Strengthening the Government of Nepal's portal for data on disaster and disaster risks

Report

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Executive summary

International policies and national priorities are gradually shifting from managing disasters to managing risks. It is becoming understood that international commitments such as the Sustainable Development Goals (SDGs), the Paris Agreement, and the objectives of the SFDRR cannot be achieved without a comprehensive approach that involves anticipatory and evidence-based DRM measures. The Disaster Information Management System (DIMS) portal — Building Information Platform Against Disaster (BIPAD) was launched in Nepal by the Ministry of Home Affairs, National Disaster Risk Reduction and Management Authority (NDRRMA). It is based on international commitments as well as the National Disaster Risk Management Act, strategy, and policy on DRM. It aims to make disaster risk management more effective. The information contained in the modules of the BIPAD portal supports risk-informed and evidence-based decisions in all four phases of DRM.

Disasters are a physical and social phenomenon. Hazard exposure and intensity and socio-cultural settings and vulnerability contribute equally to how the impact of hazards is distributed over a particular society. Social factors are crucial to understanding risk and peoples' behaviour in the face of disasters. DIMS should not be about "decision-making for the people," but instead, "decision-making with the people and by the people". This would take place in the context of effective local level collaboration and thorough contextual knowledge. Disaster risk communication is the social process of creating the meaning of disaster risk and its impact on individual lives, rather than convincing people about hazards. Therefore, effective risk communication can be achieved through the collaboration and co-production of knowledge with people at risk.

Digital data on disasters provide opportunities to innovate and transform disaster management practices. However, unauthorized use, sharing, and disclosure of information about the people at risk can significantly aggravate their vulnerability. Therefore, frameworks must be established to ensure that data users understand and mitigate data use potential risks. Ensuring adequate data security, ethical standards, and privacy protection are the collective responsibilities of disaster data users. Data responsibility goes beyond the concepts of "data privacy" and "data protection." Responsible use of data should be maintained as a continuous process in DIMS. Data should never be used just because it can be used; the need and purpose should be clear, along with strict adherence to legal and ethical standards. DIMS's role should be to orchestrate the information flow so that only the required information is provided to DRM actors who need it at the time they need it.

In its current state, the BIPAD portal does not support data processing for risk analysis but is limited to compiling multiple disaster datasets and supporting visualizing risk information. There is data gap in the loss and damage database. Also, there are issues related to the visualization of existing information, particularly in the Loss and Damage module, which may be due to errors reporting error. The Risk Info module consists of rich and informative data for effective disaster risk management. It is recommended that technical terms employed in the module are simplified and explained (e.g. 'PGA with a 10% chance of exceedance, 50 yr. Return period, RCP 4.5, SD RCP 8.5'). The risk knowledge through advanced hazard risk assessment methods should also effectively communicate the uncertainties related to the processes' scientific assumptions. The Risk Info module needs to have extensive attribute data of the exposed population and assets at risk. Also, disaggregated data on gender, disability, elderly, and children is required in the database for whom particular response action is needed, entailing adequate authorization and access control measures.

The institutionalization of the BIPAD portal requires demand-driven approaches and effective DRM governance at provincial and local levels. In this context, the most crucial question is: What are the data needs and DRM capacities at federal, provincial, and local levels for risk-informed decision-making using the BIPAD portal? This question should act as an entry point for data-driven decision making in DRM. The BIPAD portal needs to be customized to cater to 753 municipal governments, 77 districts, and seven provincial governments, and the

NDRRMA. These administrative units have diverse hazard exposure, varying capacities, and resource availability to manage disaster risk. To be a sustainable and efficient DRM platform, the BIPAD portal needs to understand local level users' requirements for data-driven decision making.

To achieve sustainable DRM and for institutionalizing the BIPAD portal at the federal, provincial, and local levels, the SHIELD model was recommended. According to priority number 2 of Strengthening Disaster Risk Governance to Manage Disaster Risk (SFDRR), the model provides strategic guidance across six themes: Sharing Knowledge, Harmonizing Capacities, Institutionalizing Coordination, Engaging Stakeholders, Leveraging Investments and Developing Communication.

The study draws the following key recommendations and specific requirements for the effective institutionalization of the BIPAD portal:

1. The DRM legislation must clearly define the chain of command, roles, responsibilities of stakeholders, and the sequential priority actions, through the SOP and DRM plans at the local level. Each local level institution must prepare their DRM plans, and MoHA shall facilitate SOP preparation.

2. NDRRMA must incorporate an effective data management strategy in BIPAD by employing cloud computing for data backup, which offers data redundancy and better data infrastructure resilience. A redundant system architecture (consisting of a national data centre and backup data centre with regular automatic data synchronization) offers uninterrupted operation and resilience.

3. The BIPAD portal must have the flexibility to add new components for decision support in the future, such as cascading effects and hazard interaction, for multi-hazard analysis. It can be achieved by increasing the monitored sources and types of data, improving the quality of data, and adding multi-hazard modelling, simulation, and analysis functionalities in the portal.

4. Pre-disaster outreach, awareness, and training are vital to ensure that the BIPAD portal is used during a disaster emergency and preparedness phase. Training is required for different tiers of users to become familiar with the system changes and ensure the BIPAD portal's daily utilization for decision-making and maintaining the database. The training activities must be prioritized and sequenced in the SOP. NDRRMA should organize regular training, simulations, and other forms of capacity building exercise for different government tiers on using the BIPAD portal.

5. Activity logs are required in the BIPAD portal for disaster monitoring, post-event analysis and future response planning. Youth Innovation Labs must add features in the BIPAD portal to record the emergency responder's and decision-makers' activity logs as per the guidance of NEOC.

6. Multi-lingual support is necessary to ensure a more comprehensive outreach in Nepal. Nepalese language interface, query, and visualization support must be added to the BIPAD portal by Youth Innovation Labs as per the guidance of NDRRMA.

7. Data security and privacy: data handling policies and frameworks are required for ensuring data protection and effective use of disaster data for effective data-driven decision-making. NDRRMA should facilitate the preparation of data handling policies and frameworks in Nepal for humanitarian data use.

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List of abbreviations

BIPAD	Building Information Platform Against Disasters
CCA	Climate Change Adaptation
CKM	Coproduction of Knowledge Model
CSO	Civil Society Organization
DEM	Digital Elevation Model
DIMS	Disaster Information Management System
DRR/M	Disaster Risk Reduction and Disaster Risk Management
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GFDRR	Global Facility for Disaster Reduction and Recovery
NDRRMA	National Disaster Risk Reduction and Management Authority
NGO	Non-Governmental Organization
NLUP	National Land Use Project
OSM	Open Street Map
PDM	Public Debate Model
PEM	Public Education Model
PGA	Peak Ground Acceleration
SFDRR	Sendai Framework for Disaster Risk Reduction
SOP	Standard Operating Procedure
UCD	User Centred Design
UNDP-CDRMP	United Nations Development Programme-Comprehensive Disaster Risk Management Programme
UNDRR	The United Nations Office for Disaster Risk Reduction
UNGA	United Nations General Assembly
UN-OCHA	United Nations Office for the Coordination of Humanitarian Affairs
WHO	World Health Organization

1 INTRODUCTION

Nepal is one of the most vulnerable countries to disasters in the world. Geological, hydro-meteorological, and human-induced hazards regularly occur across the country, causing loss of lives and damage to properties. The most commonly occurring hazards are earthquakes, landslides, floods, droughts, and epidemics. The impact of disasters can disrupt progress and development efforts. A developing country like Nepal is deeply affected by disasters, as it takes the country many years to recover from the disaster's exceeding toll in multiple sectors, including human lives, livelihoods, and the national economy. The loss and damage data (1971-2010) reveal that, on average, 2% of the GDP is lost every year nationally due to disasters[21]. The Post Disaster Need Assessment (PDNA) report of the 2015 Nepal earthquake reveals that nearly 9,000 people were killed and 22,000 injured. The damage resulted in the reduction of one-third of the national GDP[20]. Due to the impact of climate change, the hazard events have become more intense and frequent, causing large-scale and widespread damage, challenging disaster management efforts. The frequency of climate-induced extreme weather events are expected to increase in the near future[7,16]. Lack of risk-informed developments and urban expansion in risk-prone areas are further aggravating vulnerability[8,34].

The Government of Nepal has developed and adopted various legal and institutional arrangements to plan and manage DRR/M activities. One of the major one is the 2015 Constitution, formulating three tiers of government (federal, provincial and local levels). It suggests that disaster risk management is the sole responsibility of the local level, which could be supported or lead by provincial or federal level depending on the severity of the disaster[6]. Schedule 7 lists disaster preparedness, rescue, relief and rehabilitation activities in the concurrent powers of federal and provincial governments. Schedule 8 of the Constitution ascribes disaster management as sole responsibility of the local government, and Schedule 9 mentions the jurisdiction of federal, provincial and local governments in DRM.

The 2017 National Disaster Risk Reduction and Management Act is another major intervention in the DRR/M sector. It has led to the formulation of the National Council, Executive Committee, and National Disaster Risk Reduction and Management Authority, and Disaster Management Committees at provincial, district and local levels. In addition to this, the 2018 Local Government Operation Act replaced the 1998 Local Self- Governance Act. Sub-section 2(p) of Section 11 of the 2018 Act provides the overall functions of disaster risk reduction under the responsibility of rural and urban municipalities, including building permit issuance, monitoring of building code implementation and policy and plan formulation on disaster risk reduction[8,20,21].

A 2018 National Disaster Risk Reduction Policy was formulated to reduce disaster risks and prevent new risks. The policy explicitly mentions under objective 5.5 “to make disaster preparedness and response effective by improving disaster information management system and developing and expanding multi-hazard early warning system.” The policy 7.8 suggests the development of a disaster information management system based on a remote sensing system, a geographic information system and Open Source technology, which will be made easily accessible to the public and DRM stakeholders[20].

In March 2015, United Nations members adopted the 2015-2030 Sendai Framework for Disaster Risk Reduction. It sets four priority areas and seven global targets for reduction of disaster risks and losses. Nepal is a signatory state. It has prepared and adopted a “Disaster Risk Reduction National Strategic Plan of Action 2018 – 2030” with 4 priority areas and 18 priority actions. Under each priority action, strategic activities are proposed for 2018 to 2020 (short-term), 2018 to 2025 (medium-term), and 2018 to 2030 (long-term and continuous activities). The Priority Action 3 of the Strategy clearly mentions “Development of Effective Disaster Management Information System and Information Dissemination”[21].

To honor international commitments and national strategies/policies on the development of a disaster information management system (DIMS) portal, the Building Information Platform Against Disaster (BIPAD) was launched by the Government of Nepal, under the Ministry of

Home Affairs, National Disaster Risk Reduction and Management Authority (NDRRMA). The BIPAD portal is an integrated national DRM portal with independent platforms for national, provincial, and local governments to facilitate a bottom-up approach for information generation and management. It consists of six modules: Dashboard, Incident Reporting, Damage and Loss, Real Time, Risk Information and Profile. These six modules have the potential to enhance preparedness and early warning, strengthen disaster communication, strengthen emergency response, enhance coordination post-incident, support evidence-based planning, and support decision-making and policy making.

The BIPAD portal congregates validated digital and spatial data from government institutions, non-government organizations, and stakeholders into a single platform to support decision-making and visualize disaster impacts/hazards early warnings.

Risk information during, before and after hazard events can greatly reduce related losses incurred. Understanding the risks of potential hazard depends on reliable and accurate information, including historical loss and damage data. Effective disaster management can be achieved[25]by applying advanced data collection and spatial analysis technologies. Risk information combined with spatial data related to exposure, vulnerability and capacity is vital to all aspects of disaster risk management[32].

2 Objective of the assignment

The specific objectives of this assignment are to:

- Conduct research and provide analytical reviews on the use of BIPAD for risk informed decision-making at national, provincial, and local levels.
- Explore the global context of DIMS and recommend best practice.
- Make recommendations on integrating humanitarian data standards and ethics for preparedness and response for decision-making.
- Provide technical advice to adjust the platforms such as Risk Information, Real Time, Damage and Loss, Dashboard, Profile, and Incidents to suit user needs at federal, provincial, and local levels.
- Technically assess operational and practical arrangements on the institutionalization of BIPAD for decision-making at local level.

