

# Disaster Early Warning Systems in Nepal: Institutional and Operational Frameworks

Shesh Kanta Kafle\*

Disaster and Climate Change Study Centre, Nepal (DCCSC Nepal), GPO Box 8365, Kathmandu, Nepal

## Abstract

Early warning systems (EWS) are recognized in both the Hyogo Framework for Disaster Reduction (2005-2015) and the Sendai Framework for Disaster Risk Reduction (2015-2030) as an important element of disaster risk reduction and hence to the achievement of sustainable development and sustainable livelihoods. An effective EWS enables the concerned authorities and at-risk communities to know about the hazards of the locality, community vulnerability and impending risk, warning messages, and building and mobilizing their response capability to reduce risks. The Government of Nepal has reported significant achievements in the development and implementation of EWS for floods, landslides, and Glacial Lake Outburst Floods (GLOF). However, this study shows that Early Warning systems have covered only a few hazards and location so far, and has not been able to cover all the four components of the effective community based early warning system. The absence of policy and legal frameworks has weakened the efforts of the establishment and strengthening of effective and functional early warning systems in the country. The response capacity building of communities is scattered and project-based.

This paper outlines the status of EWS in Nepal, key gaps and challenges, and proposes a framework for a people-centred early warning system in the country.

**Keywords:** Disaster early warning systems; Operational frameworks; Nepal

## Early Warning Systems: Constructs and Definitions

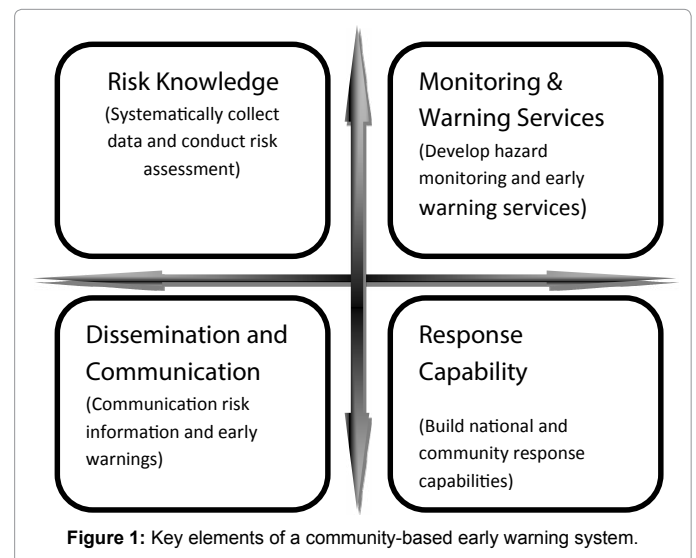
The Early Warning System is a process in which community risk knowledge is acquired and disseminated to the at-risk communities prior to the disasters strike. In other words, “the set of capacities needed to generate and disseminate timely and meaningful warning information, to enable those threatened by a hazard to prepare and act appropriately and in time to reduce the possibility of harm or loss” [1]. Practical action [2] defines Early Warning System as “the provision of information on an emerging dangerous hazard that enables advance action to reduce the associated risks”. Early warning systems include a chain of concerns, namely: understanding and mapping the hazard, monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings [3].

The ultimate goal of early warning systems is to protect lives and property, and they therefore constitute one of the key elements of any disaster reduction strategy [4]. Early warning is about the provision of information to individuals, households, groups or a community about:

1. The existence of danger or hazard
2. What can be done to prevent, avoid or minimize the danger?
3. Receiving the early warnings, analysing the messages, disseminating the warnings and responding them are the key steps of the early warning system.

The traditional framework of early warning systems is composed of three phases: monitoring of precursors, forecasting of a probable event, and the notification of a warning or an alert should an event of catastrophic proportions take place [5]. An improved four-step framework being promoted by many risk management institutions includes the additional fourth phase: response capacity building. The purpose of this fourth element is to recognize the fact that there needs to be a response to the warning, where the initial responsibility relies

on emergency response agencies (ibid). A complete and effective early warning system should comprise all these four inter-related elements: Risk knowledge, monitoring and warning service, dissemination and communication, and response capability (Figure 1). A weakness or failure in any one part could result in failure in achieving the essence of the entire system [6,7].



\*Corresponding author: Shesh Kanta Kafle, Disaster and Climate Change Study Centre, Nepal (DCCSC Nepal), GPO Box 8365, Kathmandu, Nepal, Tel: +977 9841623891; E-mail: [shesh.kafle@gmail.com](mailto:shesh.kafle@gmail.com)

Received March 27, 2017; Accepted April 19, 2017; Published April 21, 2017

**Citation:** Kafle SK (2017) Disaster Early Warning Systems in Nepal: Institutional and Operational Frameworks. J Geogr Nat Disast 7: 196. doi: [10.4172/2167-0587.1000196](https://doi.org/10.4172/2167-0587.1000196)

**Copyright:** © 2017 Kafle SK. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

“Community based early warning system (CBEWS) is a system developed, managed and maintained by the community itself. In this process the empowering of the people/community will be in the center. The role of supporting organizations will be to facilitate active and meaningful participation of all community members. Ultimately the EWS will be owned by the community [8]. Effectiveness, efficiency, equity and legitimacy are considered as the essential elements of the system. The essential features of the CBEWS include (Mercy Corps and Practical Action, 2010).

- All community members especially the vulnerable groups should be involved at all stages of the CBEWS from designing to operating the systems, receiving the warning messages and responding to the warning.
- Measures taken should be based on the needs of everyone in the community including the most vulnerable segments of the community.
- The community members will own the process and system.
- CBEWS measures will enhance the capacity of the community members to deal with their situation.
- Meaningful participation in the decision-making process of EWS.

In Nepal, the strengthening of community based early warning system is in early stage [9]. The initiatives that have happened so far are some hazard and location-specific and sporadic. This paper explores answers to the following pertinent questions:

- What is the status of EWS in Nepal?
- What are the key gaps and challenges in strengthening EWS in the country?
- What would be the appropriate EWS framework for the effective EWS covering all the aspects of the EWS system including response capacity building in the country?

### Why early warning systems?

Early warning systems (EWS) are recognized in both the Hyogo Framework for Action 2005-2015, and the Sendai Framework for Disaster Risk Reduction 2015-2030 as an important element of disaster risk reduction, and hence to the achievement of sustainable development and sustainable livelihoods. Disaster occurrences and impact are increasing, mainly owing to an increase in the size and vulnerability of exposed populations, but also possible to increase in the frequency and severity of certain hydro-meteorological hazards as a result of climate change. Economic losses from disasters can greatly set back hard-won development gains.

