authority (NDMA) (Aguirre-Ayerbe *et al.*, 2002). The MMS monitors and produces early warnings linked to tropical cyclones, tsunamis, heavy rainfall, storm surges, and floods, and the NDMA is responsible for disseminating the early warnings to relevant agencies and the general public (Ibid.).

4.2.6 Nepal

On a national level, Nepal has a flood early warning system (FEWS) to support the country in managing risks related to one of the country's most prominent natural hazards (Kafle, 2017). The system incorporates both global and regional forecasts, monitors rain and river stream gauges, and helps produce national and sub-national forecasts, for which the Department of Hydrology and Meteorology (DHM) is responsible (Department of Hydrology and Meteorology, 2018). When river gauge readings surpass thresholds, which are measured every 15 minutes, a warning is triggered. The DHM subsequently issues an alert that is forwarded to relevant stakeholders and disseminated through bulletins on their website, social media and radio, as well as by SMS to the public (Ibid.). District Emergency Operation Centres (DEOCs), task force committees and the police are largely responsible for the response capacity. At local level this is reinforced with coordination by the District Disaster Management Committee (DDMC) and the Armed Police Force (Ibid.).

Since 2018, the Nepal Red Cross Society (NRCS), Danish Red Cross (DRC) and Red Cross Red Crescent Climate Centre (RCCC) have piloted Forecast-based Action (FbA) in anticipation of floods throughout the country (Anticipation Hub, n.d.-e). Early actions include deployment of volunteers and community evacuation (Ibid.).

Start Fund Nepal (SFN), launched by Start Network (n.d.-e), constitutes the nationwide contingency fund pilot aimed at enabling timely anticipation of, and response to, crises of small to medium magnitude throughout the country. The fund is yet to be activated (Ibid.).

In 2012, the Seti River in Pokhara flooded after an avalanche plummeted into the deep river upstream from the city. Water in the river had been backed up by previous rockslides and the natural dam burst, sending water and avalanche rocks downstream (Earth Observatory, 2014). The violent flooding left over 70 people missing in the valley upstream from Pokhara City. In the following year, the Nepalese Department of Hydrology and Meteorology implemented an EWS, in part by installing a climate station and river-level sensor which enabled real-time monitoring and communication of rainfall and river water-level from communities upstream to Pokhara (Bhandari, 2021). Warnings are disseminated using SMS, display boards, automatic sirens and through home visits to vulnerable households, and information is published on the DHM website (Meechaiya *et al.*, 2019).

4.2.7 Pakistan

The 2004 Indian Ocean tsunami coupled with the 2005 Kashmir earthquake constituted an awakening in terms of disaster management in Pakistan (Nawaz and Naeem, 2016). In the subsequent years, institutional arrangements were implemented and existing early warning systems strengthened. One of the highlights was the development of Pakistan's earthquake and tsunami early warning system established at the Pakistan Meteorological Department (PMD) in 2008 with the support of UNESCO and its Intergovernmental Oceanographic Commission (IOC) (Intergovernmental Oceanographic Commission, 2008). The PMD also hosts Pakistan's Tropical Cyclone Warning Center (Nawaz and Naeem, 2016).

In 2012, a new 10 year National Disaster Management Plan (NDMP) was created as an endeavor to shift response-oriented strategies to long-term disaster risk management (Mukhtar, 2018). This includes 10 interventions, of which one is developing an MHEWS targeting hazards including: flood, GLOF, landslide, cyclone and storm surge, avalanche, drought, tsunami, earthquake as well as health emergencies (National Disaster Management Authority, 2012). In the interim evaluation of the implementation of NDMP in 2016, it was stated that an array of improvements had been undertaken. Included in the 14 accomplishments were: an upgraded EWS, installation of a satellite-based Integrated Flood Alert System (IFAS), and replacement of automatic weather stations (National Disaster Management Authority, 2017). In the previous year, the implementation timeline of the NDMP had also been revised to stretch until 2030 (Mukhtar, 2018). There already exist forecast and warning mechanisms for floods, drought, tropical cyclones, earthquakes and tsunamis, however an integrated MHEWS is not in place and neither is effective coordination and liaison between agencies (Ibid.).