3 Critical concepts on Disasters and risk communication

Disasters are becoming severe, large-scale, and unpredictable in the context of climate change, disrupting normal life, causing widespread damage and losses. Disasters occur when there is inadequate preparedness against hazards, and people or assets are exposed and vulnerable. Disasters are an equally social and physical process because culture and society determine how their impact is distributed over a particular community. Disasters are not just the combination of destructive natural or human-made forces and communities in a specific place. Disasters are also influenced by socio-culturally defined dimensions of vulnerability. When a disaster occurs, it causes death, injury, illness, loss of assets, loss of livelihood, displacement, and social and mental trauma. Only tangible harms are recorded in disaster inventories (death, injury, loss of physical assets). Intangible losses such as (livelihood loss, displacement, mental trauma etc.) also impact vulnerable populations and are a concern of the people who are impacted but are given less emphasis in disaster assessments. Disasters occur because of people and their risk perception and their need to have a livelihood, which may be in a dangerous place, or because of extreme events for which there is less experience, or due to vulnerabilities created by socio-economic systems of power. The people at risk know that they inhabit risk-prone areas. Still, they chose to live in vulnerable places, partly because they are forced to live there due to poverty and partly because of their risk perception. They decide to live in dangerous areas as a trade-off with the risk of hazard against the livelihood benefits of living there. From the outsider's view, their behaviour may appear irrational. Still, on the contrary, their behaviour is perfectly rational, when analysed through their context of poverty, limited livelihood options, and immediate needs. Therefore, social factors are crucial to understanding risk and peoples' behaviour in the face of disaster[15,24,27,31].

The three models of risk communication broadly categorized by Callon (1999) are the Public Education Model (PEM), the Public Debate Model (PDM), and the Coproduction of Knowledge Model (CKM). These models characterize the forms in which local people or end-users are involved in different disaster management practices[4]. The first model, PEM, is a traditional risk communication method, where people are "educated" about possible risks. In PEM, scientists generate knowledge and give it to the people about how they should act in disaster situations. Knowledge is considered as a generic relief package that is "given" to the public for consumption. The second model, PDM, seeks to improve the relationship between scientists and end-users by incorporating a two-way interaction in the presence of intermediaries. This model has a consultative approach. Scientists first generate and analyse the information, then consult end-users and intermediaries about the generated information in a forum. Wynne (2003) argues that PDM tools such as community meetings, collaborative mapping exercises, community consultation allow some space for the public to speak but at the same time tend to legitimize the decisions as a democratic process or "community-based approaches"[37]. The third model, CKM, seeks to overcome PEM and PDM's shortcomings. Knowledge is co-produced with scientists, experts, local people, or end-users, through a dynamic learning process involving people with a common concern: disaster risk. In this model, knowledge is neither "given" nor "taken." It is co-produced by the concerned groups who organize themselves for a common purpose and engage actively with DRM experts and scientists to solve a common problem and decide what is needed. The focus of disaster risk management should be on the co-production of knowledge for effective risk communication. DRM should not be about the "decision-making for people," but rather "decision-making by the people" with effective collaboration and thorough contextual knowledge[10,12].

Hazard risk communication using digital data technologies help anticipating hazards and make better use of available resources to avoid losses and damages. It is also equally important to realize that warning systems are social and organizational processes that use technological means to reduce risk and damage to a particular society. However, there are many more social and cultural processes involved in risk communication and early warning systems, which happen when the warning message is disseminated. This part, the community part of early warning, has received less attention and resources than the technology part. Whereas there have been significant technological developments in warnings, they have not been matched with a focus on the people at risk. Multiple disaster case studies have revealed that, despite sophisticated technology or accurate forecasting mechanisms, if the information does not reach the people at risk in a timely and understandable manner, then warning systems cannot be effective[2,14,17,18].

Early warning system effectiveness relies on how messages are perceived, interpreted, and acted upon by recipients, rather than simply sending messages out. Warning messages usually reach the people at risk. Communities however sometimes dismiss the message, because its language is too full of jargon and technical information is poorly translated into recommended actions[15]. Acting on the warning message or understanding the message is related to the people's perception of risk and their vulnerability, known as the social amplification of risk[31]. The social amplification of risk suggests that when hazards interact with various social, psychological, institutional, and cultural processes, it can heighten or attenuate perceptions of risk. It will ultimately influence individuals' behaviour during an emergency[39].

Vulnerable people's perception of risk is different from that of an outsider or expert. There are several reasons for this: firstly, DRR specialists and communities look at a potential disaster from a completely different starting point. For the individual at risk, their home and immediate locality are at the centre of the picture. Primary factors or priorities to the individual at risk are likely to be invisible to DRR system managers, who work on a much larger scale[31]. Secondly, these two groups measure and describe risk in different ways. Technical specialists draw upon scientific and engineering methods of analysis to quantify risk, while people exposed to potential disasters tend to perceive and describe risk in qualitative rather than quantitative terms[11].

Thirdly, disaster professionals' common assumption is that they alone understand and assess risk objectively (i.e. scientifically), whereas the disaster victims' understanding and assessment are merely subjective, even irrational[24,27]. Therefore, what seems rational to scientists and institutions higher up in the DRM chain may not seem so for an individual or a household at risk. A clear example is that flood-affected people may perceive the risk of evacuation, in terms of losing control of their assets and resources, livestock left behind, sleeping in the open, illnesses, mosquito bites, snake bites, etc., as more disastrous than the risk of the hazard[13]. If there are concerns about criminality or possible looting, harassment, gender-based violence, etc. communities sometimes perceive this as higher risk than the risk of staying put in the face of an impending hazard. This behaviour also explains why some of those who live in flood-prone areas that receive an adequate warning still do not evacuate in the aftermath of disasters[18].

A better contextual understanding of cultural factors and socio-economic constraints that cause diverse risk perceptions and response actions is necessary. The critical element in the success of the warning system lies in the accurate prediction and dissemination of hazards, proper understanding of risks by vulnerable people and their appropriate response actions. The expected response actions to warnings need to be institutionalized and instilled in daily practice through information and awareness campaigns[10,25,27,31].

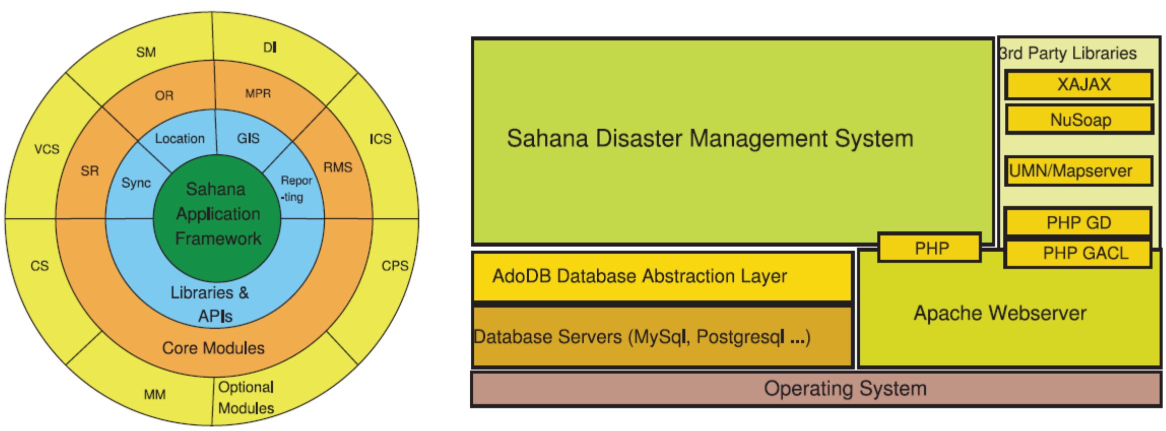
4 Case studies of DIMS, lessons learned, and key recommendations

Disaster risk management involves collaboration with diverse organizations that produce a large amount of data. DIMS plays a crucial role in coordinating with these organizations and compiling disaster data, creating meaningful information, and tracking hazards. The following review of DIMS systems will help extract lessons learned that could apply to the BIPAD portal.

4.1 Sahana

Sahana Disaster Management System (Sahana) is developed using LAMP (Linux-Apache-Mysql-PHP/Postgres) under the Opensource concept. Sahana provides a comprehensive solution for information management in the relief, recovery, and reconstruction process after disasters. (Fig.1) shows Sahana's layered architecture, which consists of an application framework at its core, surrounded by libraries and Application Programming Interfaces (APIs). The libraries and APIs are further surrounded by core and optional modules[5].

Figure 1: System architecture of Sahana portal.

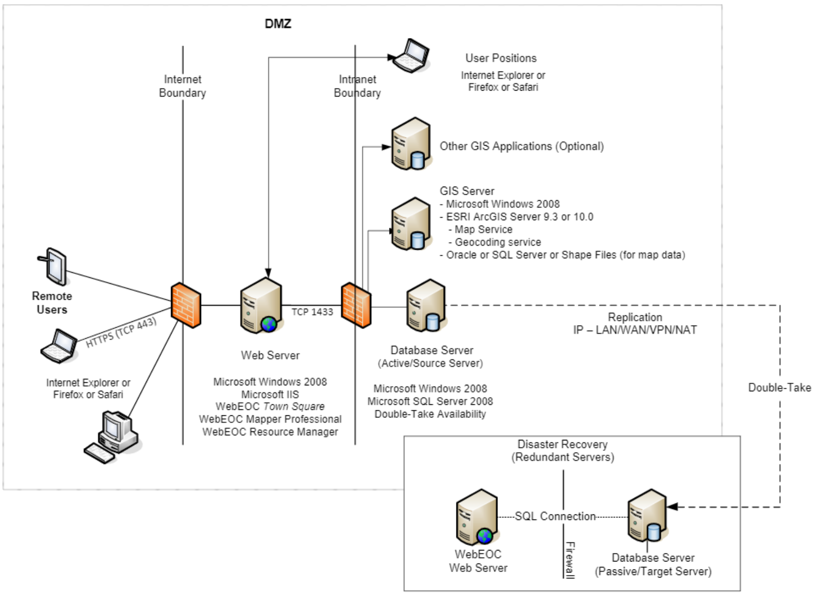


Source: Careem et al. 2006

The application framework at the core is surrounded by a set of libraries and APIs such as location, GIS, and reporting APIs. The core modules are built on top of the Sahana application framework with optional peripheral modules at the outermost layer, which are custom installed upon the client's request. The core modules of Sahana are Organization Registry (OR), Request Management System (RMS), Shelter Registry (SR), and Missing Persons Registry (MPR). The optional modules are Volunteer Coordination System (VCS), Child Protection System (CPS), Inventory Control and Catalogue System (ICS & CS), Situation Mapping (SM), Data Import (DI), and Mobile Messaging (MM). The Sahana application framework provides a flexible and modular architecture and web-based console. It supports the modules' security and facilitates internalization and localization of content. The Sahana system and database can easily be set up and configured. The module-based architecture built on the Sahana framework is composed of an operating system, above which a database and web server can be developed. Sahana can use third-party libraries such as XAJAX, NuSoap, and MapServer to facilitate its operation and handle challenging tasks in disaster management[17].

4.2 WebEOC

Figure 2: System architecture of WebEOC

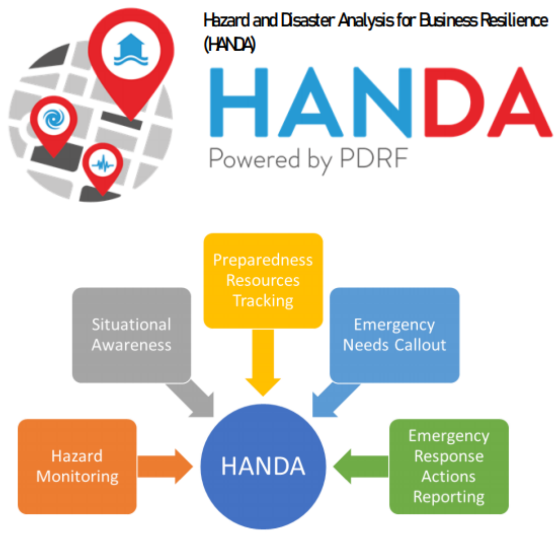


Source: Li et al. 2017

WebEOC is a web-based platform for disaster information management. WebEOC's architecture uses Microsoft SQL server as a database and a Microsoft internet information server as a web server. The system is designed to support a wide range of planning and management features in a disaster situation. The primary objective of WebEOC is to provide incident commanders with one common operating picture of public safety upon which informed and effective decisions can be made on recovery and mitigation efforts. WebEOC is also used as a disaster information sharing portal between the State Emergency Operations Centres (SEOC) and federal government, state government, and local stakeholders. The system architecture of WebEOC (Fig. 2) suggests that the system can be divided into three tiers of internet boundaries, where the leftmost tier is the user layer. The user can access the required information from the WebEOC browser. The business logic is implemented in web server in the middle tier, and the rightmost tier consists of disaster information and GIS dataset. The web server and database server are both backed up with a replication server to avoid data loss. WebEOC can publish maps, prepare dispersion models, identify evacuation routes, simulate disasters for training/drills, and aids in post-event analysis by maintaining activity logs.

