Video script of the e-learning course

“Building resilience to compound and cascading disaster risks”

Introduction

Hi, my name is Emma Fushimi. Alongside my colleague Eric Zusman, we welcome you to this training course on “Building resilience to compound and cascading disaster risks”. Eric and I will walk you through this course that is based on recent studies, voices from leading experts at local, national, and international levels as well as lessons from recent disasters involving compound or cascading hazards.

In this course, we will learn the measures that resilient communities are successfully applying to prepare, respond and recover when hazards strike at the same time, or one after another. We will guide you step-by-step with what you need to do so you can implement disaster risk management and deal with these compound and cascading disaster risks.

So, why is knowledge of compound and cascading disaster risk so important in the present and the future? Because disasters are increasing in size and frequency every year, more and more communities must deal with several disasters simultaneously. These connected disasters can escalate and cause humanitarian crises and widespread disruptions to our interconnected regional and global economies.

The COVID-19 pandemic has made it very clear how difficult it is for communities already having trouble responding to this biological disaster to face other disasters simultaneously. Asia, for instance, has experienced numerous significant disasters during the COVID-19 pandemic. There have been major floods in China, Kazakhstan, Pakistan, Uzbekistan, Iran, Nepal. At the same time, large cyclones have affected the Philippines, Vietnam, Bangladesh, and India.

For example, in July 2020, the southern prefectures of Japan, already dealing with COVID-19, experienced record-breaking heavy rain, which caused devastating floods and landslides in many areas. Since the floods and landslides happened during COVID-19, the evacuation and recovery processes were more challenging and complex, and the disaster resulted in 83 casualties.

The UN Economic and Social Commission for Asia and the Pacific has gone so far as to say that “a hazard-by-hazard approach to disaster risk management is no longer viable”. The globally agreed Sendai Framework for Disaster Risk Reduction puts a particular emphasis on multi-hazard response. That is why it is so important to expand your knowledge of single-hazard risk management and learn how to deal with compound and cascading disasters.

Before we go into guiding you step by step on how to strengthen the resilience of your community, this video will give you an overview of the lessons that this course will cover and how these lessons all come together to help your community to withstand compound and cascading disaster risks. The “Building resilience to compound and cascading disaster risks” course is organized into four chronological video lessons, covering all the basic steps needed to strengthen resilience against compound and cascading disaster risks. We strongly recommend you go over the video lessons of the course in chronological order.

So, the first part will start by briefly reviewing the essential concepts of disaster risk management like hazard, risk, vulnerabilities, and exposure. Following that, the course will introduce the concept and characteristics of compound and cascading disaster risks.

In the second part, we will go on to assess the risk of your community to compound and cascading hazards scenarios with a 6-step process.

The third part will introduce how to design resilience strengthening measures that could be applied to prepare for disasters and then to respond to and recover from them.

The fourth part of the course will guide you on how to implement the measures for disaster risk management in the plans and policies of your community.

There are worksheet templates available on the webpage that could be used to practice and deepen your understanding. If you are a trainer of the training, the worksheets might be useful when organizing training workshops.

Now let's go to the next video lesson, and let's start the course!

Lesson 1: Compound and cascading disaster risks. What are they?

(1) Fundamental concepts of disaster risk management

In this first part of the course, you will learn what compound and cascading disaster risks are. We will also teach you about the characteristics and impacts of these types of disaster risks. But first, let's review some essential concepts of disaster risk management. Let's start by making very clear what we mean by the terms HAZARD and DISASTER. Here, we have adopted the definitions established by the UNDRR.

A **hazard** is a potential source of harm. It is defined as "a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation." There are "natural hazards" such as earthquakes or heavy rain and there are also "man-made hazards" such as chemical explosions or traffic accidents.

On the other hand, a **disaster** is defined as "a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." A disaster occurs when the potential harm of a hazard is realized, impacting a human settlement whose population and infrastructure are vulnerable and cannot withstand the impact, injuring and killing people and causing destruction and economic loss. So, for example, if heavy rains fall in the middle of the ocean or other uninhabited places, there is no disaster. It is just the weather. But if the same heavy rains fall near human settlements, affecting people and their property, we have a disaster.

When is a hazard formally considered as a disaster? According to EM-DAT, an event is counted as a disaster if it fulfills one of the following criteria: 10 or more people lose their lives, there are one hundred or more affected people, there is a declaration of a state of emergency, or there is a call for international assistance.

Let's illustrate this with the case of the 2020 heavy rains in Kyushu, Japan. During this event, the rainfall rate exceeded 100 millimeters (3.9 inches) per hour, a record-breaking amount of rain, never seen in the region before. If this record-breaking rainfall had fallen in the middle of the Pacific Ocean, there would be no disaster. However, the rain hazard became a disaster when it fell on the populated areas of Kumamoto and Kagoshima prefectures, devastatingly affecting the people living there and their infrastructure.