Start Network established a Pakistan Hub in 2020, which seeks to strengthen preparedness as well as predictable response to crises (Start Network, n.d.-f). A key achievement so far is the launch of a Disaster Risk Financing (DRF) system aimed at enhancing anticipatory action throughout the nation. In 2016 and 2018, the Start Network's Start Fund released funds in anticipation of heatwaves to undertake early action such as establishing heatwave camps equipped with first aid and emergency kit and hazard communication through billboards, SMS, radio and public service announcements on taxis and rickshaws (Start Network, 2016; Start Network, 2018b).

While Pakistan lacks city-level EWS, it does host DRF systems for a variety of urban contexts (Start Network, n.d.-g). The Pakistan DRF model builds on three pillars, namely using science to grasp and quantify risks, developing pre-agreed emergency plans, and prepositioning of funds once pre-established triggers are met (Ibid.). In cities such as Karachi, Larkana, Multan, Sibi, Nawabshah and Jacobabad, DRF systems can release funds to enable the implementation of early actions when anticipating extreme heat (Ibid.).

4.2.8 Sri Lanka

In Sri Lanka, the MHEWS focuses on riverine flood, landslide, flash flood, tropical cyclone, storm surge, earthquake and tsunami (Disaster Management Centre, n.d.). The forecasting is largely operated by the Department of Meteorology and the Irrigation Department, while the Disaster Management Centre (DMC) is the hub responsible for early warning coordination and dissemination and the maintenance of equipment (Ibid.). Other key responsibilities include developing strategy and policy related to disaster risk management and running awareness raising and capacity building activities regarding responding to early warnings. Additional institutions involved in the EWS framework are the National Disaster Relief Services Centre, National Council for Disaster Management, National Disaster Management Committee, Marine Environmental Protection Authority, Geological Survey and Mines Bureau, and Coast Conservation Department (Aguirre-Ayerbe *et al.*, 2020). Apart from the monitoring systems, none of the core elements of EWS are considered fully developed (Ibid.).

While Sri Lanka does not house its own anticipatory programme, between 2015 and 2020, the Start Fund released funding at four occasions for the implementation of early action in anticipation of floods (Start Network, 2015; Start Network, 2018a; Start Network, 2018c; Start Network, 2021). Actions implemented include distributing chlorine tablets, plastic bags for sandbagging and debris cleaning machines; establishing temporary learning centres; and leading awareness raising campaigns on health and hygiene practices (Ibid.).

Table 3: ***Existing EWS and EWEA in each South Asian country***

	National EWS	City EWS	Future plans for EWS	National EWEA	City EWEA	Future plans EWEA
Afghanistan	*Flood, Snow*	*None*	*Ongoing project by AMD, TSMS, WMO to strengthen the capacity of work-force and hydromet services*	*None*	*None*	*In 2021-2024, the 'Early Warning, Early Finance and Early Action' project will be implemented*
Bangladesh	*Cyclone,Cold wave, Storm; Drought, Flood, Heatwave;, Tsunami*	*Landslide EWS in Chittagong Metropolitan Area and Cox's Bazar*	*Improve the EWS' hazard mapping, communication, dissemination; Enhance human technical capacity; Increase lead time; Introduce MHEWS*	*FbF programme by GRC, BDRCS, WFP, RCCC; Start Fund Bangladesh by Start Network*	*None*	*None/Unknown*
Bhutan	*Flood, including GLOF*	*None*	*Ongoing capacity building and investments, e.g. development of 35 sets of integrated EWS; 70 automatic weather stations, 8 automatic water level sensors etc.*	*None*	*None*	*None/Unknown*
India	*MHEWS (Dust storm, rainfall, strong wind, cold wave, sea state, cyclone, heatwave, fog, thunderstorm, frost); Tsunami; Earthquake*	*FEWS in e.g. Shimla, Surat, Kolkata, Chennai, Bangalore, Guwahati, Madurai and Mumbai*	*None/Unknown*	*India Humanitarian Hub by Start Network*	*Heat Action Plans in over 100 cities e.g. Nagpur, Ahmedabad, Hyderabad, Bhubaneswar etc*	*EAP through FbA by the DREF currently developed by IRCS*
Maldives	*Cyclone, Heavy rainfall, Storm surge, Flood, Tsunami*	*None*	*None/Unknown*	*None*	*None*	*None/Unknown*