4.3 PDRF-HANDA (Philippine Disaster Resilience Foundation-Hazard and Disaster Analysis for Business Resilience)

Figure 3: Overview of PDRF-HANDA



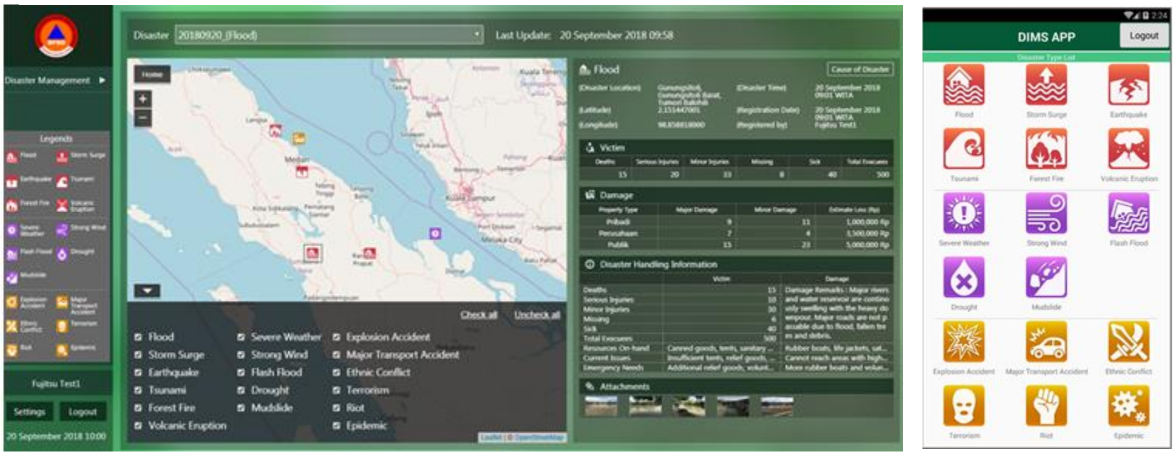
Source: pdrf.org

To avoid widespread confusion and breakdowns of communication causing lags in communication during disasters, the Philippine Disaster Resilience Foundation launched HANDA DIMS. HANDA integrates reliable and accurate information for disaster management and employs a customizable online GIS platform to serve as a unified platform for DRM initiatives. The HANDA platform also supports planning relief, reconstruction efforts and is used to prepare business continuity plans. The four key features of PDRF-HANDA are incident reporting about natural hazard incidents and coordination with emergency operation centres for immediate response, incident monitoring across the country, developments tracking, incident management of the reported services, and monitoring of geohazard data pooled from various government agencies, as shown in the overview of the DIMS (Fig.3).

4.4 Fujitsu DIMS

Fujitsu DIMS can collect and share various data for all phases of disaster management and mitigation. Fujitsu DIMS is a disaster management command centre, which can be operated by governments to gather, analyse, and share disaster data for quick decision making and response action to avoid further loss. Local governments in Indonesia and Japan have adopted Fujitsu DIMS for DRR/M. Its key features are to: transmit accurate early warning messages automatically to response managers based on telemetric hazard monitoring to speed up evacuation processes; data collection and sharing by using data entry forms and automatic data synchronization; and supports in swift decision making by displaying disaster affected areas and available options such as critical facilities in a single map (Fig. 4). The platform supports a multi-lingual interface and compilation of policy and SOP documents in the portal.

Figure 4: Fujitsu DIMS interface



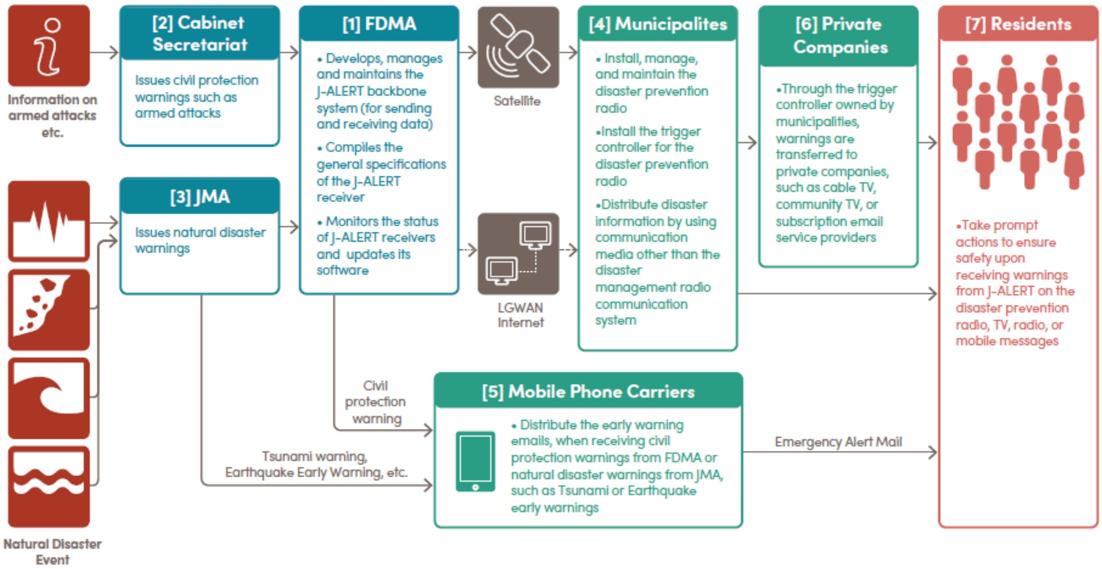
Source: fujitsu.com

4.5 J-Alert

J-Alert is a nationwide instantaneous warning and alert system in Japan that facilitates rapid dissemination of the early warnings requiring immediate attention and response planning. J-ALERT was developed by the Fire and Disaster Management Agency (FDMA) of the Ministry of Internal Affairs and Communications (MIC) in 2004, and operations were launched in February 2007. J-Alert disseminates risk information from the government of Japan directly to the vulnerable people through automatic activation of local radio communications and other communication lines. Warnings are transmitted from the Cabinet secretariat and Japan Meteorological Agency through the FDMA. Information includes warnings for hazards such as earthquakes, tsunami, volcanoes, meteorological events, and flood forecasts, as well as technological hazards and risks due to terrorist attacks. J-ALERT employs a satellite system for communication to municipalities and citizens, with terrestrial backup lines used for monitoring and updating J-ALERT warnings.

All the municipalities in Japan have ‘trigger controllers,’ which enable information to be automatically sent to their disaster prevention radios or other channels. Emergency information is distributed to the public through local loudspeakers, mobile phones, and broadcast media (i.e., TV and FM radio). This multi-format communication ensures widespread penetration of essential disaster-related information. The system has also incorporated major utility companies, hospitals, public schools, and mass media, expanding the reach of urgent emergency messages[12].

Figure 5: Institutional overview of J-Alert.



Source: GFDRR 2019

4.6 Key recommendations and lessons learned from DIMS

This section deals with the lessons learned and key recommendations from the several DIMS studied around the world, which could be relevant for the BIPAD portal.

4.6.1 Legislative framework and SOP:

The legislation should clearly define the chain of command and the roles and responsibilities of relevant organizations for DRM. The sequential priority actions and terms of cooperation must be clearly defined and understood in advance to ensure that DIMS is effectively utilized in the case of disasters. DIMS cannot be effectively implemented unless there is clarity on the details, such as who inputs what kind of information, and reports to whom, and how the data is processed further and disseminated. In developing countries, disaster management plans are prepared at national level, but most local levels lack municipal or local level disaster management plans[12]. It is vital to have disaster management plans and standard operating procedures at national and local levels for effective DIMS implementation.

The SOP must be developed in alignment with the local level disaster management plan, to define step by step procedures during emergencies. DIMS's roles and responsibilities should be clearly defined in the SOP, which must be integrated within the disaster response manual or business continuity plans. The SOP should clearly state the reporting structure, reporting chain, as well as type of data to be shared to different stakeholders based on their roles in DRM. The SOP will facilitate response, recovery, and associated communications to effectively function, based on DIMS during a disaster event as well as for disaster preparedness. Without a SOP, DIMS will not be owned and maintained by stakeholders in regular times and times of crisis, making DIMS ineffective. Therefore, SOP is fundamental for the effective functioning of the BIPAD portal.

4.6.2 Ensuring effective data management:

DIMS must be backed up within the accepted rules and procedures for data generation, data sharing, analysis, and use of data. Access to reliable and timely data is crucial for effective DRM. A redundant system architecture (consisting of a national data centre and back-up data centre with regular automatic data synchronization) offers uninterrupted operation and resilience. During large-scale disasters, a power failure could make DIMS inaccessible;

therefore, DIMS must be made accessible from mobile devices following an authorization process automatically put in place. Also, cloud computing offers effective data management by providing redundancy and resilience due to its off-premises nature.

4.6.3 System design for today and future:

DIMS must be based on the existing communication infrastructure as well as allow for future developments. The DIMS systems must be flexible to add new components of analysis for decision support at a later time such as cascading effects of disaster, hazard interaction, and multi-hazard analysis system.

4.6.4 Pre-disaster outreach and engagement:

DIMS cannot be used effectively in an emergency unless participants are accustomed to using the system in normal times. Day to day utilization and maintenance allow different tiers of users to become familiar with its operation. There must be periodic training to enhance familiarity with the system, and to make sure it will function during an emergency. Regular drills, simulations, and other forms of capacity building exercises are necessary to ensure functionality during a disaster.

4.6.5 Awareness and Training:

An effective DIMS requires not only a well-designed digital infrastructure, but also that users understand how DIMS functions and how data is crucial for decision-making during the preparedness and response phase. Awareness and education encourage people to contribute information to DIMS. If stakeholders are not fully aware of the direct benefit of DIMS, in the event of a disaster they are unlikely to input data given other urgent priorities. Also, if specialized information is required during a disaster situation, training ensure that users have the required skills to extract, analyse and visualize the required data.

4.6.6 Activity Log:

DIMS should be used to record and share information about disaster status and response activities. The activity log records critical response-related actions and decisions taken by emergency responders sequentially and chronologically. The activity log allows a quick assessment of current progress and helps in identifying areas that might need additional support. Critical response-related activities recorded by chronological order could also be used by decision-makers for the post-event analysis and to prepare for future response actions.

4.6.7 Multi-lingual support:

DIMS must support a multi-language interface so that different cultural groups can access the risk information. A multilingual system is crucial, especially in Nepal because of its diverse culture and language. Warning messages must be disseminated in local languages to ensure that information is correctly understood and acted upon.

4.6.8 Data Security and privacy:

It is of the utmost importance to secure personal information and exposure data such as critical infrastructure and services in DIMS, especially for human-induced disasters such as terrorist attacks, to avoid unintended use of data. DIMS should install efficient data backup and authorization policies to ensure that sensitive information can only be accessed by authorized users and for DRM purposes only.

5 Data Quality and Data Ethics for Data Driven Decision-Making

Data is a critical component for understanding risk and to support decision making in DRM. Quality datasets are needed to assess hazards, exposure, and vulnerability conditions in different geographical areas and specific sectors such as critical infrastructure. Quality data is also required to monitor DRR/M measures after implementation. Despite the overwhelming amount of information available through remote sensing and open-source repositories, data is scattered and contained within specific organizations. This is hampering the effective use and translation of knowledge into actionable information for decision-makers. Also, there is limited capability to extract and interpret data and translate it into action[36].

Specific requirements to improve data reliability and usability are as follows:

- Expand and improve the databases of hazard sources.
- Improve the availability of detailed climate information using dynamic downscaling and statistical methods to propagate uncertainties across space and timescales.
- Better detailed knowledge of the characteristics of the populations at risk of different hazards including women, the elderly, children, and people with disabilities.
- Exposure information about the built environment, critical infrastructure, services and networks at risk.
- Hazard specific vulnerability classes for exposure datasets.
- Develop capacity database comparing the vulnerability classes.
- Establish consistent loss and damage database and harmonize collection and input protocols in loss and damage datasets from various sources.