The occurrence and impact of disasters is increasing, a result both of the increase in the size and vulnerability of exposed populations as well as an increase in the frequency and severity of hydro-meteorological hazards. Economic losses from disasters greatly set back hard-won development gains, particularly in low income countries like Nepal. Globally, the establishment of early warning and associated preparedness and response systems has helped to reduce the number of deaths from disasters over the last decade. Early warning systems promote the development and application of scientific knowledge, including improved information dissemination.

Advances in science and technology during the last decade have improved the potential of early warning to reduce human loss. Early

warning systems also must be comprehensible and accessible to all users. They must deliver clear and concise messages tailored to respective social and cultural contexts. The ability to deliver vital information to the public at risk has not always been successful. In many cases, local mechanisms for communicating risk and interpreting warnings remain very weak.

Early warning and early action can often prevent a hazard turning into a human disaster by preventing loss of life and reducing the economic and material impacts. An effective EWS enables the concerned authorities and at-risk communities to know about the hazards of the locality, community vulnerabilities and impending risk, warning messages, and building and mobilizing their response capabilities to reduce risks [10]. Early warning helps reduce economic losses by allowing people to better protect their assets and livelihoods. For example, they can safeguard homes, save livestock or find out safest locations for shelter in times flood or other disaster events, thus limiting not only the immediate impact of disaster but also the effects on assets that can reduce economic wellbeing and increase poverty.

The establishment of early warning and associated preparedness and response systems has been an important contributor to the reduction in the number of death from disasters over the last decades. EWS also promotes the development and the application of the scientific knowledge, including improved science and technology information dissemination.

The importance of Flood Early Warning Systems can be further articulated in the following points:

- Get advance notice of some selected hazards such as floods.
- Early Warning Systems can help to reduce casualties and damages.
- Vulnerable people can be informed ahead of the hazard meets the vulnerable population or properties.
- Can transfer moveable items to safer grounds.
- EWS contribute in protecting and supporting sustainable social and economic development.
- The society benefits from an early warning system.

The community based Early Warning Systems help:

- Better understanding and knowledge of local hazards, vulnerability and risks.
- Quick analysis of the information and delivery to the at-risk communities.
- Easy to communicate with people in local languages.
- Cost effective and efficient.
- Easy to monitor hazards and vulnerability.

### Nepal: A disaster prone country

Nepal faces several types of disasters due to natural hazards every year, the most prominent being floods including glacial lake outburst flooding (GLOF), drought, landslides, wildfires and earthquakes. The population in the country faces multiple disaster risks which have caused widespread damage to the life and properties. Floods and landslides damage crops or property in one part or the other almost every year. In Nepal, poor people mostly women in the rural areas, elderly, boys and girls and the people living in river banks and

plain areas are vulnerable to recurrent natural hazards such as flood, landslides, epidemic, cold wave, and avalanche and forest fire. Nepal ranks 11<sup>th</sup> in the world in terms of vulnerability to earthquakes and 30<sup>th</sup> in terms of flood risks. Approximately 70% of the recent disasters are weather-related and this proportion is likely to grow as climate change processes increase unpredictability and intensity of weather events. Although the frequency of earthquakes in Nepal is low, however, the earthquakes have affected the maximum number of people among all disasters that occurred between 1990 and 2015 (Figure 2).

Flood is an annual phenomenon in Nepal. Annual Precipitation in Nepal is 1630 mm. If the rainfall is more than 300 mm in a day, then many rivers in the country will lose its retaining capacity causing serious flooding. In addition, due to global warming the melting of the snow in Himalayan region is causing an increase in the water level in the river. The climate change model shows that intense summer monsoon is increasing the rainfall events. As the impact of climate change melting of the glaciers will cross the peak period at 150-170% between 2030-2050 in Nepal [11].

The average annual rainfall in the country is 1500 to 2500 mm. around 80% of the rainfall occurs between June to September. According to Government database, the average human deaths per year due to flood is more than 80, and the economic loss is equivalent to 1.5 million USD [12]. In Nepal, each year floods and landslides cause deaths of about 300 people and economic loss of over 1 billion NPR on average (Table 1) [13].

Nepal has the highest mortality risk index to landslides in South Asia and is on the sixth position in terms of Multiple Mortality Risk Index [14]. A combination of rough topography, steep slopes, active seismic zone and intense impact of monsoon rains makes Nepal extremely vulnerable to disaster impacts. Lack of appropriate policies, operational frameworks and tools and poor early warning system provisions and interventions have further exacerbated the vulnerability to natural hazards in Nepal.

Forest fires, epidemics, windstorms, thunderbolts, Glacial Lake

Disaster	Year	People killed	People affected
Earthquake	1934	9040	215884
Earthquake	1988	709	301016
Flood	1993	1048	553268
Landslide	2002	472	265865
Earthquake	2015	8831	8 million

Table 1: Recent major disasters in Nepal.

Outburst Floods (GLOF), avalanche, drought, cold and heat waves are other severe and frequent occurring hazards in Nepal. However, EWS provisions and practices are limited to mostly hydro-meteorological hazards (Figure 3).

Among the key natural hazards in Nepal, floods, landslides, forest fires are recurring events. Early warning and early action is possible and are generally known to the public (Table 2).

### Early warning system frameworks in Nepal

The Government of Nepal has reported significant achievements in the development and implementation of EWS for floods, landslides, and Glacial Lake Outburst Floods. However, this has not been very effective in practice as not all the four components of the people-centred EWS have been taken into account. The response capacity building is scattered and project-based. A brief description of the current status of the legal and institutional frameworks is given below.

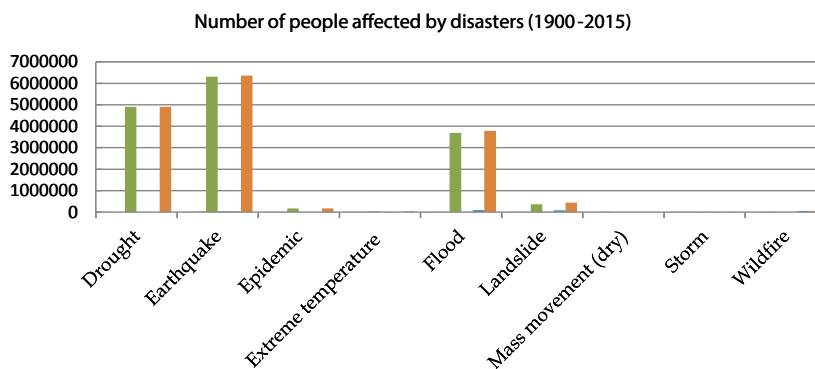
### Legal and policy instruments

The Government of Nepal has included Disaster Management programs in its 10<sup>th</sup> National Development Plan for the first time. The 10<sup>th</sup> five year plan set its objectives as 'to contribute substantially to make the public lie secure by managing the natural and man-made disaster systematically and effectively and by making the development and construction related programs in the country sustainable, reliable and highly gainful'. A clause to strengthen the provisions of assessing disaster risk in development infrastructures as also highlighted.