Let us now go into more detail about how a hazard could become a disaster, expressed as disaster risk. Disaster risk is defined as "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity." So, for an area that experiences a hazard, if there is a high probability that the hazard's potential for harm is realized, we would say that this area is at a HIGH RISK of experiencing a disaster.

But what exactly does it mean for a community to have higher disaster risks? This depends on how much the community is exposed to the hazard, how vulnerable the community is as well as the community's capacity to cope with hazards.

To better understand this, let's go back to the case of the Kyushu floods of 2020. In this event, a total of 68 people lost their lives. However, 14 of these casualties (or 20% of the total) came from just one flooded elderly-care facility in Kuma, Kumamoto. People there were stranded after mud and flood water gushed into the building. The rescue personnel managed to rescue residents who had made it up to the second floor but could not reach those left on the first floor after water broke through the windows.

The residents of the elderly-care facility were living in a place that could be affected by rains and flooding. They had a high level of exposure. Also, the residents were elderly, many were sick and unable to walk, and the facility and community did not have a system in place to evacuate them quickly enough. They were highly vulnerable. So, when the flood hazard met with these "vulnerabilities" and "exposure", it created a high-risk situation for the people living in this facility, which resulted in a tragedy.

As we could see from the case in Kyushu 2020, a hazard's level of risk depends on two variables: exposure and vulnerability.

- Exposure is "the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas".
- Vulnerability is "the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, or assets or systems to the impacts of hazards".

With these elements, this area had a high risk of disaster which tragically materialized in 2020.

There are many types of hazards, including both natural and human-induced hazards.

According to a recent synthesis work by UNDRR, hazard classifications include 8 categories:

- meteorological and hydrological
- extra-terrestrial
- geohazards
- environmental
- chemical
- biological
- technological, and,
- societal hazards.

Let's look at some examples.

- Tropical cyclones, drought, riverine floods, and heatwaves are examples of "meteorological" and "hydrological" hazards.
- Meteorological and hydrological hazards are those resulting from the state and behavior of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces, and the resulting distribution of water resources.
- Pandemics like COVID-19, insect infestations and animal accidents are all considered "biological hazards" caused by an "exposure" to living organisms and their toxic substances or vector-borne diseases that may be carried. Like venomous wildlife and insects, poisonous plants and mosquitoes carrying disease-causing agents such as parasites, bacteria or viruses like the coronavirus and malaria.
- Technological hazards arise from the possibility of failure of an existing technology as well as from emerging technologies. Chemical spills, collapses, explosions, fires, gas leaks, poisonings, radiation leaks and oil spills are examples of industrial accidents. There are also transport accidents in the air, road, rail, or water. And finally, miscellaneous technological hazards like factory collapse, explosions, and fires.

In 2015, several countries came together to find solutions during the Third UN World Conference on Disaster Risk Reduction in Japan and created the Sendai Framework for Disaster Risk Reduction 2015-2030. The Sendai Framework sets out seven targets to be achieved by 2030, with a goal to prevent new and reduce existing disaster risk. To achieve that, the Sendai Framework outlines the following four priorities for action to prevent and reduce disaster risks:

(i) Understanding disaster risk,
(ii) Strengthening disaster risk governance to manage disaster risk,
(iii) Investing in disaster reduction for resilience,

(iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation, and reconstruction.

This brings us to the end of this video lesson, where we reviewed important concepts of disaster risk management like hazard, disaster, risk, vulnerabilities, and exposure. We also learned the different types of natural and man-made disasters and the underlying conditions that turned these hazards into disasters.
Now, we can go to the next video lesson in the course and see how all these concepts apply to situations with compound and cascading disaster risks.