5.1 Data Responsibility

Disaster data provides excellent opportunities to innovate and transform disaster management practices by supporting preparedness activities, rapid response and faster post-disaster assessments. However, the use of disaster data has also raised concerns and challenges. Affected populations can be further harmed by inappropriate sharing and unintended use of data. Therefore, proper frameworks must be established to ensure that data users understand and mitigate the potential risks of data use. Ensuring adequate data protection, ethical standards, and privacy are the collective responsibilities of disaster data users. Data responsibility goes beyond the concept of “data privacy” and “data protection.” The group of data producers and users makes a complex and diverse data ecosystem, and digital data flowing through the ecosystem includes social media posts, satellite imagery, GIS datasets, sensor data, personal information, and vulnerability conditions about disaster-affected communities and their contexts. The disclosure of sensitive, personal, and demographic data about vulnerable populations can lead to communities being further harmed or exploited. Inappropriately collecting, storing, or sharing sensitive data can affect individuals and their communities, aggravating their vulnerability conditions. There are concerns over ad-hoc sharing practices, data security, privacy, data ownership, and potential harm to already vulnerable populations in the absence of minimum data protection guidelines[35].

Data responsibility can be achieved through a four-step process provided by the UN-OCHA (2016) guide for humanitarian actors on data responsibility. The guidelines support the preparation of a comprehensive framework for data handling and minimum standards for responsible use. The four-step process for achieving data responsibility is as follows:

1. **Evaluating the context and purpose within which data is being generated and shared:**
   - What is the anticipated benefit of using the data?
   - Who has access to the data?
   - What are the threats of data being misused?

2. **Taking inventory of the data and how it is stored:**
   - Where is the data? Is it stored locally or hosted by a third party?
   - Where could the data be housed for security purposes?
   - Who might gain access to the data in the future?
   - Is data access being monitored?

3. **Pre-identifying risks and harms associated with the proposed use of data before data is collected:**
   - Could the data be combined with other data sources to expose individuals?
   - What happens if the raw data is publicly released?
   - What happens if the organization is maliciously breached?
   - Who could use data to harm the affected populations deliberately?
   - Can the data analysis be misinterpreted to the detriment of the programme?

4. **Developing strategies to mitigate those risks:**
   - Developing data handling policies, scenarios, and SOP.
   - Implement access controls to the data.
   - Adopt technological solutions and firewalls.
   - Train data users.

Responsible data use should be maintained as a process rather than a policy. DRM organizations must develop and adhere to clear rules before data-based DRM interventions. Minimum standards for responsible use of data and the capacity to implement them will ensure that DRM actors use the data to the highest professional standards while maintaining the fundamental imperatives for humanitarian action: humanity, neutrality, impartiality, and independence.

The minimum requirements for the responsible use of data are:

- **Identifying the need:** Data should never be used because it can be; the data need and its purpose should be clear and defined.
- **Assessing core competencies:** DRM actors should identify what core competencies are required to deploy a specific data-driven approach during an emergency and only proceed if those competencies are available to them (such as secure infrastructure, data sharing, code of conduct and guidelines).
- **Managing risk to vulnerable population:** DRM actors should identify risks and harms posed by the use or non-use of data to individuals and communities before initiating DRM interventions and commence to manage and mitigate those risks.
- **Adherence to legal and ethical standards:** DRM practitioners are responsible for determining what legal and ethical standards apply to proposed data applications in specific contexts and adhering to these, to prevent potential violations of laws and rights.

5.2 Data Quality in DIMS

Data-driven decision-making for the DRM requires confidence in the data quality. Inconsistent, inaccurate, incomplete, and outdated data will only lead to false interpretations of the context resulting in poor decision-making. The data quality refers to the utility of the dataset on its intended purpose, which consists of multi-dimensional characteristics: accuracy, timeliness, accessibility, interpretability, and comparability.

The information should reach people who need it, ensuring only what is required is communicated. Recent disaster studies have shown that often at the time of a crisis, a continuous stream of disaster information is provided and swamps emergency responders. They are then unable to filter or process it, leading to information overload and confusion, hindering the DRM process. Therefore, the role of DIMS should be to orchestrate the information flow so that only the required information is provided to the DRM actors who need it at the time they need it. The characteristics of quality data defined by the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA) is as follows:

- **Relevance:** Relevance is determined by whether the data meets users' needs and the extent to which the information that reaches the actors matches its intended use. Information should be practical and driven by the operational need to support decision-making throughout all the phases of DRM. The volume and velocity of information can cause information overload, making it difficult for the actors to find the information they need or even contribute to discarding or neglecting relevant information. Irrelevant information contributes to information overload. DRM actors should only receive relevant information for their role.

- **Accuracy:** Data accuracy is the degree to which the data correctly describes the phenomenon or a context. Users must evaluate the reliability and credibility of datasets by knowing their sources and collection methods. Information should be accurate, consistent, and based on sound methodologies, validated by external sources, and analysed within the proper contextual framework.

- **Timeliness:** Risk information should be collected, analysed, and disseminated efficiently and must be kept current. Timeliness refers to the degree to which the information received by actors is up to date. Timeliness is crucial and often the most critical characteristic of the data in DRM. Timeliness is a factor that directly affects both relevance and accuracy.

- **Accessibility:** Accessibility refers to the ease with which data can be obtained or shared. The degree to which an actor can easily use the provided information and its content also relates to the data language and format. Risk information should be made accessible to all humanitarian actors by applying easy-to-use formats and translating data into common or local languages.

- **Interpretability:** It refers to the availability of supplementary information or metadata that effectively helps analysts understand and interpret the data. The metadata and description should clearly define and elaborate the dataset and its use in the simplest form to make it understandable for non-specialists and general users.

- **Comparability:** It refers to the degree to which multiple datasets can be successfully brought together within a common analytical framework for decision-making. Comparability of data is critical while compiling diverse datasets from different sources in DIMS.

5.3 Data privacy and protection in Nepal

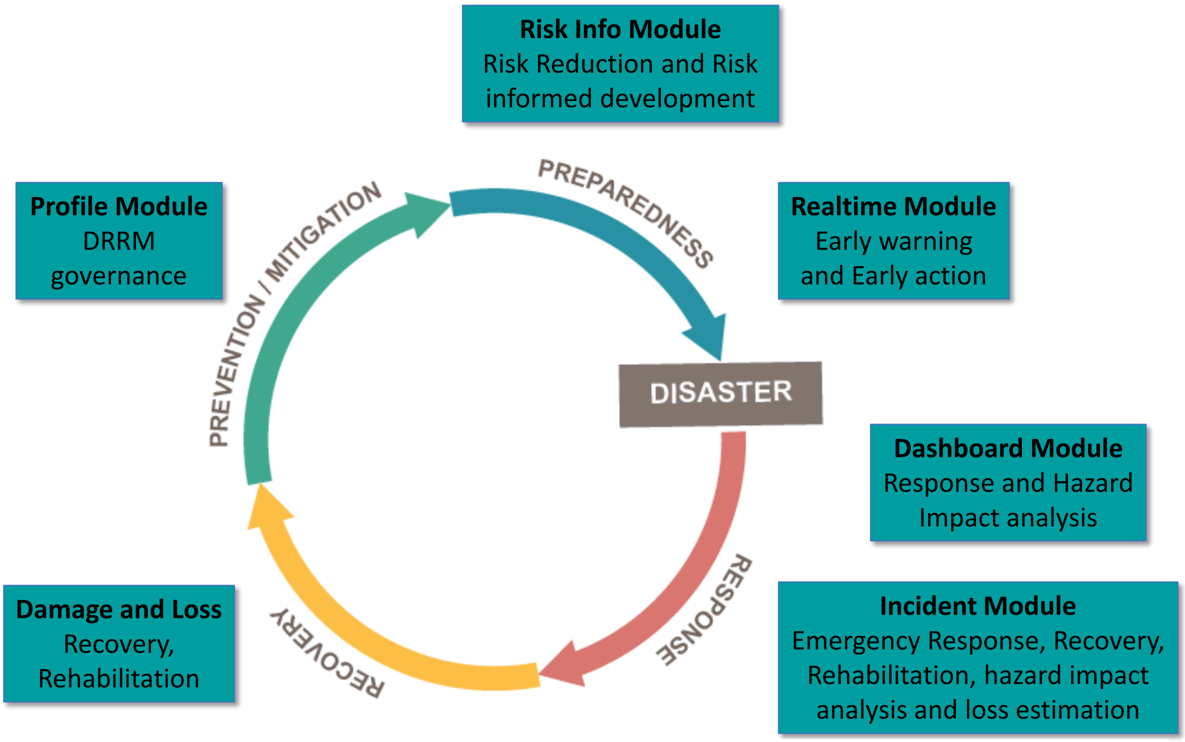
Article 28 of the 2015 Nepal Constitution provides the right to privacy and protection of one's information as a fundamental right. The 2018 Privacy Act deals with data protection law in Nepal. Chapter 6 of the Act deals explicitly with data privacy and Chapter 10 deals with private data collection and protection. The Act states that the Constitution provides each citizen with the right to keep their personal data confidential. Consent is mandatory for collecting such information. The collected data shall only be used for the intended purpose by the authorized body. The authorized body must also ensure that the collected data is protected against illegal access or unintended use, disclosure, or publication. The privacy Act defines caste, ethnicity, age, religion, marital status, education qualification, address, phone number, citizenship, and passport ID as personal data, which are generally stored in the DIMS.[28]

6 BIPAD Portal- Observation and recommendations

6.1 BIPAD Portal Overview

The BIPAD portal is comprised of six core modules: Dashboard, Incidents, Damage and Loss, Real-time, Profile, and Risk Information. The data and information contained in the modules support risk informed and evidence-based decisions in all four phases of DRM (Fig. 6).

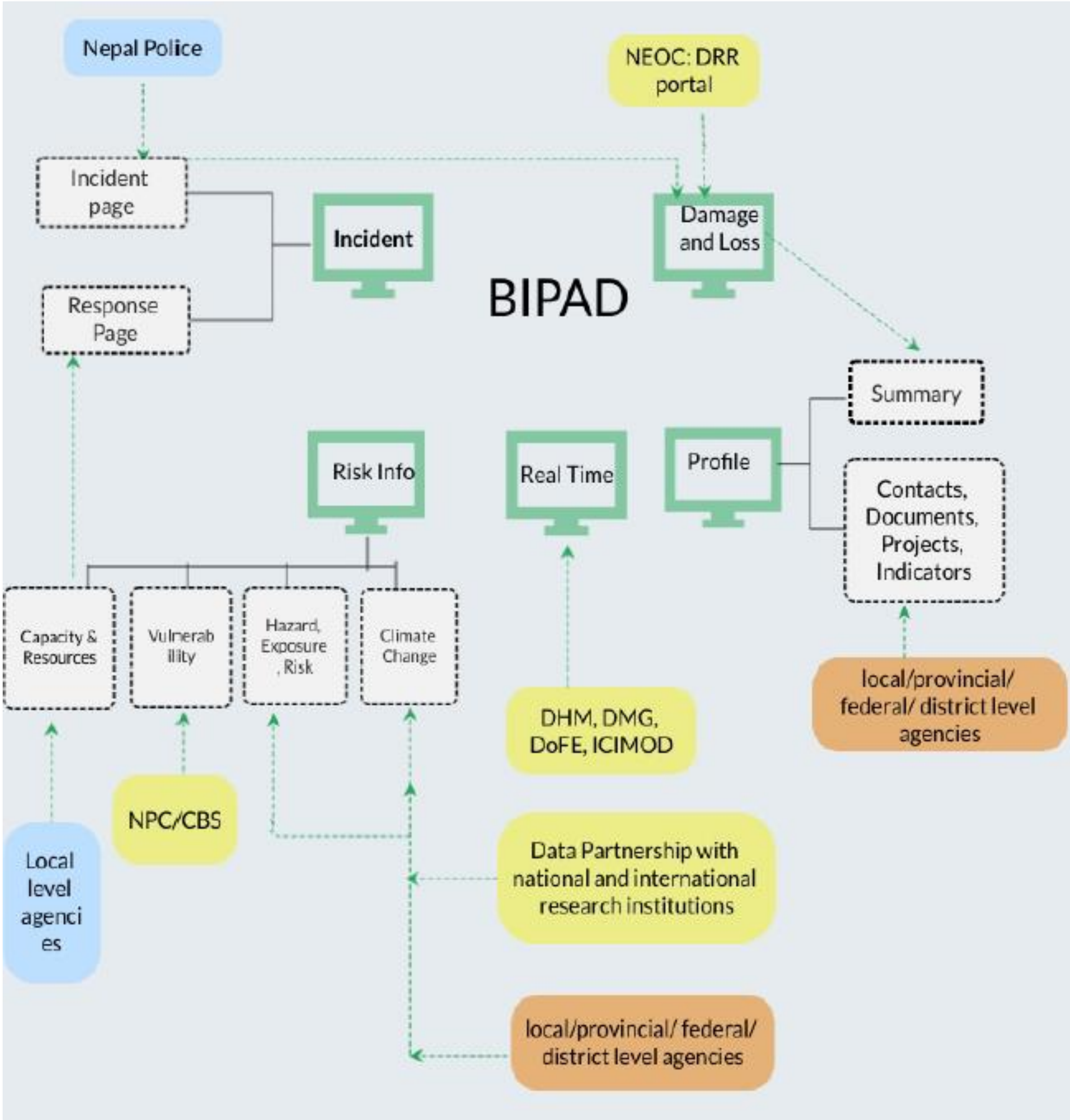
Figure 6: Modules of BIPAD Portal and DRM Cycle.