	National EWS	City EWS	Future plans for EWS	National EWEA	City EWEA	Future plans EWEA
Nepal	*Flood*	*FEWS in Pokhara*	*None/Unknown*	*FbA by NRCS, DRC, RCCC; Start Fund Nepal*	*None*	*None/Unknown*
Pakistan	*Tsunami, Earthquake, Drought, Cyclone, Flood*	*None*	*Ongoing MHEWS development (flood, landslide, cyclone, storm surge, avalanche, drought, tsunami, earthquake)*	*Pakistan Hub by Start Network; Start Fund by Start Network has released funds in anticipation of heatwaves*	*Disaster Risk Financing systems for heatwaves in Sibi, Karachi, Multan, Larkana, Jacobabad, Nawabshah*	*Plan to expand and develop the Pakistan Hub, e.g. by bringing Start Fund funding mechanism into Pakistan Hub and other funding mechanisms.*
Sri Lanka	*MHEWS (riverine and flash floods, cyclone, storm surge, tsunami, earthquake)*	*None*	*None/Unknown*	*Start Fund has released funds in anticipation of floods*	*None*	*None/Unknown*

Summary

- All countries in South Asia have some form of national EWS and are covered by a number of regional EWS which provide foundations from which to establish new and reinforce existing EWEA programmes, both at national and city level.

- City EWSs exist in a great variety of urban settings throughout three countries in South Asia, focusing on heatwave, flood and landslide.
  - The city of Hanoi in Vietnam presents a salient example of a city-specific EWEA programme. Heat action plans are also implemented in over 100 cities in India.

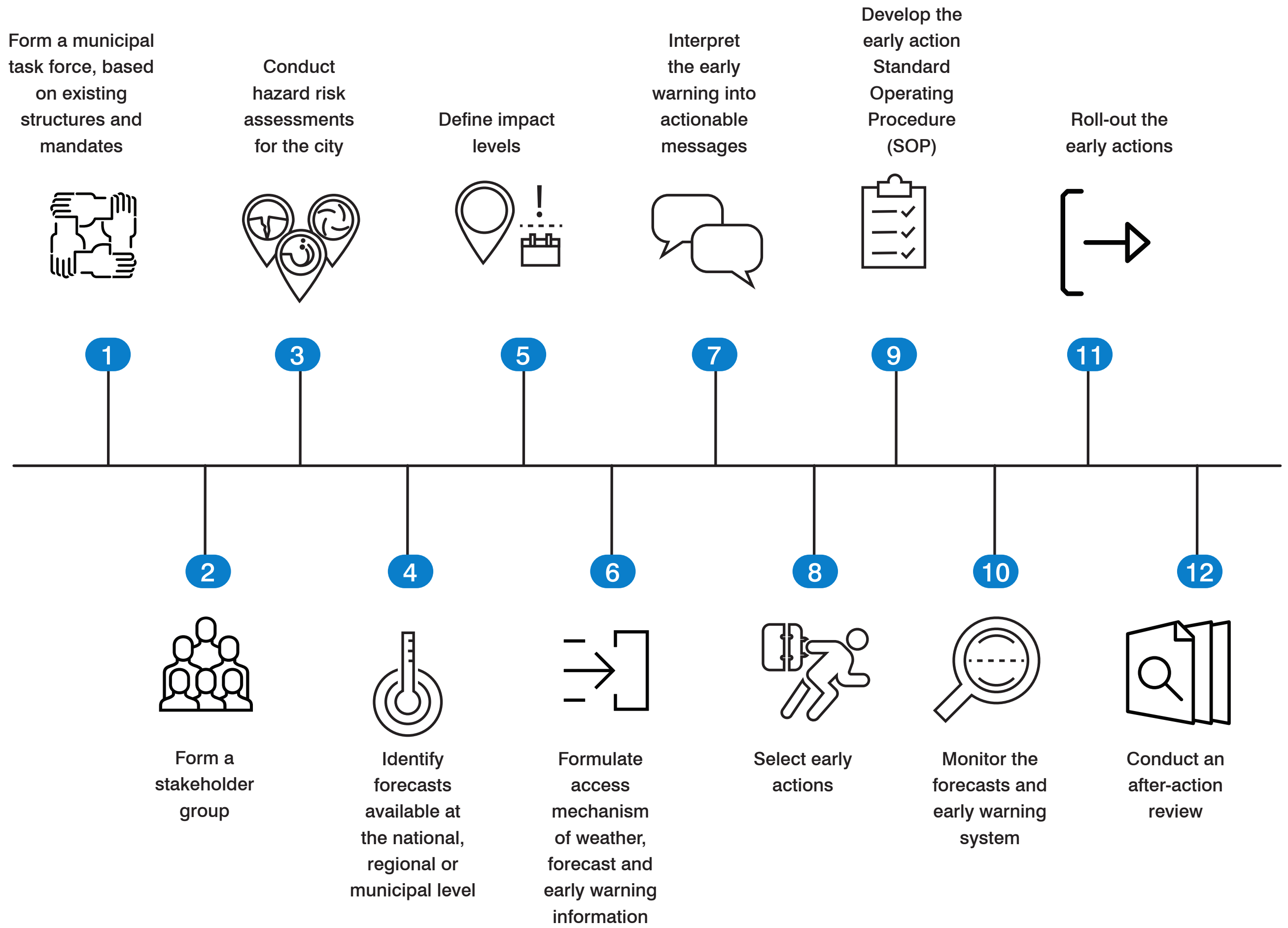
- Dialogue and cooperation between city authorities and humanitarian actors in cities that share characteristics can enable fruitful exchange of best practices, methodologies and learnings, thereby facilitating scale-up of EWEA for additional cities.