Ministry of Home Affairs is the nodal body in the field of Disaster Management in Nepal. There are provisions of Central Natural Disaster Relief Committee, Regional natural disaster relief committee, and district natural disaster relief to coordinate the disaster preparedness and response activities in the country.

Nepal is the pioneer country in formulating DM Act in South Asia. The Natural Disaster Relief Act of 1982, Local Self Government Act 1999, Building Code 1994, DRR strategy 2009 are some of the existing legal provisions in Disaster Management in Nepal. These legal and institutional provisions are flexible and all the activities relating to gender sensitive EWS can be done using these instruments. The following are the key legal instruments related to the DRR and EWS in the country:

1. Natural Calamity (Relief) Act 1982.
2. Local Self Governance Act (1999).



Source: EM DAT, 2016.

Figure 2: Number of people affected by disasters in Nepal.

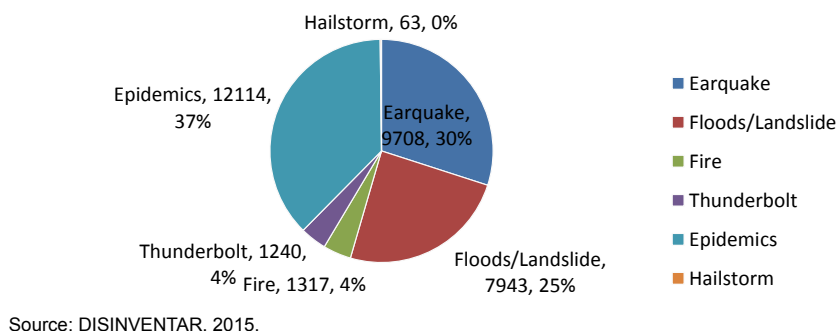


Figure 3: Number and % of death due to disasters in Nepal (1972-2014).

Hazards	Recurring	Defining seasonality	Defined Location	Probability of early warning	Generally well known
Floods	x	x	x	x	x
Landslides	x	x	x	x	x
Drought	x	x	0	0	0
Cyclone	-	-	-	-	-
Earthquake	0	0	0	0	0
Tsunami	-	-	-	-	-
Volcanic eruptions	-	-	-	-	-
Forest fire	x	x	x	x	x
Avalanche	x	x	x	x	0

x: Presence; 0: Absence; -: Not relevant.

Table 2: Characteristics of hazards in Nepal.

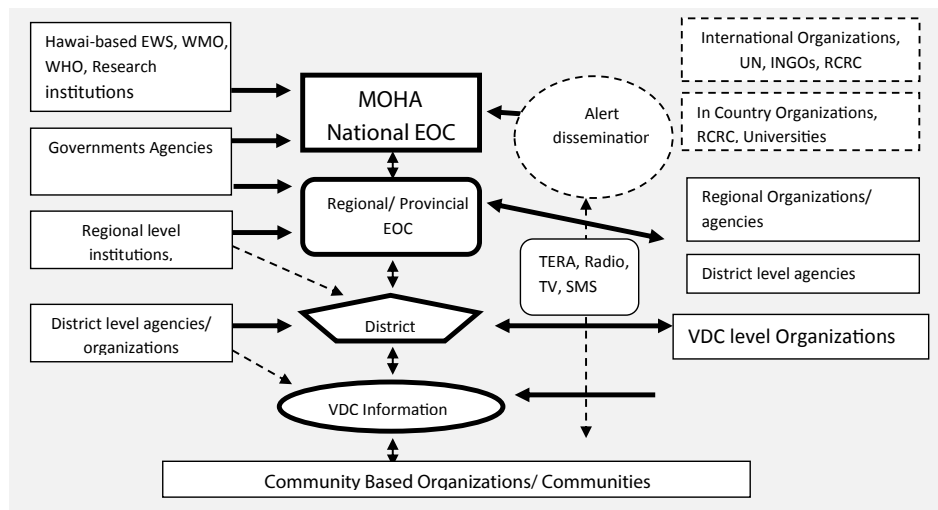


Figure 4: Proposed early warning system framework.

3. The Tenth-Plan (2002-2007).
4. Medium Term Expenditure Framework (MTEF).
5. Sendai Framework for Disaster Risk Reduction.
6. DRR strategy 2009.
7. Nepal Water Resources Act 1992.
8. Nepal Water resources Strategy 2002.
9. National Action Plan on Disaster Management 1996.
10. National Disaster Response Framework (NDRF).
11. Nepal National Building Code 1992.

12. Local Disaster Risk Management Planning Guideline (LDRMP Guideline)-2011.
13. National Early Warning Strategic Action Plan, 2013 (draft), MoHA, Government of Nepal.

However, many of these policies/provisions are not specific to EWS.

### EWS operational framework

An operational framework for the smooth running of the early warning system in the country is proposed (Figure 4). The national framework outlines the linkages between local, provincial, national, and international institutions for sharing of information and its dissemination.

Majority of the organizations (75%) consulted were involved in providing technical support in the areas related to early warning system (Figure 5).

The Ministry of Home Affairs as a nodal body plays a key role in all activities of disaster management. The primary role of this ministry is to coordinate the disaster management activities at national level. In order to coordinate the efforts for the effective early warning dissemination and community institutional and capacity building, an Institutionalization Implementation Framework has been initiated between three key ministries.

- Ministry of Science Technology and Environment (MoSTE, DHM)-Monitoring and observation lead.
- Ministry of Home Affairs (MoHA)-Response lead.
- Ministry of Federal Affairs and Local Development (MoFALD)- Knowledge management and replication lead.

### Risk knowledge

In the study conducted by Shrestha et al. [9] it was observed that around 60% respondents did not have the institutionalized system of knowledge management and documentation in the case of EWS. None of the organizations did the comprehensive hazard and vulnerability assessment with giving enough impetus on women’s traditional knowledge and perceptions in the natural hazard analysis. Ten percent organizations reported that they involved women groups in community mobilization and implementing of community level initiatives (Table 3).

### Monitoring and warning services

It is important to engage men and women to do a regular monitoring of hazards in the locality and generate information for warning purposes. Involvement of women and men will help identify the information accurately, on time and earlier than done stand alone. It will help reduce the risks. In Nepal, “community level disaster management committees are being trained to monitor and keep records of flood level, extent and duration of flooding in their area, data and information on loss of life, people missing and damage to properties. Local knowledge on the location, time, duration, frequency,

Categories	Number	%
Risk Knowledge	11	42
Monitoring and warning services	16	62
Dissemination/information	18	69
Response capacity	19	73

Source: Shrestha et al. 2014, revised.

Table 3: Involvement of organizations in EWS.

intensity and predictability of previous flood hazards will be important for an effective early warning system” [15].