Source: Adapted from UNDRR 2020

The Dashboard module in the BIPAD portal provides real-time alert messages of hazard incidents and their spatio-temporal information. The Incident module provides data on loss and damages caused by hazard incidents, including death, injury, infrastructure damage, and monetary loss values updated from the Nepal police. The Loss and Damage module provides information on historical loss and damages, visualizes datasets in a graphical format, and compares data between different regions or administrative boundaries. The Real-Time module displays real-time information on rainfall, river level, air pollution, forest fire, and streamflow. The Risk information module consists of information about the hazard, exposure, vulnerability, risk, capacity and resources, and climate change. The Profile module consists of four tabs: resource summary, ongoing DRM projects, essential contact information, and document repository of DRM laws and acts.

Figure 7: System architecture of BIPAD portal.



Source: BIPAD portal

The system architecture of the BIPAD portal (Fig. 7) reveals that it is a platform that integrates available data about risks and hazards from multiple sources that are freely available. It uses multiple data for visualizing but currently does not support further processing or risk analysis. The BIPAD portal information sources are as follows:

- Central Bureau of Statistic (CBS): census information on demographics, households (sources and access to drinking water, communication, toilet facilities)
- Department of Forest and Environment (DoFE): air pollution data
- Department of Hydrology and Meteorology (DHM): hydro-meteorological information- river watch and rainfall watch real-time data
- Department of Water Resources and Irrigation (DoWRI): flood hazard data
- Durham University: earthquake and landslide hazard risk information

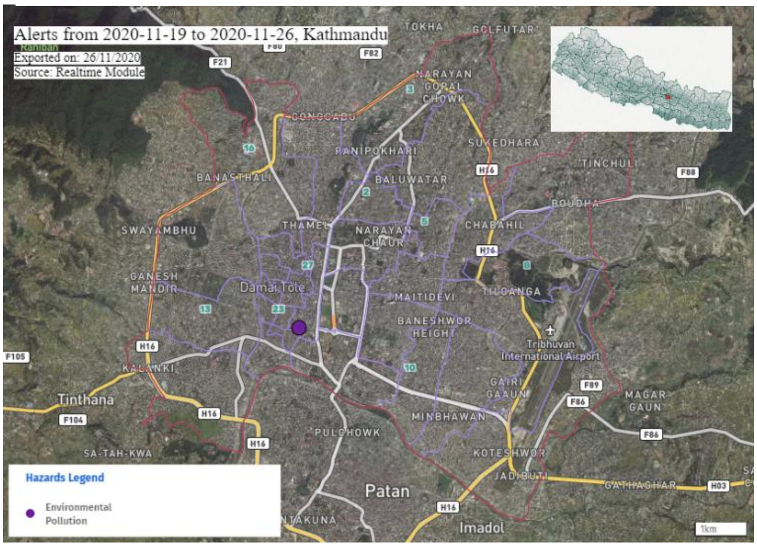
- International Centre for Integrated Mountain Development (ICIMOD)/National Adaptation Plan (NAP): climate data, forest fire information, and streamflow prediction data
- Ministry of Forests and Environment (MoFE): air pollution data
- Ministry of Home Affairs, National Emergency Operation Center (NEOC), Nepal Police through DRR Portal: disaster loss and damage data, stockpiles
- Modelling Exposure Through Earth Observation Routines (METEOR) project: flood and earthquake risk data
- National Planning Commission (NPC): Nepal socio-economic data (Human Development Index (HDI), Life expectancy, Human Poverty Index (HPI), Per Capita Income)
- National Seismology Centre (NSC): earthquake data
- Nepal Rastra Bank (NRB): geographic coordinates and information of financial institutions
- Open Street Map (OSM): exposure and critical infrastructure information
- World Food Program (WFP): flood inundation data of 2017 and 2019.

6.2 Specific recommendations for Modules

The recommendations based on the observation of the BIPAD portal and its modules are the following:

6.2.1 Module- Dashboard

Figure 8: Map downloaded from BIPAD portal



Source: BIPAD portal

- Features such as "full extent zoom", "zoom to the previous extent", and "zoom into a geographic widow" by dragging a box will provide easy map navigation. Currently, the location query by re-clicking the "submit" button does not refresh the map state, requiring attention.
- The current features allow the map to be downloaded in low-resolution PNG (Portable Network Graphics) format. High-resolution map or satellite imagery download features are not available. The published maps do not contain the minimum map requirements such as: data source, latitude-longitude information, date of source data, and map orientation information (Fig. 8). South Carolina Geographic Alliance has

specified the basic requirements in a map as TALDOGS, an acronym for – Title, Author, Legend, Date, Orientation of the map, Grid, Scale which needs to be incorporated in the BIPAD portal.

- On the fly, base map selection ability is required for smooth operation in the map. Currently, base map layer selection (OSM, Mapbox Light, or Mapbox Satellite) during the navigation undoes all the search queries. It brings the map back to the extent of covering the whole of Nepal.

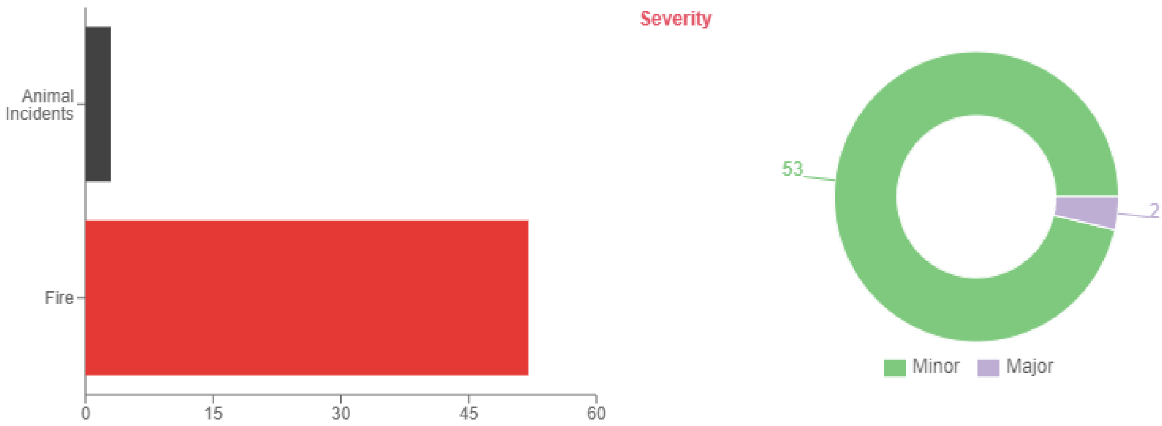
6.2.2 Module- Incident

- Loss information in the module does not provide clarity on which incident has resulted in the displayed number of human and economic loss and infrastructure damage. For example, for a query in Kathmandu Metropolitan City from January to November 2020, the damage and loss data shows that 61 incidents had occurred, but no deaths were reported, causing ninety million Nepalese rupees worth of loss and two infrastructure damage due to the incidents. But there is no feature to check which incident caused the damage without going to the DRR portal of the Ministry of Home affairs.

- The bar-chart style hazard occurrence does not relate to the severity of the incidence, but the number of incidence occurrences only. The severity pie chart does not reveal the type of major incident or minor incident. In (Fig. 9), the bar chart suggests that there were 53 fire incidents in the monitored time and two animal incidents. Those two animal incidents were more severe or caused more damage than the 53 fire incidents. Also, no human casualty or infrastructure damage was reported due to the animal incidents, but the estimated loss was of 500 thousand Nepalese rupees. What were the animal incidents? How did they cause the loss? This could not be determined in the module.

- The BIPAD portal hazard list needs to be revisited as per the recommendations the UNDRR 2020 Hazard Definition and Classification Review. The definition of 'hazard' adopted by the United Nations General Assembly (UNGA) in February 2017 states that hazard is "a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or

Figure 9: Visualisation of Hazard Occurrence and Severity



Source: BIPAD portal

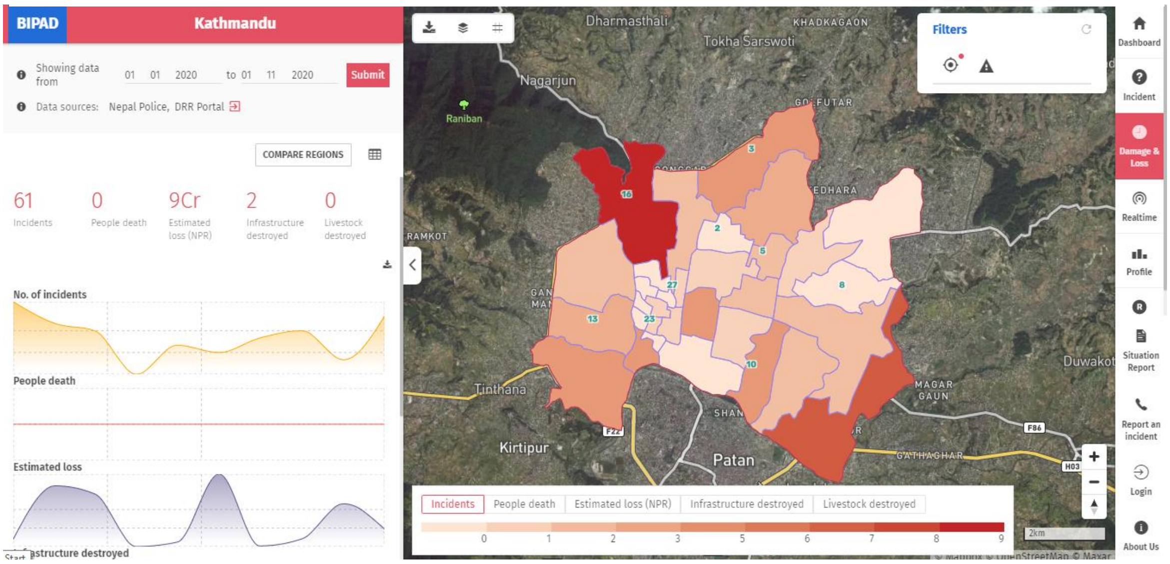
environmental degradation." Hazard definition and classification review by the Technical Working Group members of UNDRR in 2020 suggested the three inclusion criteria for hazards, which are: (1) Hazard can impact a community (2) Proactive and reactive measures are available or could be developed in the future to tackle the hazard; and (3) Hazard must be measurable in spatial and temporal dimensions.

6.2.3 Module- Damage and Loss

- There are data gaps in the loss and damage database, specifically regarding spatial and temporal coverage. There is also missing information from some districts and VDCs.

- Human loss indicators are generally well-captured, but the economic loss calculations are unclear. For example, in (Fig. 10), the portal suggests ninety million rupees worth of damage. All losses financial estimates appear in round figures as if the estimated amounts were put on an ad-hoc manner based on individual assumptions.

Figure 10: Damage and loss values in BIPAD interface



Source: BIPAD portal

- Damage and loss values need to be geo-referenced and standardized terminologies are required for damage and loss estimations related to hazards like earthquakes, landslides, floods, and climate-induced hazards. There is also a need for clear national guidelines on recording loss and damage data and financial estimates.

- There are many data visualization issues, particularly in the Damage and loss module, which creates confusion for users. For example, in (Fig. 11), while comparing damage and loss between Province 2 and Sudurpaschim Province from flood hazards between the 1st of January to 1st of December 2020, the data shows five flood incidents in Province 2 and 16 flood incidents in Sudurpaschim Province. The floods resulted in 39 infrastructure damage and ten fatalities in Sudurpaschim Province. No damage or loss was recorded in Province 2. However, the estimated loss was two hundred thousand in Province 2, but non-existent loss in Sudurpaschim Province. If the error is due to the lack of data, it should be reported as blank or "no data" to avoid confusion.