- Further mainstreaming of anticipatory action in disaster risk management on all levels of government will facilitate scale-up of EWEA programmes (Anticipatory Action Task Force, 2021).
  - Increased political recognition can enable greater pre-allocation of funding for early action.
  - Predictable, flexible and timely release of funding is key to implementing needed action and tightening the gap between early warning and early action. Investments in response capacity will require more funding.

Chapter 5: Guidance on EWEA development for secondary cities

The figure below lists the major steps in implementing EWEA and the sections below give a simplified overview of the different steps if applied in a secondary city.

Suggested EWEA development process for secondary cities



1. **Form a municipal task force based on existing structures and mandates:** The task force will facilitate the entire process of developing, implementing and maintaining the EWEA mechanism. It will ensure early actions are taken on time to reduce the risks facing communities. Further, they will coordinate with city stakeholders and other government departments, and nodal agencies for weather and forecast information; and roll out effective communication mechanisms with city residents and vulnerable communities. The role of the task force is critical, in particular when the city authority does not have a designated officer or specialist to carry out the EWEA. Ideally, the task force should be formed by engaging the key officials from the critical municipal departments directly linked with disaster management. However, it should be at the discretion of the respective city authorities and its decision-making bodies.

    - **Who:** Municipal officials with around 4-5 members (e.g., disaster, planning, engineering, social development and health departments)? The municipality can also delegate to a civil society actor such as a National Red Cross or Red Crescent (RCRC) Society to take the lead as convener.

    - **When:** At the initiation stage to kick off the process.

2. **Form a stakeholder group:** The stakeholder group will hold a pivotal role in the decision-making process. It will be engaged in iterative and extensive consultations to understand the risks (especially those of vulnerable communities), identify the thresholds, outline the early warning messages, identify early actions and determine the SOP, as well as in the after-action review process. There is no one-size-fits-all approach for stakeholder mapping. Selection of the analytical perspective depends considerably upon the objectives and scoping of the EWEA process.

    - **Who:** Relevant municipality and government departments in the city/region; civil society organisations; local universities, colleges and institutions; private bodies such as small and medium-sized enterprises groups or business associations; community representatives or leaders; religious leaders; local media houses; and other relevant actors.

    - **When:** During the kick-off meeting.

3. **Conduct hazard risk assessments for the city:** Identify, analyse, map and assess hazards, vulnerability, and exposure, as well as their likelihood and potential impacts. These assessments are carried out to outline historical impacts and gauge current and prospective hazard risks. These will moreover help the city prioritise risks. Assessments can be done through literature and historical data reviews, census reviews, mapping, community and stakeholder consultations, and the Enhanced Vulnerability and Capacity Assessment (EVCA) developed by IFRC[8]. It can also be helpful to visualise and calculate risks through a seasonal hazards calendar and risk matrix and to use tools such as geographical information systems, as well as hazard and climate change projections. Note that activities such as these are likely already conducted at municipal level, potentially under different departments so this may also be more of a translation or data gathering exercise.

    - **Who:** Task force and stakeholder group.

    - **When:** Once the initiative is officially kicked off and then updated regularly.