### Dissemination and information

Women as disaster alert recipient were not considered while sending disaster messages. Sending disaster messages through radios, mobile phones do not ensure that the messages are received by women and girls. Some organizations have formed women groups and mobilized women and girls in EWS. However, messages are not gender sensitive and dissemination mechanisms are not gender either.

The systematic flood forecasting and warning system is recent in Nepal. In 2009, the Department of Hydrology and Meteorology assessed the flood warning level and danger level. “A web based telemetry system for real time data acquisition was established in 2010. At the same time, a Community Based Flood Early Warning System (CBFEWS) was set up to facilitate dissemination of warning information and immediate response to flood warning with a collaborative effort of the Department of Hydrology and Meteorology, Practical Action, local government and non-governmental organisations” [15].

In Nepal, gauge readers carefully monitor when water levels approach warning and danger levels, ready to disseminate warnings. “District-level government maintain electronic flood monitoring display boards, with sirens that sound automatically when water reaches warning levels. The web-based telemetry system also triggers a SMS, text message, warning that is sent to Chief District Officers”.

### Response capacity building

Majority of the organizations surveyed were involved in response capacity building. However, it was not systematic and linked to EWS. Although women play an important role in responding to disasters and are capable to cope with, adapt and withstand the impact of disasters, they are usually not involved in the EWS processes. Various government and non-governmental organisations are implementing awareness raising activities through FM radio, posters, calendars, leaflets, wall paintings, song competitions, street theatre, and schools art and essay competitions (Table 4).

Gautam and Phainju states that the effectiveness and success of the community based approach were observed during floods in 2012. “In 2012, there was continuous rainfall in the West Rapti basin on 3<sup>rd</sup> and 4<sup>th</sup> August. The water level at Kusum started rising at 9:00 am on 3<sup>rd</sup> August and crossed the danger level at 2:00 pm. Then it continued rising and reached 7.24 m (5000 m<sup>3</sup>/s) at midnight. Water started receding at 01:00 am on 4<sup>th</sup> August. At 10:00 am, the water was below danger level and at 11:00 am, it was below warning level. The water level remained above danger level for about 20 hours.”

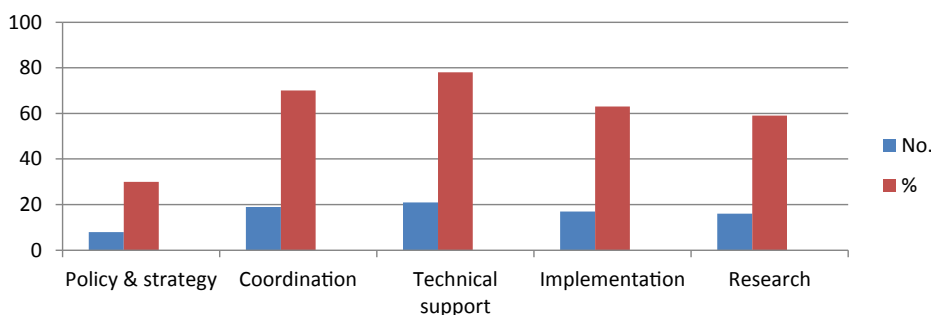


Figure 5: Nature of engagement of organizations.

Natural hazards	Occurrence <sup>1</sup>	Status of EWS <sup>2</sup>			
		Risk Knowledge	Monitoring and Warning Services	Dissemination and communication	Response capability
Earthquakes	All of Nepal	M	L	L	M
Floods	Terai, middle hills	H	H	M	M
Landslides	Hills and mountain	H	M	M	L
Debris flow	Hills and mountain; severe in areas of elevations greater than 1700 m that are covered by glacial deposits of previous ice age.	M	M	L	L
GLOF	Origin at the tongue of glaciers in Higher Himalayas, Higher Mountains, flow reach down to middle hills regions.	M	L	L	L
Avalanche	Higher Himalayas	M	L	L	L
Forest fire	Hills and Terai (forest belt at foot of southern-most hills).	H	H	M	M
Drought	All over the country	L	L	L	L
Windstorm	All over the country	L	L	L	L
Hailstorm	Hills	M	M	L	L
Lightening	All over the country	L	L	L	L

<sup>1</sup>Source: Nepal country report, ISDR Global Assessment Report on Poverty and Disaster Risks 2009.

<sup>2</sup>Current study. H: High, Government agencies and NGOs involved; M: Medium, Sporadic interventions; L: Low, NGOs in some areas, project specific.

**Table 4:** Status of EWS by hazards.

“The Department of Hydrology and Meteorology had established an early warning system in connection with imminent Tso Rolpa Glacial Lake Outburst Floods in 1998. However, this system is no longer in operation. In collaboration with the Department of Hydrology and Meteorology, local bodies and communities concerned, Practical Action has established and promoted early warning systems in the districts of Chitwan, Nawalparasi, Banke and Bardiya. Similarly, Mercy Corps has established and promoted community-centred early warning system in the district of Kailai. In these districts, local disaster management committees have been already established. Linkages of Flood Warning Centres have been established with the District Natural Calamity Relief Committees, communication media, Nepal Red Cross Society, Nepal Police, and Nepal Army. Since 2007, community-based flood early warning systems are in operation in Narayani, East Rapti, and West Rapti and Babai rivers. Likewise, Action Aid, Nepal has established and promoted community-based early warning system in Sunsari district in collaboration with the Department of Hydrology and Meteorology. Early warning system has also been established in Upper Bhotekoshi Hydro Project. Similarly, the Department of Water Induced Disaster Prevention has established a community-based early warning system for landslides and excessive rains along the Mugling-Narayanghat Highway at Kabilas VDC of Chitwan district”.

### Key Actors in Disaster Management and Early Warning System in Nepal

Disaster Early Warning Systems are an infancy stage in Nepal. No effective multi-hazard early warning systems at national and local levels have been established. Some hazard specific alerts generation and dissemination mechanisms have been established and response capabilities of local communities have been built, however these are project specific and cover a few hundred villages.

A number of Government, non-government and humanitarian organizations are working in the community based disaster risk reduction including early warning systems in Nepal. Studies suggest that very few organisations have covered all the four aspects of the early warning system in their program interventions (Table 5).

Some non-government and humanitarian organisations which have extensive activities in community based EWS include Practical Action, Mercy Corps, Nepal Red Cross Society. Their major activities include:

- Development of early warning systems at local level.
- Advocacy for policy and practice in inclusive EWS.
- Implementation of community based disaster risk management programs including early warning system as a component.
- Capacity building of government institutions, community members and mobilizers/volunteers.

Practical Action has helped local communities to set up Community based flood early warning systems in various communities Nawalparasi, Chitwan, Banke and Bardia districts. “For the Flood Early Warning Dissemination System, and Community based System for effectively disseminating flood warning information to the communities, various agencies are responsible for disaster management and district level authorities. The system has been set up in collaboration with District Disaster Relief Committee with technical and financial support from Practical Action” (Table 6) [16].