Figure 11: Comparison between two provinces in damage and loss module

Source: BIPAD portal

6.2.4 Module- Realtime

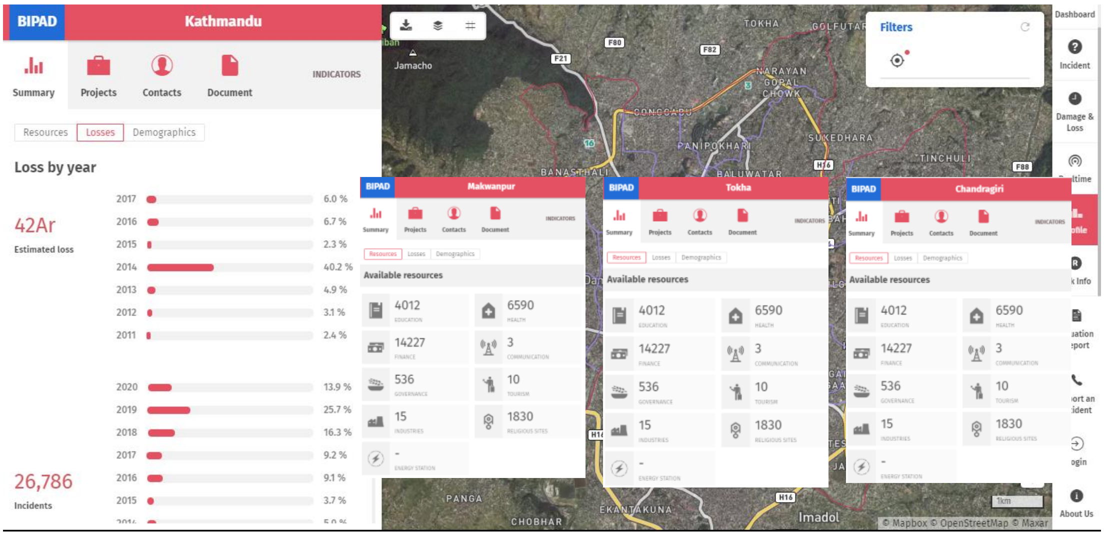
- Pulled information from DHM shows telemetric river level information, which does not translate spatially about the flood risk to a specific location. Impact based forecasting is required in the portal suggesting the exposed infrastructure and community rather than weather-based forecasting.
- Modelled information from MIKE-11 and flood bulletins from DHM also need to be included in the portal real-time module.
- Overlay of exposed building footprints or infrastructure on the flood risk areas could significantly lead to response and early action activities.
- The real-time module should include features to overlay information on hazard maps to aid in early warning systems. For example, the Rain Watch information from DHM could be used along with the landslide susceptibility data to inform about possible rainfall-induced landslides.

6.2.5 Module- Profile

- The profile module requires information about available capacities and resources in a georeferenced map format for the preparedness and response phase of DRM.
- The demographics data displayed in the portal is from the 2011 census data, which is nine years old. Therefore, the information needs to be projected with an appropriate growth rate for a close approximation.
- The demographic information is displayed in the map form at the national level and zoomed to the extent of the administrative boundaries queried. Therefore, the detailed demographic variation within the administrative boundary or local level cannot be observed in the map or the legend key.
- The loss estimates and number of incidents in the Profile module are given in lump sum value, which does not provide meaningful information, as shown in (Fig. 12).

- Similarly, irrespective of the location searches, the available resource value remains the same as shown in the figure for Makwanpur District, Tokha municipality, or Chandragiri municipality, which needs correction.

Figure 12: Interface and Data from Profile Module in BIPAD Portal

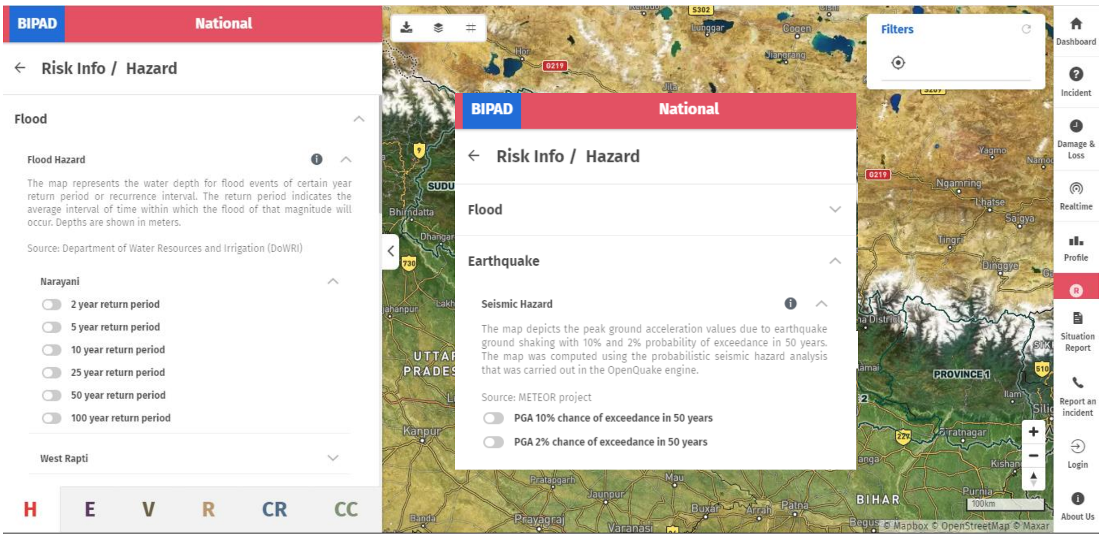


Source: BIPAD portal

6.2.6 Module- Risk Information

- The module risk information (‘risk info’) consists of rich and informative data for effective Disaster Risk Management. There is still a need to elaborate on the technical terms used in the portal (Fig. 13), such as “PGA with 10% chance of exceedance in 50 years” and “Return period of 5 years and 50 years” for the general audience. It should be clear what the data refers to and what the data does not mean.

Figure 13: Technical Parameters in Risk Info Module in BIPAD



Source: BIPAD portal

- There should be description and caveats on the metadata of risk information. For example, the audience needs to be explained that the return period of a flood might be 100 years, expressed as its probability of occurring being 1/100, or 1% in any one year. It does not mean that if a flood with such a return period occurs, then the next will occur in about one hundred years. Instead it means that, in any given year, there is a 1% chance that it will happen, regardless of when the last similar event was.

- The risk knowledge through advanced hazard risk assessment methods should include effectively communicating the uncertainties related to the processes scientific assumptions. There are assumptions in each data creation that accumulate significantly as multiple layers of information are inputted. The risk information should inform the limitations of each data used, and with what method the information was collected.

- The risk info module needs to have extensive attribute data of the exposed population and assets to have efficient risk-informed planning.

- The Vulnerability Tab needs disaggregated information about gender, disabled population, the elderly, and children, who require particular response action to facilitate data-driven and response actions. This sensitive information requires authorization and access control measures adhering to national data policies.

- Integration of Digital Elevation Model (DEM) and slope information will provide additional functionality and analysis capabilities for local level spatial decision-making.

- Information about safe shelters and evacuation routes are required for safe evacuation during emergencies. The data integration from the National Land Use Project and UNDP-CDRMP on risk-sensitive land-use plans could also support risk-informed planning process.

- Functionality such as evacuation route modelling, or dispersion simulation function can be added using the OSM road network, and DEM including the critical services and infrastructure facility data to support the distance analysis function in BIPAD.

- While doing the overlay operations in the module, there is no flexibility of function except for using the opacity slider for changing the transparency of layers for visualization. Also, the legend key colours are not automatically adjusted even when the layer's opacity is adjusted.

- All the information is available based on the administrative boundaries in the portal. Environmental hazards do not obey administrative jurisdictions; therefore, basin and sub-basin level data is necessary for decision-making related to flood forecasting or to assess the impacts of climate change.

- No overlay analysis or weightage distance analysis function is supported in the risk info module, even though this feature is available and automatically calculated in the incident module while using “Go to Response” button.

7 BIPAD for informed decision-making at federal, provincial, and local levels

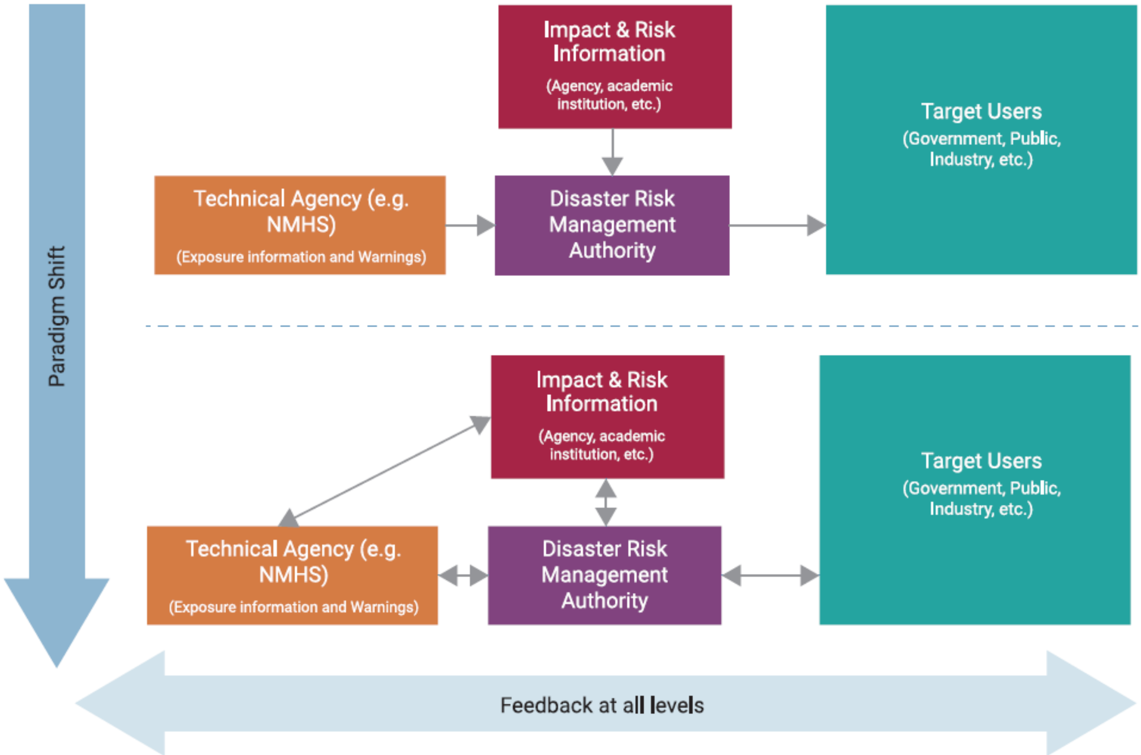
International policies and national priorities are gradually shifting from managing "disasters" to managing "risks". The shift incorporates broader approaches from sectors such as science, governance, policy, and social sciences. It emphasizes the connection between risk reduction and sustainable development. International commitments such as the Sustainable Development Goals (SDGs), the Paris Agreement, and the objectives of the SFDRR cannot be achieved without a comprehensive approach including anticipatory and evidence-based DRM measures. Risk information is crucial for decision-making in all DRM phases, and access to the accurate information at the right time can make the difference between life and death (Arnesen and Chang 2019). The 2015 Nepal Earthquake revealed the importance of disaster data during the crisis and post-disaster relief works. Filling in the data gaps in Nepal for post-disaster relief coordination involved a massive combination of crowdsourced crisis mapping, analysis, and displaying disaster information to support relief and recovery functions. Mobile and web-based applications were also used to mark people safe or locate missing people using Facebook Safety Checks and Google Person Finder App (Ayeb-Karlsson 2015).

The SFDRR explicitly states that risk knowledge generation and understanding should be based not only on disasters historical records but also on forecasts and projection. Risk assessments based mainly on existing hazards rather than vulnerabilities and exposure of elements at risk will not be sufficient to tackle large-scale events and societal challenges in the context of climate change. The decision-making process needs to be supported by advanced simulations based on the latest information and research. The simulation-based risk and impact assessment can make science understandable to policymakers and at the same time helps to acquire more useful and evidence-based knowledge for informing resilient development practices. Therefore, risk information needs a wider range of inputs rather than just existing hazard information. Risk information should support the multi-hazard risk assessment and decision-making, including hazards interaction and cascading effect analysis.