4. **Identify forecasts available at the national, regional, or municipal level:** Hydro-meteorological forecasts and observations form the basis of hazard early warning systems. Note that if the country already has an Early Action Protocol, or Standard Operating Procedure, this step and the next could be disregarded and the trigger could be the same. Identification of forecasts is already done in the national early warning system and the city must understand how this applies to them, and their coverage and implications in the respective cities. The task force is, however, advised to assess whether the forecasts used in the national EWS are sufficiently detailed and granular at city level. Note that this type of activity may require significant technical expertise which can be found at the national hydromet agency and in local universities, to name a few. If additional forecasts are needed, a first step can be to investigate if e.g. governments or partners or have reliable information of use.

    - **Who:** National hydrometeorological service, state or provincial nodal agencies, city task force, and stakeholder group.

    - **When:** Once and updated regularly to bring in new products and capacity.

8 https://www.ifrc.org/risk-assessment-and-planning

5. **Define impact levels:** Understanding the potential impacts of a hydrometeorological hazard and the level at which a specific phenomenon is likely to have significant or "extreme" impacts is a key step in building anticipatory action programmes. Defining impact levels will then determine the point at which the city and its various stakeholders should take action (i.e., "thresholds" which, if reached, will trigger early action). Through this comes a definition of normal and atypical/extreme periods for early action to be triggered. The data identified in the risk assessments can be particularly useful for this step. This may very well be a concept already familiar to many emergency and early warning services.

    - **Who:** Task force and stakeholder group.

    - **When:** Once and updated regularly to account for changing conditions.

6. **Formulate an access mechanism of weather, forecast and early warning information:** City authorities are dependent on the respective nodal agencies in their countries, such as the Department of Hydrology and Meteorology (DHM) in Nepal and India Meteorological Department (IMD) in India, for forecasts and weather information. However, in most cases, the information does not come to the secondary city authorities directly. A mechanism to access information swiftly will facilitate effective dissemination to communities and support early action. It would be advisable to assign a focal officer to communicate with the respective national and local nodal agencies on a regular basis.

    - **Who:** City authority/city task force or other convening agencies such as the International Red Cross and Red Crescent Movement.

    - **When:** Once and updated regularly to account for changing conditions.

7. **Interpret the early warning into actionable messages:** Municipal authorities provide a gatekeeper point of contact for their communities and may feel the need to translate the early warning messaging received by national hydrometeorological services into actionable messages for their citizens. The messages passed on to communities have to be easy to understand, impact-based (describe what the weather will *do*, not just what it will *be*) and contain clear instructions for recommended actions. Capacity within municipal agencies to have this translation role is important. Cities should also consider developing frameworks and mechanisms to allow them to interpret the forecast into actionable messages through stakeholder consultations. Additional considerations should include decisions informed by behavioral research (e.g., how people perceive risks, which communication channels at-risk populations use, and what motivates people to act).

    - **Who:** City authority/city task force or other convening agencies such as the International Red Cross and Red Crescent Movement and stakeholders group.

    - **When:** Once and updated regularly to account for changing conditions.

8. **Select early actions:** Early actions to mitigate the impacts of upcoming extreme weather must be identified, prioritised, and designed. This can be done through; stakeholder consultations, analysis of case studies or experience from other cities, exploring local and indigenous knowledge and developing a theory of change examining links between the proposed early action with its desired outcome. After having listed possible early actions, test them thoroughly to verify their eligibility.

    - **Who:** City task force or other convening agencies such as the International Red Cross and Red Crescent Movement and stakeholders group.

    - **When:** Once and updated regularly to account for changing conditions.

9. **Develop the early action Standard Operating Procedure (SOP):** Standard Operating Procedures document that describes the functioning of early warning early action mechanisms. The document should detail the risk analysis, trigger, early actions, funding mechanism, monitoring and evaluation provisions, and any other component deemed crucial to the maintenance of the EWEA system. Once the SOP is authored, it must be validated by the stakeholder group as well as local and/or external experts.

    - **Who:** City authority/city task force or other convening agencies such as the International Red Cross and Red Crescent Movement and stakeholders group.

    - **When:** Once and updated. Each update should have some form of re-validation by experts.

10. **Monitor the forecasts and early warning system:** This component is usually already built into established early warning systems but city authorities and the task force should keep a trained eye on these forecasts and ensure constant communication with the national hydromet office.

    - **Who:** National hydrometeorological service; City authority/city task force or other convening agencies such as the International Red Cross and Red Crescent Movement.

    - **When:** Constant.

11. **Roll-out the early actions:** Early actions are deployed when the forecasts and/or observations reach the predetermined threshold(s). No cost, low cost and costly actions can also be rolled out, based on contingency budgets and other funding.