### Key challenges and gaps

Flooding is a serious problem in Nepal during the monsoon period, especially in the southern plain Terai area. However, due to the limitation of data, budget, infrastructure and manpower, flood forecasting and a warning system in Nepal are not yet fully operational [17-23]. The absence of policy and legal frameworks is weakening the efforts of the establishment and strengthening of effective and functional early warning systems in Nepal. Some of the key challenges for effective early warning systems in Nepal include inadequate investment, lack of effective monitoring and evaluation, lack of responsible national early warning centre, inadequate publicity at the community level, inability to develop appropriate mechanisms for communications, weak capacity for response, lack of coordination among various bodies, lack of legal, policy and institutional provisions and inability to conduct adequate training courses, research and study activities on regular basis.

Apart from this, the following gaps in the early warning systems may be listed:

- Legal and policy frameworks that ensure the establishment and mobilisation of government, non-government and private sectors.
- Coordination with various partners.

S.No.	Organizations	Risk Knowledge	Monitoring and warning services	Dissemination and communication	Response capability
<b>A</b>	<b>Government agencies</b>				
1	Ministry of Irrigation			•	•
2	Department of Hydrology and Meteorology		•	•	
3	Department of Water-Induced Disaster Preparedness		•	•	•
4	Ministry of Home Affairs	•	•	•	•
5	Ministry of Education	•	•		
6	National Planning Commission	•	•		
7	Ministry of women and children	•	•		
8	Department of Soil Conservation and Watershed Management		•	•	•
9	Ministry of Health	•			
10	Ministry of Information	•			
11	Ministry of Defense	•	•		
12	Ministry of Federal Affairs and Local Development (MOFALD)	•	•	•	•
13	Ministry of Tourism and Civil Aviation	•			•
<b>B</b>	<b>INGOs</b>				
1	Practical Action		•	•	•
2	Plan International		•	•	•
3	Oxfam		•	•	•
4	Mercy Corps		•	•	•
5	Save the Children		•	•	•
<b>C</b>	<b>National NGOs</b>				
1	DPNet Nepal			•	•
2	NDRMF			•	•
3	CDMS		•	•	•
4	SOHAN			•	•
5	AFFAN			•	•
6	CORD				•
<b>D</b>	<b>UN and humanitarian organizations</b>				
1	UNDP-CDRMP	•		•	•
2	Nepal Red Cross Society	•	•	•	•
	<b>Total</b>	11 (42%)	16 (62%)	18 (69%)	19 (73%)

•Involvement of the organizations in the corresponding areas.

<sup>1</sup>This is not the complete list; only those who were interviewed during the study.

Source: Shrestha et al. [9]; revised.

**Table 5:** Involvement of organizations<sup>1</sup> in the key elements of the people-centred EWS.

- Sectoral linkage/integration is a challenge.
  - Linking work of various ministries to the disaster risk management is lacking.
  - So far coverage of EWS is very limited to certain geographic areas; improvement in technology is also needed.
  - Resource constraints (financial and human resources).
- A number of challenges and issues have been noticed in the effective and efficient early warning systems in Nepal. They include:
1. Usually Government EWS has been standalone.
    - No link to community based programming. Standalone EWS will be ineffective as there will be no response capacity of communities.
    - Stakeholders will not be able to understand the messages.
    - A holistic approach to early warning should be developed - both disaster early warning system (DEWS) and natural hazards early warning system (EWS).
  2. Lack of coordinated efforts between 4 key elements of EWS:
    - Risk knowledge.
    - Monitoring and warning services.
    - Dissemination and communication.
    - Response capacity building.
  3. Lack of innovation.
    - Indigenous knowledge.
    - Technology
  4. Lack of comprehensive vulnerability assessment-lack of or scattered risk assessment.
  5. Scattered approaches - not linked to Government EWS.
  6. Absence of national EWS framework, SOP.
  7. Lack of partnership with private sectors.

## Conclusions and Recommendations

The disaster early warning system is at infancy in Nepal. There is a strong need of legal policy framework, institutional set up, standard