Gaps and concerns in understanding the risk information include unavailability of accurate exposure data and inadequate information about socio-economic vulnerability of people at risk. Improved risk knowledge through advanced risk assessment methods should consist of data management and information update processes using earth observations, historical disaster information, as well as qualitative social data. The risk knowledge should also include communicating the uncertainties of the scientific assumptions in the methods and models to the stakeholders. Social, environmental, and political complexities affect scientific knowledge production, especially in the uncertain context of climate change. Therefore, scientists and DRM practitioners must interact with local communities from the beginning of the risk information generation process to maximize opportunities for the co-production of knowledge and to effectively communicate the risk assessment process uncertainties.[9,22]

Multi-sector collaboration should contribute to improvements in risk modelling, knowledge management, and information sharing and avoiding the "siloed" science and policy approaches in DRM. The UNDRR (2020) suggests that a paradigm shift is required in risk communication with feedback mechanisms at all levels, and by establishing a common platform and mechanisms for sharing different aspects of risk information (hazard, exposure, vulnerability) to ensure the effective disaster risk management (Fig.14).

Figure 14: Feedback at all levels for effective DRM



Source: UNDRR 2020

The key priorities in improving risk and impact assessment for DRM are as follows:

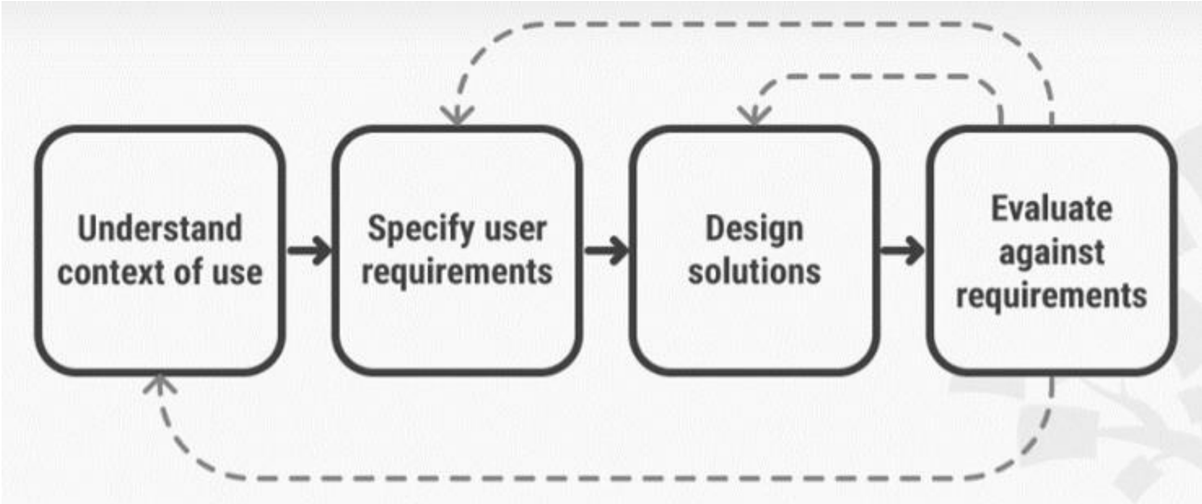
- Improving the understanding of hazard dynamics based on research and hazard monitoring and forecasting, including socio-cultural contexts.
- Identify and communicate the uncertainties in hazard assessment.
- Develop exposure and vulnerability analysis methods, including sectoral expertise and specific knowledge domains such as land administration, health, social science, cultural heritage, environment and biodiversity, and economic sectors like tourism, industry, and agricultural production.
- Develop methodologies for assessment of indirect economic impacts, biodiversity loss, and social impacts.
- Standardize exposure and vulnerability analysis for single-hazard, multi-hazard, cascading effects, and Na-Tech hazards.
- Develop tools for multi-hazard impact assessment, including hazard interaction and cascading effects.

7.1 Information need for risk informed decision-making:

One of the significant challenges in digital technology is its outreach to potential users. The institutionalization of the BIPAD portal requires a bottom-up approach and effective DRM governance at federal, provincial, and local levels through demand-driven and user-centred design. User-centred design (UCD) is an iterative design process in which the end-user and their needs are at the primary focus in all stages of the program (Fig. 15). End-users are involved in the project for knowledge co-production from the conception and design phase through various research and design techniques to create acceptable, sustainable, and community-owned programs. First, the context analysis is done, and specific user requirements identified. Then, design solutions are developed in collaboration with local users.

The evaluation is done with users and experts to check whether the users' requirements and context are effectively addressed by the design. It involves multiple iterations and feedback loops, which run until the users' needs are addressed.

Figure 15: Schematic diagram for UCD.



Source: interaction-design.org

Therefore, to institutionalize the BIPAD portal for risk informed decision-making at federal, provincial, and local levels, the most crucial question is:

What are the data needs and DRM capacities at federal, provincial, and local levels for risk-informed decision-making using the BIPAD portal?

This question should act as an entry point for demand-led, data-driven decision making for sustainable and efficient DRM. The BIPAD portal needs to be customized to cater to 753 municipal governments, 77 districts, and seven provincial governments and the NDRRMA. Local level institutions have varying hazard types and intensities, varying needs, and varying capacities to tackle hazards. With a detailed understanding of local level users' needs and capabilities, and customizing and responding to those data needs, BIPAD can perform as a sustainable and efficient DRM portal.

From a DRM practitioner's point of view, the required information for DRM decision-making through DIMS at federal, provincial, and local levels are presented as follows:

1. **What is the hazard risk in a particular area?**
   - Hazard information- earthquake, landslide, flood, drought, etc.
   - Hazard maps, landslide susceptible maps, engineering geological maps- liquefaction susceptible areas, fault lines information etc.
2. **How many people and assets are exposed to a particular risk?**
   - Exposure Data- vulnerable people at risk, assets, and infrastructure at risk.
   - Vulnerability data- disaggregated data about gender, age (children, elderly) and disability.
   - Contextual socio-economic information about the community and their cultural setting.
   - Resilience parameters: available resources, socio-economic condition, livelihood condition, social networks, education, income, poverty status, insurance etc.

3. **What can be done to protect vulnerable people from disasters? Where are the safe areas where people can be relocated?**
   - Available safe open spaces information: land records, risk-sensitive land use maps, engineering geological maps.
   - Digital elevation model to assess multiple spatial suitability assessments.
   - Number of people or households that can be accommodated in the specific space - Polygon Area calculation in GIS and SPHERE standards.
4. **How to reach the safe locations in case of disasters?**
   - Access route modelling: road network information, bridge data.
   - Shortest distance mapping for resources: inventory of critical services and emergency facility.
   - Spatial information about health centres, water supply networks, security services, and other resources in the vicinity- proximity analysis, coverage analysis.
5. **What is the existing capacity and resources?**
   - Technical capability and human resource mapping.
   - Institutional mapping, institutional structure analysis.
   - Existing infrastructure condition, and logistics planning.
   - Preparedness status: trainings, simulation and mock-drills, emergency shelter, warehouse, and stockpiles emergency funds and resource backup.
6. **Who will do what? During, before, and after the disaster?**
   - Acts, regulations, guidelines, and DRM plans.
   - SOP based on the DRM plan at all levels.
   - Multi-sector collaboration and coordination: information about private sector, NGOs, CSOs, security forces, and community responders.

8 Disaster governance for effective disaster risk management

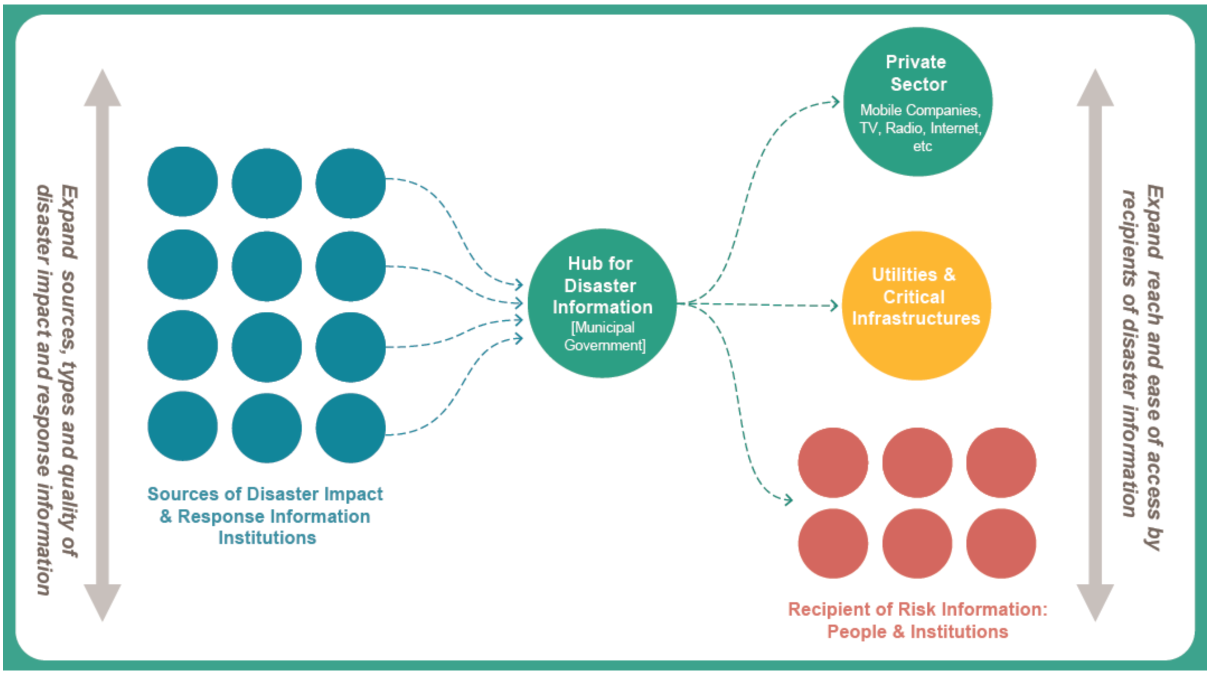
DRM is a collaborative social and institutional process of disaster governance, which uses technological means such as DIMS and governance frameworks to reduce disaster losses. DIMS is not a discrete tool but rather an integrated component of disaster governance, which involves structural arrangements and processes to facilitate shared understanding and coordinated response actions.

Disaster governance has become a central theme for DRM globally and is elaborated by priority two of the Sendai Framework for Disaster Risk Reduction. Disaster governance involves “the interactions among structures, processes, and traditions that determine how power is exercised, how decisions are taken, and how citizens or other stakeholders have their say”[23]. Disaster governance consists of the interrelated sets of norms, organizational and institutional actors, and practices that relate to before, during, and after the disaster event; that are designed to reduce the impacts and losses associated with disasters arising from natural and technological agents and from intentional acts of terrorism[29]. The Sendai Framework for DRR clearly states that governance measures must be prioritized in all four phases: Prevention, Preparedness, Response and Recovery of the Disaster Risk Management cycle. In the complex and uncertain world created by climate change, governance appears to be a key to the future DRR/M initiatives, where a wide range of actors across different sectors and boundaries need to collaborate and coordinate to share knowledge[33].

The UNDRR defines disaster risk management (DRM) as “the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reducing disaster losses.” DRR practitioners generally emphasize the core elements of the DRM cycle (prevention, preparedness, response, and recovery) but overlook the disaster governance measures, which are equally vital for implementing DRM plans.[29] Therefore, the aims of the disaster management policies and strategies need to explore beyond the ‘management’ roles and collaborate with diverse sets of actors with differing viewpoints through an integrated DIMS for effective DRM.[38]

In the DIMS process, information flows from disaster impact sources and response institutions to a disaster information hub. From there, risk information disseminates to utilities and critical infrastructures, private sector stakeholders, people, and institutions. The effectiveness of DIMS lies in: increasing the monitored sources of data, improving the types and quality of disaster impact and response information, and expanding the reach and ease of access to the wide range of recipients of disaster information.[1] The GFDRR Report (2019) suggests that effective DIMS should expand the data types and quality of risk and response information at the source, and simultaneously broaden the outreach and ease of access of the disaster information on the supply side. It should do so by providing need specific information to the private sector, utilities, and critical infrastructure services such as the Department of Roads, the Water Supply Department as well as people and institutions (Fig. 16).

Figure 16: Expand the sources and expand the outreach for efficient DIMS.