    - **Who:** City and response teams. Consider bringing the national/state disaster response teams and National Red Cross or Red Crescent Society if pertinent.

    - **When:** When the threshold is reached.

12. **Conduct an after-action review:** Monitoring and evaluations are key to garner insights and lessons learned from the EWEA for the respective risks. These should be conducted with robust methodologies through quantitative analyses, structured consultations and shared learning dialogue.

    - **Who:** City authority/city task force or other convening agencies such as the International Red Cross and Red Crescent Movement and stakeholders group.

    - **When:** After the risks for the particular hazard are over or conducted seasonally.

5.1 How to prioritise risks

The goal of prioritising risks is to identify the main disaster risks in a particular city. This is central to understanding the key threats, including populations most at risk and is key to the development of an effective EWEA mechanism.

- If this is not already outlined, define the scope of the EWEA mechanism (including geographical boundaries, at-risk populations and specific hazards). This can be done by analysing existing data on e.g., previous disasters and seasonality, such as seasonal hazards calendars, risk and vulnerability assessments and hazard and climate change projections.

- Identify which hazards have had a critical effect on the city and/or are likely to materialise in the future. Map the areas and population groups that were most affected. This can be done by analysing data on hazard and climate change projections and previous disasters.

- Pinpoint the likely season(s) and frequency of each hazard. This can be done by analysing past disasters and seasonality data.

- Assess the expected impact of each hazard, including the numbers affected from each population group and the area most at risk. This can be done by analysing data on previous disasters and consultations with stakeholders.

- Calculate the risks for each hazard by making a risk matrix. This can be done by quantifying the likelihood and estimated impact of each hazard. Note that a risk matrix can be created in numerous ways. Here is one simple example:
  - Assess and determine the likelihood of each hazard occurring in the next 12 months: Rare (1), Unlikely (2), Possible (3), Likely (4), Certain (5).
  - Assess and determine the impact of each hazard, considering both magnitude and severity: Insignificant (1), Marginal (2), Moderate (3), Critical (4), Catastrophic (5). To calculate the final risk level of each hazard, multiply the values obtained for each variable (likelihood x impact) to classify its seriousness. 1-7 is low, 8-14 is medium and 15-25 is high.
  - To gain an overview of the hazard risks, place the hazards in a risk matrix such as the one shown below (see Table 4). The higher the final value, the more severe the hazard risks and the higher will you need to prioritise them.

Table 4: ***One example of a risk matrix***

Likelihood \ Impact	Insignificant	Marginal	Moderate	Critical	Catastrophic
Rare	1	2	3	4	5
Unlikely	2	4	6	8	10
Possible	3	6	9	12	15
Likely	4	8	12	16	20
Certain	5	10	15	20	25

5.2 A seasonal hazards calendar: What is it, and why is it useful?

A seasonal hazards calendar is a calendar in which you aggregate data on hazards and their impacts. This practice can help you gain clarity on when crises tend to occur and detect possible compounding risks to be aware of. Crucially, it can enable a fruitful process to identify which indicators to monitor in the early warning system and potential periods when monitoring should be intensified, as well as the different "windows of opportunity" during which to implement impact-mitigating early actions.

The seasonal hazards calendar of your making will depend on which hazards your risk quantifications identify as the highest priority. Say you have identified heatwaves, floods and tropical cyclones as the main risks for your city, then the calendar and its indicators can look something like the example below (see Table 5). Note, however, that the example is non-exhaustive and that hazards and impacts differ between contexts, which is why it is crucial that you conduct assessments and identify those of your own city. These calendars should also take into account changing risks, shifting seasonal patterns etc. The past is not always a guarantee of the future, especially with climate change increasing unpredictability.

As you collect and assess data, note in the calendar, the periods of time when risk is increased. Should you find that there are differences in risk between at-risk populations, which there often are, consider color-coding the markings differently to enhance the level of detail and potential efficiency of the targeted early actions.

Table 5: ***One example of the layout of a seasonal hazards calendar***[9]

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hazards	*Flood*												
	Cyclone; storm surge												
	Heatwave												
Impacts of hazards	*Lack of drinking water*												
	Lack of irrigation water												
	Damaged infrastructure												
	WaSH-related illnesses												
	Displacement												
	Poor air quality												
	Heat-related health illnesses												
	Hazard-related morbidity												

5.3 How to choose indicators and set thresholds

As mentioned in chapter 3, indicators to be monitored in the EWS require predictability, timeliness, sensitivity and reliability to enable them to detect divergences from normal trends and to trigger warnings early. This is key to providing sufficient "windows of opportunity."