Government agencies	Key roles and responsibilities in EWS
Department of Hydrology and Meteorology	The Department of Hydrology and Meteorology (DHM), under the Ministry of Science Technology and Environment (MoSTE), is involved in monitoring hydrological and meteorological activities in Nepal. DHM collects hydrological, meteorological, and climate information and disseminates it to a variety of stakeholders for water resources, agriculture, energy, and other development activities (www.dhm.gov.np). DHM has 286 meteorological stations nationwide. In addition, there are 170 hydrological stations, including 20 with sedimentation monitoring. Most of the hydro-meteorological stations are manually operated, while some have been upgraded to automatic stations, able to continuously monitor flood parameters such as rainfall and water level around the clock and to transmit the data in real time."
Ministry of Irrigation (MoI)	MOI provides policy support, coordination and technical assistance. Primary responsibility of this Ministry is water delivery. Issues related to flood hazard are incorporated in the design of the water supply schemes. Out of 4 components of EWS, this ministry works partly in risk knowledge, risk monitoring and communication/dissemination. Response is limited to closing the canal intake when flooding crosses the danger limit. EWS intervention is limited to protecting the infrastructure. No mechanism exists to coordinate with other actors. Out of 50 staff, 10 are women, and among them 2 are in officer level position. Usually projects are implemented through 'users' committees'.
Ministry of Irrigation (MoI)	MOI provides policy support, coordination and technical assistance. Primary responsibility of this Ministry is water delivery. Issues related to flood hazard are incorporated in the design of the water supply schemes. Out of 4 components of EWS, this ministry works partly in risk knowledge, risk monitoring and communication/dissemination. Response is limited to closing the canal intake when flooding crosses the danger limit. EWS intervention is limited to protecting the infrastructure. No mechanism exists to coordinate with other actors. Out of 50 staff, 10 are women, and among them 2 are in officer level position. Usually projects are implemented through 'users' committees'.
Department of Water-Induced Disaster Preparedness (DWIDP)	DWIDP is involved in coordination, implementation, research and technical support. Flood/landslide risk assessments are conducted through technical lens. No specific focus is given to women. Women are involved through users committee, and should have representation as guided by government policies. No specific mechanism is in place for monitoring. Response mechanisms are only related to river control. No early response. Public awareness materials (posters/pamphlets etc.) are produced and distributed.
Ministry of Home Affairs (MoHA)	MoHA is involved in policy/strategy formulation, coordination and technical support. The disaster risk management section is responsible in coordination with disaster related organisations in the country. The primary focus of this ministry is the disaster preparedness and response. Emergency Operations Centres (EOCs) are operational at the ministry and at the district levels.
National Planning Commission (NPC)	NPC involves in policy/guidelines formulation, coordination, technical support and research. Develops national level plans. There is a Gender based budgeting and planning process. NPC does not implement project itself. Recommendations are also made through ministry level action committee and national development action committee. National plan has incorporated some issues on flood/disaster. Monitoring based on development indicators on projects on program.
Department of Soil Conservation and Watershed Management (DSCWM)	DSCWM is involved in coordination, implementation, technical support and researches related to flood risk management and early warning system. No specific EWS project at present. There is a guideline which has a mandatory provision for the involvement of women in users committee. Department (through district soil conservation offices) provides technical support.
Ministry of Health (MoH)	MoH is involved in policy/strategy formulation, coordination, technical support and research. Have projects for epidemics and health issues. But not related to flood (epidemics may also resulted after floods, however, no specific projects/plans for that scenario. No risk assessment related to natural hazards or EWS is carried out. Monitoring is done for epidemics and other disease-related outbreaks; some may be result of flood or similar hazard. Very little research about the correlation in Nepalese context. Produces and disseminates lots of material on health issues, through each media (print, electronic, posters, pamphlets etc.) gender issues are considered and addressed. However, not on flood/EWS.
Ministry of Federal Affairs and Local Development (MOFALD)	Mainly involved in policy/strategy formulation, coordination, and technical support. Not directly related to EWS. Many local development projects through DDC on disaster mitigation, but not through the ministry directly; Total staff around 200; of them 25 are women and 10 women are at officer level position. Gender issues considered at local level. Ministry has developed guidelines to include women. Ministry coordinates the Flagship 4 of NSDRM (from government side); and working to make all VDCs FS 4 compliant, which includes EWS and also addresses gender issues. Ministry's performance monitoring mechanism includes gender indicators. No information about risk assessment on EWS. But all feasibility studies including disaster include gender issues (however, in practice, we have to admit that this is not well followed, women are participating in name, but meaning full participation is in question.)
Ministry of Defense (MoD)	Is involved in policy/strategy formulation and coordination. Total staff 130, female 17 and 4 in officer level position. Ministry just coordinates with Army. Army has some regular training programs on disaster response (Search and Rescue). No gender sensitive risk assessment is done. Response starts when information is received. Primarily, the mechanism is also coordinated by CDO at district level. Focused on search and rescue (SAR); no risk reduction activities. Army communication network is utilized to report internally. Does not communicate directly with the public except the activities related to response and recovery. Such as health camps after disasters. Army is the key unit dispatched for response. Gender issues are considered. The personnel are trained about what kind of special needs will be for women, disabled, elderly etc. during rescue operations.
Ministry of Education (MoE)	Involved in policy/strategy formulation, coordination, technical support and research. No EWS project. Out of 80 staff 14 are women and 8 are in officer level position; Develops national level plans. There is a Gender based budgeting and planning process Does not implement project itself. Has not assessed disaster risks itself. Women vulnerability assessment carried out. Recommendations are also made through ministry level action committee and national development action committee. National plan has incorporated some issues on food/disaster. No hazard monitoring and dissemination of warnings is done by this ministry. National lead agency on planning, budgeting and monitoring.
Ministry of Forest and Soil Conservation (MoFSC)	"The Ministry of Forest and Soil Conservation is responsible for formulating plans and policies regarding forest and soil conservation. Its responsibilities include conservation of forests, control of rivers and landslides. MoFSC undertakes activities for identification of areas affected or to be affected by natural hazards and takes measures for controlling them. The MoFSC has a role to make the communities aware of landslides and fires in forests and thus reduce such losses by developing early warning systems (MoHA, 2013).



Ministry of Agriculture Development (MoAD)	The main objective of the Ministry of Agriculture Development is to uplift the living standards of people by promoting sustainable agricultural development in the country. The Ministry is responsible for formulating and implementing various plans and policies at local level to prevent decrease in production of agricultural crops due to droughts, heavy rainfall followed by floods that destroy crops. Developing early warning system to forecast disasters like droughts, landslides or flooding and disseminating information to farmers in advance of hazards like droughts and landslides are also the major responsibilities of the MoAD as it can be instrumental in minimizing the impacts of the disasters (MoHA, 2013).
National Planning Commission (NPC)	NPC involves in policy/guidelines formulation, coordination, technical support and research. No EWS project. Develops national level plans. NPC does not implement project itself and has not assessed and disaster risks itself. Women vulnerability assessment is carried out. Recommendations are also made through ministry level action committees and national development action committees. National plan has incorporated some issues on flood/disaster. Monitoring based on development indicators on projects on program. (No. monitoring of risk/EWS).
Ministry of Urban Development (MoUD)	The Ministry of Urban Development is responsible in developing and implementing policies and plans for construction of earthquake resistant buildings, raise awareness, formulate plans for planned development of urban areas.
International Non-Governmental Organizations	
Practical Action	Practical Action is one of the most active international NGOs in Nepal in the areas of disaster risk reduction and early warning system, and is primarily involved in coordination, technical support, implementation through local partners and research. Closely works with DHM, MoHA, MOFLAD at central level and local NGOs at the community level.  Currently EWS programs running in Tanahun, Banke and Bardia. Some modal activities were accomplished in Kailali, Chitwan and Eastern Nepal. Risk assessment is done at the start of the Project, but not enough focus gender sensitive focus. However, gender focus has been guided by the organizational strategy and enough focus has been given in the project implementation especially in training, group formulation. Practical Action one of few organizations in Nepal which works in all the four key components of the EWS. Disaster alerts/communication is disseminated through all means. CDO, Police, FM, mobile phones, landline and siren are some of the channels/means/media for emergency communications used by Practical Action. Women volunteers are also mobilized for EWS dissemination at the community level. Response capacity is built through essay competition, letter writing contest, quiz contest, debate competition and FM and radios.
Mercy Corps	Is involved in coordination, technical support, implementation and research. It implements EWS project in schools (SCORE project on EWS). It works with mother groups. Women are involved in all the phases of the project cycle. Gender issues are under priority. Mercy Corps has specific gender related outcome indicators. Impact on women is evaluated. Has M&E framework with including gender considerations. Gender considerations are integrated into disaster risk reduction. Works with women groups; and their traditional knowledge on DRR is analysed. "We have a high level participation of women in assessing vulnerability. Women needs and concerns are analysed. We identify capacity of both women and men. Their traditional knowledge is respected.
Plan International	Is involved coordination, technical support, implementation and research. Children focused disaster management program in Morang, Sunsari, Banke, Makwanpur, Sindhuli, Rautahat districts. Beneficiaries at approx.. 500,000. No gender disaggregated data. Out of 200 staff 50 are women. Women and children participation in development programming is given enough attention. No specific EWS project, but women participation in all projects is encouraging. No specific risk monitoring experience. Women focused capacity building activities are carried out, but not necessarily related to response capacity building.
Oxfam	Engaged in coordination, technical support, implementation and research. Implements an EWS project (since 2011), Dadeldhura, Sarlahi, Saptari, Dhanusa, Rautahat; Direct beneficiaries: 30,000; Total 21 staff and 8 are women; 3 are at officer level position; Women Vulnerability assessment was carried out during project formulation. Knowledge Attitude and Practice analysis was also carried in project site with special focus on women and disadvantage groups. Women's traditional knowledge assessed and respected in KAP analysis. Women and men both involved in risk assessment.  Organizational arrangements are in line to engage women in capacity building, training, assessments etc. Women and men are equally involved in vulnerability analysis. Maps and other information include gender differentiated data and are available to stakeholders. "We have provisions that women should be involved in all processes." Equal involvement of men and women are ensured. Both are trained and participate equally. Response team includes both men/women. coordination with police, district authorities. Gender issues incorporated in the mechanism street drama, PSA, radio program and print materials are produced. Gender issues are considered for each
Save the Children (SC)	SC is involved in coordination, technical support and implementation; Implements school DRR program in Ilam and Taplejung, approx. 26,000 direct beneficiaries. Impact indicator includes gender indicator as well. Works with schools. Both boys and girls participate in the school DRR activities. Capacity Gender disaggregated data are available. However, no specific projects on EWS. SC's primary focus is on children, women issues get priority. Information and data are gender disaggregated. Women's needs, concern and knowledge are included in assessments. Radio programs/ Psychosocial activities (PSA) are being implemented in target areas. "We specifically review the content through gender lens."
DPNet	DPNet is a pioneer organization involved in networking of DRR organizations in Nepal. It provides technical support to government, organizations in formulating policies and strategies. Also, it implements some projects based on available resources; Develops tools and techniques in DRR in the country. Does not have EWS project at present.
National Disaster Risk Management Forum (NDRMF)	NDRMF is a national NGO involved in response capacity building of communities and implement some flood risk management activities. Currently does not have any EWS project.
Centre for Disaster Management Studies (CDMS)	An active national NGO in the field of disaster research and response capacity building in various districts. Majority of the board members/staff including chairperson are women. CDMS primarily focus on hazard specific research and response capacity building of community members.
Society of Hydrologists, Nepal (SOHAN)	Network of hydrologist in Nepal. Conducts research and technology transfer activities. Currently does not have EWS project.
Agro-Farm Foresters' Association Nepal (AFFAN)	Involved in research, technology transfer and community capacity building in the flood damaged areas of various agro-climatic regions of Nepal. Various agro-forestry designs developed by this NGO have been widely applied in reclaiming flood-damaged areas in the country.
Centre of Resilience Development (CoRD)	Works for building community resilience in some parts of Nepal. EWS is one of its priority areas for building community resilience, although it now focuses on building earthquake resistant houses and community awareness.