Source: GFDRR 2019

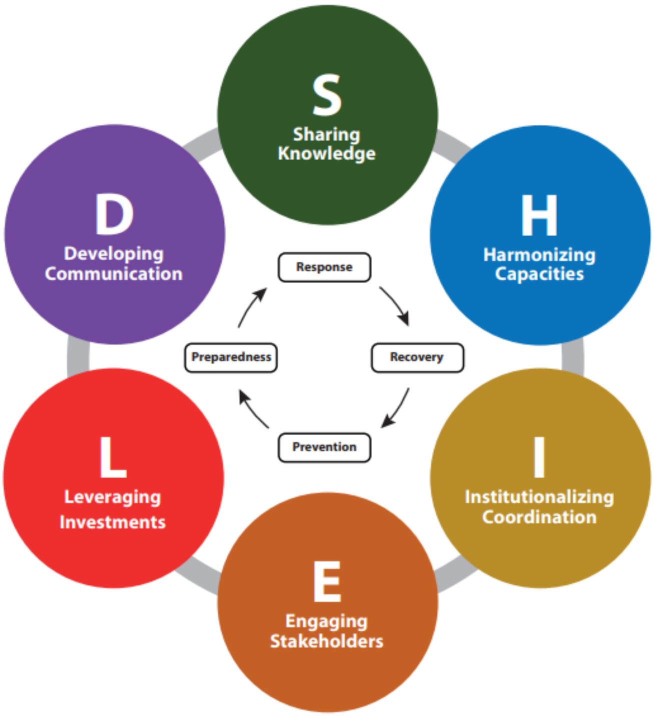
The European Union "Horizon-2020", the biggest EU research and innovation programme, produced a guideline and vision paper as an outcome of its coordination work strand, entitled "Enhancing synergies for disaster prevention in the European Union." It suggests recommendations for governance and management measures to support all four phases of DRM (Fig. 17).

This model could be very useful in the context of Nepal to direct the newly formed local level institutions on effective disaster risk governance to achieve sustainable DRM using the BIPAD portal.

The recommendations and guidelines are referred to as the SHIELD model, with strategic recommendations across six themes: (1) Sharing Knowledge; (2) Harmonizing Capacities; (3) Institutionalizing Coordination; (4) Engaging Stakeholders; (5) Leveraging Investments; and, (6) Developing Communication. The model includes recommendations on optimizing disaster risk management capabilities through risk governance approaches.[39]

The SHIELD model guidelines and recommendations could apply to the Nepalese context for institutionalizing the BIPAD portal at federal, provincial, and local levels, which are presented as follows:

Figure 17: SHIELD model as a guidance recommendation to support governance at all phases of DRM



Source: espressoproject.eu

Sharing knowledge: Effective DRM efforts depend upon accurate knowledge.
Effective actions rely on the ability of institutions to share knowledge and information, which includes information from forecast models, risk analysis, and local knowledge of past disaster

events. Sharing knowledge is vital across all disaster management phases. In the preparedness phase, a common understanding of the risk and hazard is critical for producing consistent risk assessments and engaging with the community to build resilience. During the disaster response, effective crisis management relies on accurate and timely information. Similarly, in the recovery phase, for post event analysis, the latest information is needed for coherent recovery efforts.

Sharing knowledge in the context of disasters involves knowing what to share, whom to share it with, when to share, why to share, and how to share. To share knowledge in the DRM context, actors and stakeholders need to identify what type of information or knowledge they need, what barriers exist for data sharing, and how to overcome them. Knowledge sharing entails sharing the right knowledge to the right person at the right time and avoid information overload to the recipient.

Recommendations for sharing knowledge:

- Map the field of relevant actors for knowledge sharing.
- Bridge knowledge gaps between science and policy by identifying partners who could enable knowledge sharing between science and policy domains.
- Build diverse networks for knowledge sharing, including government, private sectors, NGOs, and other stakeholders.
- Create frameworks and platforms for data sharing.
- Provide incentives for sharing, especially to private sectors and NGOs.
- Balance national and local scales of data sharing by creating a trusted platform that links science, policy, and practice.

Harmonizing Capacities: DIMS require specialized capacities. Harmonizing capacities includes ensuring that necessary forms of expertise, equipment, and capacities in public institutions that deal with DRM and CCA are available. The Sendai framework explicitly mentions: "governments must consider respective capacities and capabilities, in line with national laws and regulations" (UN 2015). Capacity building and maintaining the necessary skills among employees in all government bodies is crucial for effective DRM. The term "harmonizing capacities" refers not only to prioritizing and investing in material assets but also to human resource development and ensuring a coherent distribution of response and recovery resources across regions, municipalities, and cities at risk.

Recommendations for harmonizing capacities:

- Map existing technical and human capacities in key organizations.
- Assess and balance capacities: understanding which types of capacities are required and which are in surplus.
- Match capacities to risks: the capacities also need to be weighed against the existing hazard, vulnerability, and risk assessments.
- Evaluate and learn to assess whether the present set-up suffices to tackle the risk.
- Create local partnerships with private and non-government actors.
- Create continuity for capacities: sustaining funding and support for the right technical and human forms of expertise in the long-run and creating synergies between different kinds of emergency responders.

Institutionalizing coordination: Institutionalizing the coordination process by establishing agreed procedures for coordination between government bodies and stakeholders is vital for DRM. Coordination should not be thought of as a rigid process required for response and recovery phases; on the contrary, continuous coordination is also needed during the prevention and preparedness phases.

A well-planned and approved coordination plan deals with aligning and engaging the different actors and ensuring that necessary policies and agreements are in place, including chain of action, synchronization of languages and terminology, response timing, and legal and governance arrangements.

Recommendations for institutionalizing coordination:

- Clarify mandates for coordination.
- Acknowledge the need for balance and flexibility.
- Practice and exercise roles.
- Set up coordination forums.
- Align and streamline priorities.
- Build new partnerships for crisis management across administrative jurisdictions.

Engaging stakeholders: Engaging with stakeholders beyond the government domain and private sector actors and civil society organizations is critical for building disaster-resilient societies by supporting bottom-up initiatives and multi-stakeholder forums. Government, private sector, NGOs, CSOs, local organizations, and individual citizens all have a role in disaster management.

Recommendations for Engaging Stakeholders:

- Map and clarify the roles of each stakeholder.
- Create incentives for stakeholder participation.
- Create web-based online platforms for engagement.
- Locate mediators and experiment with roles during the engagement.
- Utilize local stakeholder knowledge for DRR actions.
- Ensure sustained commitment by all stakeholders.

Leveraging investments: Investing in DRM will, in the long run, reduce the cost for response and recovery activities. Governments should acknowledge that a cost-effective way to deal with disasters is by using financial investments aimed not only at prevention but also at building resilience. Studies have found that significant investment in risk reduction can reduce economic losses following disasters and that this shift in investment strategies can benefit the national and regional economy.

Recommendations for leveraging investments:

- Make more DRR activities value-visible to attract investments.
- Connect politicians and affected communities.
- Review and refresh existing disaster risk financing structures.
- Create partnerships for DRR investments with the private sector.

- Make long-term political agreements.
- Identify areas of overlap for CCA and DRR to reduce duplication of efforts and resources.

Developing communication: In the context of climate change, DRM interventions depend much more upon the exchange of knowledge and information. The need to create more comprehensive and efficient communication forms between experts, government entities, and the public is central. Government entities must acknowledge the need for a more significant effort towards innovating ways of communication between authorities and citizens in emergencies and disasters and co-production of DRM knowledge.

Recommendations for Developing Communication:

- Create multi-media platforms for risk awareness.
- Collaborate with media partners.
- Strengthen and streamline early warning platforms.
- Innovate disaster risk awareness campaigns.
- Embed disaster risk management courses into the education curriculum.

9 Recommendations

The study raises important questions and suggests further work opportunities. The additional tasks required are presented as short-term, medium-term, and long-term recommendations for the BIPAD portal. Specific recommendations based on each module of the BIPAD portal can be found in section 6.2 of this document, in addition to the following:

Recommendations for short-term measures:

1. The DRM legislation must clearly define the chain of command, roles, responsibilities of stakeholders, and the sequential priority actions, through the SOP and DRM plans at the local level. Each local level institution must prepare their DRM plans, and MoHA shall facilitate SOP preparation.
2. It is recommended that technical terms (e.g. “PGA with a 10% chance of exceedance, 50 yr. Return period, RCP 4.5, SD RCP 8.5”) are explained in plain language. The metadata and description should include caveats and clearly define and elaborate the dataset and its use in the simplest form to make it understandable for non-specialists and general users.
3. Pre-disaster outreach, awareness, and training are vital to ensure that the BIPAD portal is used during a disaster emergency and preparedness phase. Training is required for different tiers of users to become familiar with the system changes and ensure the BIPAD portal's daily utilization for decision-making and maintaining the database. The training activities must be prioritized and sequenced in the SOP. NDRRMA should organize regular training, simulations, and other forms of capacity building exercise for different government tiers on using the BIPAD portal.
4. Awareness and training: users must understand how to use the BIPAD portal for DRM and why[30].
5. Multi-lingual support is necessary to ensure a more comprehensive outreach in Nepal. Nepalese language interface, query, and visualization support must be added to the BIPAD portal by Youth Innovation Labs as per the guidance of NDRRMA.
6. Activity logs are required in the BIPAD portal for disaster monitoring, post-event analysis, and future response planning. Youth Innovation Labs must add features in the BIPAD portal to record the emergency responder's and decision-makers' activity logs as per the guidance of NEOC.
7. The risk information in the BIPAD portal, which is calculated through advanced hazard risk assessment methods should also effectively communicate the uncertainties related to the processes' scientific assumptions through elaborate descriptions.
8. Better data visualization and description is required in the BIPAD portal for clarity in the meaning of information as discussed in the section 6.2.2 and 6.2.3 of this document.

Recommendations for medium-term measures:

9. NDRRMA must incorporate an effective data management strategy in BIPAD by employing cloud computing for data backup, which offers data redundancy and better data infrastructure resilience. A redundant system architecture (consisting of a national data centre and backup data centre with regular automatic data synchronization) offers uninterrupted operation and resilience.
10. Data security and privacy: data handling policies and frameworks are required for ensuring data protection and effective use of disaster data for effective data-driven decision-

making. NDRRMA should facilitate the preparation of data handling policies and frameworks in Nepal for humanitarian data use.

11. Multi-stakeholder collaboration: engaging with multiple partners such as academia, the private sector, CSOs, I/NGOs, and locals are essential for the BIPAD portal outreach.

12. More flexibility is required on data download, visualization, and risk analysis features in the BIPAD portal.

13. The BIPAD portal can also be effectively used to monitor the achievements of the SFDRR targets as well as national, provincial, and local level action plans. It will further aid the institutionalization of BIPAD at all levels.

14. Data need assessment and resource mapping as well as capacity mapping is necessary across all the government tiers to ensure the institutionalization of the BIPAD Portal.

15. The risk information module needs to have extensive attribute data of the exposed population and assets and disaggregated information about gender, disabled, the elderly, and children, requiring particular response action to facilitate data-driven and response actions, entailing adequate authorization and access control measures.

Recommendations for long-term measures:

16. The use of standardized definitions and terminologies for recording loss and damage is necessary for a consistent database. The NDRRMA should facilitate to have clear methodologies and guidelines for defining and recording the damage and loss values for all DRM stakeholders.

17. The BIPAD portal must have the flexibility to add new components for decision support in the future, such as cascading effects and hazard interaction, for multi-hazard analysis. It can be achieved by increasing the monitored sources and types of data, improving the quality of data, and adding multi-hazard modelling, simulation, and analysis functionalities in the portal.

18. The BIPAD portal needs to update the missing datasets on loss and damage, recovery, and rehabilitation. Nepal's historical loss and damage information between 1971-2011 is available in the Desinventar opensource database, which could fill the data gap.

19. The hazard classification in BIPAD needs to be revisited as per the newly approved definition of hazard and classification by the UNDRR in 2020. The classification suggests three inclusion criteria for hazards: the hazard can impact a community; proactive and reactive measures are available or could be developed to tackle the hazard; and the hazard must be measurable in spatial and temporal dimensions.

20. Features such as a mobile text system and email for alert and incident reporting can provide additional utility to the BIPAD portal.

21. Uninterrupted internet access: after a major disaster like an earthquake, electricity and internet disruption can make BIPAD unusable, thereby hindering disaster response and recovery processes. Network congestion also puts an extra burden on the communication system leading to difficult information exchange. To resolve this issue, Japan launched the “Never Die Network” consisting of mobile nodes using vehicles, fixed relay stations, and satellite networks to quickly re-establish information access for large-scale emergencies. Nepal could replicate this model for uninterrupted internet service for response institutions during large-scale disasters.[26]

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