One way to identify relevant indicators is to collect and assess data on previous disasters in your city. Investigate whether indicators have proved to correlate (as in, increase and decrease) with recorded impacts and if one or more do correlate, how early the indicators show signs of deviation. This will point to how well the indicators serve their purpose. It is advisable to select indicators based on both forecasts and seasonal observations, as well as vulnerability and exposure factors.

Once you have selected indicators, the next phase entails setting their thresholds. The latter entails the predetermined extent of the forecast hazard-induced impact that will trigger early action. Here are some of the steps that can help you to identify thresholds:

9 Anik and Khan (2012)

- Review historical data to understand how the indicators behave e.g. if they fluctuate predictably throughout the seasons or if they remain largely the same.
- Use observations and historical data to identify what constitutes “normal” and “atypical” or ”extreme” periods for each indicator.
- Once you have agreed on thresholds for each indicator, test their ability to provide timely alerts and early warnings when the relevant hazards are forecast to occur. Repeat this step until you have identified threshold levels that maximise the “windows of opportunity” yet ensure that forecasts hold a high degree of certainty.

When indicators vary in importance, make a weighting system

Most often, indicators have different levels of importance and varying ability to detect deviations. For this reason, they must be weighted against each other and allocated different values. One straightforward way of going about this is simply to assign values between 1 to 5 to each indicator (where 1 is of lower relevance and reliability and 5 is of higher relevance and reliability), throughout the process of assessing, setting and testing thresholds.

Say, for example, that you have selected three indicators and they are attributed different values, as in weight and importance. This means that you will have to calculate the average of partial scores. Indicator #1 can for instance be given a 3 (33,33 per cent), Indicator #2 a 4 (44,44 per cent), and Indicator #3 a 2 (22,22 per cent). Together, they total at 100 per cent. Combining indicators through a weighting system will allow you to finetune the monitoring and trigger of your early warning system, by creating a balance between your indicators. Note that since indicators’ relevance change seasonally, each indicator must be weighted accordingly. Make sure to test and adjust indicator values as regularly as needed to find the most reliable balance.

Table 6: ***Examples of early actions of low to no cost***

Action(s)	Hazard(s)
Disseminate weather forecast information, early warning and early action messages to at-risk populations	*All*
Launch an awareness campaign regarding recommended temporary behavior changes during heatwaves	*Heatwave*
Distribute heat-related health information and instructions on how to prevent heat-related illnesses	*Heatwave*
Open cooling centres in existing facilities and tents to provide refuge for people to cool down and hydrate	*Heatwave*
Provide first aid for people suffering from mild heat-related conditions	*Heatwave*
Assist in referring people struggling with severe heat-related conditions to nearby hospitals or health centres	*Heatwave*
Dig trenches and embankment to divert flood water	*Flood*
Reinforce riverbanks to avoid erosion and prevent flooding	*Flood*
Collect waterproof silos/containers/bags to enable rapid distribution	*Flood; tropical cyclone*
Clear drainage infrastructure to prevent clogging and flooding	*Flood; tropical cyclone*
Train volunteers to deliver education programmes related to water, sanitation and hygiene promotion	*Flood; tropical cyclone*
Fill and pre-position sandbags to enable swift distribution	*Flood; tropical cyclone*
Distribute sandbags and assemble sandbag constructions to prevent damage of households and assets, and contain flooding	*Flood; tropical cyclone*
Distribute chlorine tablets for water purification	*Flood; tropical cyclone*
Prepare "go bags" with essential items to enable swift evacuation	*Flood; tropical cyclone*
Provide evacuation assistance for at-risk populations and their assets	*Flood; tropical cyclone*
Provide first aid at shelters	*Flood; tropical cyclone*

Forecast-based Financing (FbF) Practitioners Manual

For more in-depth guidance on the above issues and more, consult the FbF Practitioners Manual at https://manual.forecast-based-financing.org. The manual is a step-by-step guide for the implementation of anticipatory approaches such as EWEA and FbF, including key questions for assessments and other technical assistance and advice.

Chapter 6: Frequently Asked Questions (FAQ)

What is EWEA?