Disaster and Climate Change Study Centre (DCCSC Nepal)	Involved in research, technology transfer and community capacity building in flood risk management and community resilience. Research, awareness raising and response capacity building are three key areas of this organization.
UN and Humanitarian Organisations	
UNDP-CDRMP	Is involved in providing technical support to MoHA in formulating policies/strategies, capacity building, coordination and implementation a CDRM Project through MoHA that includes EWS as well. This covers 35 districts of Nepal. Gender disaggregated data are collected. Gender sensitivity analysis was not done at the start of the Project; however women are given high priority while forming community disaster management committees, training and disseminating early warnings. CDRMP has strengthened national and district level emergency operations centers in the project areas that are effective in end-end early warning system. Emergency Operations Centers (EOPs) receive, analyze the information and disseminate early warning. The response capacity building is also being held by the program through staff/DMCs. Although highly conscious about the gender issues, practical tools, approaches and budget have been allocated to address the gender sensitive issues.
	<b>Nepal Red Cross Society (NRCS)</b> NRCS is involved in coordination, implementation, technical support and research. EWS has been implemented in partnership with Practical Action and Mercy Corps. Kailali, Kanchanpur, Bardiya and Tanahun for EWS (disaster work in all districts) since 2008. Direct beneficiaries: 1,000,000 (approx.; hard to estimate). NRCS represents in DDRC. Works on all cycles of disaster risk management, with special expertise/focus on response and recovery. Total number of staff members are 200, of which 25 are women and 14 are in officer level position. NRCS has a women empowerment department, which coordinates all gender issues. Women are involved in all project cycle. Gender issues are under priority. Impact on women is evaluated. NRCS has M&E framework with including gender consideration. Gender issues are integrated into risk reduction strategies. "We have a high level participation of women in assessing vulnerability. Women needs and concerns are analysed. We identify capacity of both women and men, their traditional knowledge respected."

**Table 6:** An overview of key government and non-governmental agencies and their roles and responsibilities in early warning systems.

operating procedures, and interventions in all the aspects of an early warning system. The gender aspect of the flood early warning system in Nepal is in early stage. So far, efforts have been made to install and disseminate the early warning messages and response capacity building in limited river basin [24-30]. The coverage is limited to certain project areas and it requires detailed risk assessment and coordinated efforts.

Advances in science and technology during the last decade have improved the potential of early warning to reduce human loss. Early warning systems also must be comprehensible and accessible to all users. EWS must deliver clear and concise messages tailored to respective social and cultural contexts. The ability to deliver vital information to the public at risk has not always been successful. In many cases, local mechanisms for communicating risk and interpreting warnings remain very weak.

In order to make the system more effective, the following recommendations may be made:

1. Promulgation of appropriate policy and EWS frameworks should be developed and make operational. The provision of early warning systems is sporadic and project-specific in Nepal. The existing legal system does not ensure participation of all vulnerable groups in the EWS including ensuring the receiving of the disaster alerts and response capacity building.

2. There is a need to strengthen the mechanism for regular monitoring of local hazards and communications between CBOs, District, province and the national Emergency Operations Centres (EOCs). So far, this has been hazard-specific and only in times of disaster period.

3. In Nepal, so far the early warning systems at local level are project and location specific. This should be made nationwide. Government agencies taking the lead role. Involvement of other stakeholders including private sector in EWS initiatives should be ensured.

4. Capacity of staff, volunteers and local community members needs to be enhanced in hazard monitoring and dissemination. Their relevant capacity in response to disaster alerts is a prerequisite for effective EWS.

Turnover of trained volunteers, community members and mobilisers (they go for foreign employment) is one of the challenges

for the effective early warning system. It requires an establishment of a mechanism that ensures trainings on a regular basis.

5. Gender perspectives should be integrated into project cycle management of a DRR program including the disaster risk assessment, early warning system, information management, community awareness and training. Gender disaggregated data on local hazards, community vulnerabilities, capacities and risk need to be maintained.

6. Early warning systems lack a sound research in various aspects such as type of EWS, its usage, sustainable mechanism on disaster risk assessment, dissemination, and response capacities. Studies on various aspects of inclusive EWS i.e., mainstreaming of various vulnerable groups in the process in Nepali context is strongly suggested.