The concept of Early Warning Early Action encompasses the provision of useful and timely information, which empowers people to take humanitarian action designed to mitigate impacts of hazards.

How does EWEA function?

EWEA builds on Early Warning Systems to trigger a warning once hazardous thresholds have been reached. This creates a so-called "window of opportunity" between the warning and the hazard materialisation, during which pre-agreed early action can be implemented to preemptively mitigate humanitarian impacts.

How will EWEA benefit secondary cities?

By implementing EWEA, secondary cities can significantly increase their resilience to natural hazards and will have the means to protect more lives, livelihoods and assets. Acting in anticipation of a hazard is more cost-effective and provides more dignified aid than acting once a crisis has unfolded, so investing in EWEA can be an effective way to utilise secondary cities' scarce resources.

Which are the core components of EWS?

- Risk knowledge: systematic collection and analysis of risk information.
- Monitoring and warning: risk detection and analysis, and hazard forecasting.
- Dissemination and communication: warning messages are drafted and disseminated.
- Response capability: risk education and preparedness programmes, including drills.

How can secondary cities create an enabling context for EWEA?

Some of the steps toward implementation of EWEA include (see all at page 21-22):

- Form a core team or task force in the municipality to lead the EWEA implementation and maintenance process, and build their capacity through training and drills.
- Form a stakeholder expert committee and take the role of convener for regular coordination meetings.
- Harness local knowledge through consultation processes with stakeholders, including setting up the indicators and triggers.
- Hire external experts/consultants, if it is possible.
- Form city volunteer groups and integrate them within the EWEA and overall DRR frameworks in the city.Offer training, drills and simulations regularly.
- Collaborate with Civil Society Organisations (CSOs) and humanitarian organisations.
- Learn from other cities' experience in implementing EWS and early action mechanisms, e.g. Karachi, Mumbai and Chennai.

When to start the EWEA development process?

As soon as possible, acknowledging that many of the components of early warning early action may already exist, albeit under a different name and as yet uncoordinated. Anticipatory action has a high return on investment. It saves more lives and limits human suffering, and reduces costs associated with disaster response and disaster recovery.

Who are the important actors in EWEA in cities?

City and municipality authorities, hydrometeorological institutions, disaster management department, emergency service providers, at-risk populations, civil society organisations, community-based organisations, universities or research centres, businesses or small and medium sized enterprises (SMEs), humanitarian and development actors and the media.

What are key recommendations for implementing EWEA in secondary cities?

- Existence of a functional and skillful early warning system by national or state nodal agencies, with warnings interpreted for local contexts and language and including the integration of actionable messages.
- Constructive partnerships with local stakeholders and experts and effective communication mechanism for stakeholder coordination.
- Risk education and awareness generation among communities and emergency service providers.
- Risk/vulnerability mapping through community participation.
- Develop early action SOP in coordination with different stakeholders and backed by the vulnerable communities.
- Examining the (somewhat rare but robust) examples of recent EWEA development in urban contexts can be a good first step in applying these principles in other cities.

What are the policy interventions that secondary city authorities require to enshrine EWEA in the functioning of a city?

- Passing a resolution for developing an EWEA protocol in e.g. the municipal board meeting.
- Integrating the EWEA mechanism in the city disaster risk management policies.
- Developing an EWEA Standard Operating Procedure, including e.g. defined actions, roles and responsibilities and a description of the coordination mechanism' and a step-by-step outlining of the implementation of early actions.

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Annex

Glossary

Early Action Protocol (EAP)

An Early Action Protocol (EAP) functions as a guide for National Societies in the International Red Cross and Red Crescent Movement and its partners (IFRC and GRC, 2018). The EAP outlines roles and responsibilities of the actors involved, and encompasses information on which triggers are set for respective hazards, which early actions to implement, and the funding allocation of the pre-agreed financing of early actions (RCCC, IFRC and GRC, 2020). Importantly, it contains a step-by-step implementation plan for early actions after a threshold is met (Ibid.).

Trigger

A trigger entails that a pre-agreed probability threshold and danger level of a hazard is exceeded, e.g. by a forecast (RCCC and GRC, n.d.). The trigger, in turn, sets into motion the release of predetermined funding allocation and implementation of early action (Ibid.).

Indicator

An indicator gauges the state of something, which in Early Warning Early Action typically relates to hazard, vulnerability and exposure levels (RCCC, IFRC and GRC, 2020).