7. In Nepal, early warning systems are a neglected aspect of the Government due to other burning issues the government is facing. Some government departments with support from international agencies have initiative EWS interventions in certain locations and for certain hazards mainly floods. There is a strong need for the Public-Private Partnership (PPP) initiative in EWS and promotion of corporate social responsibility to share the burden of government agencies.

8. The Ministry of Home Affairs (MoHA) needs to adopt more holistic method on disaster risk management as current practices are more focused on preparedness and response. An integrated community-based risk reduction approach that ensures the organisational capacity building, community risks reduction, and resilience building that incorporates community early warning systems as well.

9. Local political institutions have given less priority in the disaster risk management including the importance of early warning systems. It is suggested to have a compulsory provisions of focal points and capacity building of local political authorities

10. Various DRR and EWS tools and frameworks need to be revised and made them inclusive of gender, disability, elderly and other vulnerable groups. EWS must be built on four essential aspects: effectiveness, efficiency, equity and legitimacy. The system should be gender-sensitive, disability and elderly friendly, and should be able to address the needs and concerns of the other vulnerable groups at the community level.

11. EWS must be part of the broader DRR framework and

activities. This will enable the agencies and communities to assure the effectiveness of all the components of the EWS including response capacity building.

12. Coordination with all the stakeholders including local government, private sectors, community leaders and members, media, local and international NGOs, vulnerable groups should be ensured.

13. Use of existing and local resources in warning dissemination ensures the sustainability of the system. Priority should be given wherever possible.

A number of recommendations are suggested to ensure the early warning messages are understood right. They include:

1. Use of local language while disseminating disaster alerts. The language should be simple and well understood by the ordinary people.

2. Less technical jargons and precise but complete. For instance, the early warning alerts “*Water level due to heavy rainfall in Andhikhola river has crossed the danger level.*” This is a warning but incomplete. The better message would be “*Water level due to heavy rainfall in Andhikhola river has crossed the danger level. Your community might be inundated. Please go to the upper land and far from the river bank.*”

3. Repeated dissemination: One time dissemination of disaster alerts may not be effective. The alerts should be disseminated on a regular interval and repeatedly so that every person or household members will be able to listen and act accordingly.

4. Feedback mechanism (loop): The early warning dissemination mechanism needs to have feedback mechanism as well.

5. Messages should not be scary; need to ensure the remedy as well. Disaster alerts should always contain the message “what to do” as well.

6. Create a volunteer database with details of names, addresses and telephone numbers at the community level.

7. Regular update of the trend-worsening and improving.

8. The following pre-requisites are also suggested:

- Appropriate legal and policy frameworks.
- Operational tools-SOP and guidelines.
- Effective coordination for 4 key elements.
- Development of innovative technology-hazard specific technology may be required.
- Linking EWS to community based programming.

## References

1. UNISDR (2006) Global Survey of Early Warning Systems: An Assessment of Capacities, Gaps and Opportunities towards Building a Comprehensive Global Early Warning System for all Natural Hazards, United Nations International Strategy for Disaster Reduction, Geneva, 25, Switzerland.
2. Practical Action (2008) Establishing community based early warning systems in Nepal.
3. UNISDR (2004) Basic Terms in Disaster Risk Reduction.
4. UN (2002) Living with Risk: A Global Review of Disaster Reduction Initiatives- Preliminary Version.
5. Villagran je L, Juan C, Janos B (2006) Early Warning Systems in the Contexts of Disaster Management. UNU-EHS.
6. UNISDR (2005) Elements of People- Centered Early Warning System, Geneva.
7. Kafle SK (2017) Disaster risk reduction: Case studies from Asia. DCCSC Nepal, Kathmandu.
8. Mercy Corps and Practical Action (2010) Establishing community based early warning system: practitioners' handbook. Mercy corps and Practical Action, Kathmandu, Nepal.
9. Shrestha MS, Kafle SK, Gurung MB, Nibomupudi HK, Khadgi VR, et al. (2014) Flood Early Warning Systems in Nepal: A Gendered Perspective. ICIMOD, Working paper 2014/4, Kathmandu, Nepal.
10. Kafle SK (2007) Linking PMI EWS to National EWS: Some Indicators. In: CCEP (Online).
11. Oxfam International (2009).
12. CEDMHA (2015) Centre for Excellence in Disaster Management and Humanitarian Assistance. Disaster Management.
13. Disinventar (2015) UNDP, Nepal.
14. Kafle SK (2012) Emergency communications and early warning systems development: lessons learned from Aceh and Nias. Indonesia.
15. Gautam D, Phajju A (2013) Community Based Approach to Flood Early Warning in West Rapti River Basin of Nepal. J Integr Disas Risk Manage 3(1).
16. Spotlight (2013) Early Warning System: Curbing Damage.
17. Gautam D, Dulal K (2013) Determination of Threshold Runoff for Flood Warning in Nepalese Rivers. J Integr Disas Risk Manage 3(1).
18. IFRC (2008) World Disaster Report 2008.
19. Kafle SK (2006) Integrating community based disaster risk reduction into the government policy and programming in Southeast Asia. IDRC, Davos, Switzerland.
20. Mercy C (2013) Early Warning in Nepal. The Mercy Corps experience 2008-2013.
21. NPC (2015) PDNA report. Nepal Earthquake, GoN.
22. Palang Merah Indonesia- PMI (2009) Standard Operating Procedure (SOP) and Communication Guidelines, Indonesia (in Bahasa Indonesia).
23. Learning & Experience 2002-08. Practical Action. Nepal.
24. GoN (2009) Disaster Risk Management Strategy. Government of Nepal.
25. IFRC (2009) World Disasters Report Focusing on Early Warning Systems. IFRC. Geneva.
26. Ikeda K (1995) Gender Differences in Human Loss and Vulnerability in Natural Disasters: A Case Study from Bangladesh. Indian J Gender Stud 2: 171-193.
27. Kafle SK (2012) Measuring disaster resilient communities: A case study of coastal communities in Indonesia. J Business Continuity Emergency planning 5: 316-26.
28. Kafle SK (2007) Linking Early warning system to national early warning systems: some indicators. Canadian Centre for Emergency Preparedness.
29. Kafle SK, Zubair M (2006) Community based disaster risk management for local authorities. ADPC, Thailand.
30. Lamichane R (2011) People's perception in Early Warning System: A case study of Bhandara VDC Padariya -7 in Chitwan district, Nepal, A Dissertation for the Degree of Master in Disaster Management, BRAC University, Dhaka.

Citation: Kafle SK (2017) Disaster Early Warning Systems in Nepal: Institutional and Operational Frameworks. J Geogr Nat Disast 7: 196. doi: 10.4172/2167-0587.1000196