(2) Compound and cascading disaster risks. What are their characteristics and impacts?
This video clarifies what compound and cascading disasters are, their characteristics, and their impacts.
So far, we have looked at some fundamental concepts of disaster risk management, taking them as single hazards, or single disasters. Most of the disaster risk reduction research and strategies deal with hazards individually, one by one. However, with the increasing magnitude and frequency of disasters happening in the world today, the trend more and more is to have multiple disasters striking a community at the same time, and this is partly related to climate change. This worrying trend is also highlighted in the latest assessment of the IPCC AR6 report.
Dealing with cascading and compound disasters simultaneously makes it extremely difficult for government officials and other people in charge to respond to these events appropriately. People and authorities in charge need to be equipped with a better understanding of and strategies to respond to such types of disasters. This lesson will give some measures to assess such risks, enhance resilience and implement these risk management strategies in society.
The first approach to understanding compound and cascading disaster risk is by looking into how individual hazards connect and relate to each other in space and over a long time. Here, we will mainly explain two types of hazards relationships: Compound hazards and cascading hazards.
Compound hazards happen when multiple disasters coincide in time or happen sequentially. In this case, hazards do not cascade, causing each other; they "compound", meaning they reinforce each other, creating a more complex situation that magnifies the impact of the individual disasters. A hydrological hazard such as a flood can compound with a meteorological hazard like a storm. A geological hazard like an earthquake can combine with a biological hazard like COVID-19.
In the case of Kyushu in 2020, the Kuma River overran its bank in eleven different locations and breached one levee, causing floods. At the same time, there were 12 landslide events. These disasters happened when those communities were battling the COVID-19 pandemic, a biological disaster of a different kind, making the disaster response more difficult. At the time, the authorities instructed more than 75,000 residents to evacuate in the prefectures of Kumamoto and Kagoshima, and 109 shelters were opened in the region. However, they had to rely on local volunteers, since concerns about COVID-19 infection prevented volunteers from travelling from far away. Evacuees and local officials also raised concerns regarding emergency shelter. For instance, some evacuees arriving at shelters were asked to go elsewhere to maintain social distancing. Some evacuees chose to take refuge in their cars, while others stayed with friends.
The other situation we can encounter are **cascading hazards.** Cascading hazards happen when one hazard type triggers another hazard in a series. Similarly, each cascading hazard could give rise to disasters depending on the level of exposure and vulnerabilities. However, cascading disasters are usually non-linear and the impact of one disaster continues to advance beyond the location of impact and/or for an extended time.
For example, in the 2011 triple disaster in Fukushima, Japan, first, there was an earthquake, a geophysical type of hazard. This earthquake triggered a tsunami, a hydrological hazard. The

tsunami damaged a nuclear power plant causing explosions and release of toxic radioactive substances, a technological - industrial accident. In this event, the communities were first hit by the earthquake. Minutes later, they were impacted by the tsunami and then, were potentially exposed to toxic substances from the crippled power plant. The disaster impacts continued to cascade to the national level and then to international supply chains of electronics, cars and other exports. In a situation with cascading hazards, the interactions between disasters can be one way, like a domino effect or a contagion effect, but can also have complex interactions, where disasters can feed back to one another.

So, as we can see from these examples, compound and cascading hazards can combine different kinds of hazards, resulting in numerous combinations of possible disastrous situations and system-wide impacts. And when considering cascading hazards, a hydrological disaster like a flood can cascade to create another hydrological disaster like a landslide, trigger a biological disaster producing waterborne diseases, and finally, make a technological disaster in the form of a factory fire.

To understand the characteristics of compound and cascading disasters, we need to examine different factors such as the following:

Triggers or causes

First, you have a trigger that causes the disaster.

These triggers can be a single hazard or a combination of hazards.

It could be that a single hazard triggers other hazards over time.

And there can also be complex interactions and non-linear feedback between the disasters.

After the triggering events, you have the following:

Occurrences

Disasters can occur simultaneously or successively, so not all compound disasters are simultaneous events.

For example, even if heavy snow falls several weeks after an earthquake, it will still affect the earthquake's recovery process and make it very difficult.

Disasters can also have a fast or slow onset. Slow start and an intensifying or intensified and gradual progression to multiple areas and sectors.

Scale

Disasters can reach various scales of exposure. They can have a small scale, just touching the local level, but may also grow to affect national, regional, and even global levels. For example, COVID 19 started as a local problem, and at that time, people would never have thought that the virus would spread globally and change people's lives almost forever.

Impacts and damages

These impacts can be primary, taking a hit directly from the hazard. But there are also secondary and tertiary cascading impacts. There may be an out-of-control domino effect in the impact chain affecting many connected systems. Moreover, there may be system-wide and long-lasting impacts affecting multiple sectors.

Surprises and knock-on effects to multiple sectors are also to be expected.

Response

When there is no sufficient understanding of underlying cause and impacts, the response tends to be ad hoc and uncoordinated since information and orders may come from different government agencies. Lack of information and coordination gaps might create confusion and ineffective response and recovery. Ultimately, what is needed is a coordinated, systematic response, considering all the sectors and areas that this hazard will affect.

To be better prepared for compound and cascading disaster risks, we introduce the idea of "Impact Chains" as a methodology to analyze compound and cascading disaster risks. It is the chain of impacts caused by one impact triggering other impacts across different sectors, or a series of impacts in different sectors resulting in an enormous impact.
Focusing on the endpoints of the chain, the outcomes can be as diverse as impacts on

- Health,
- Agriculture,
- Forestry, and
- Water industry;
- On industry and economic activities
- People's livelihoods, and
- Impacts due to disruptions in infrastructure and lifelines.

In the next lesson, we introduce a way to develop risk scenarios using a visualization tool of the Impact Chain.

So that's it, we have come to the end of this lesson and the end of part one of the course where:

- We reviewed essential concepts in disaster risk reduction, including risk, exposure, and vulnerabilities.
- You gained knowledge about compound and cascading disaster risks.
- We introduced key characteristics of compound and cascading risks to show what factors you need to pay attention to in order to prepare for multiple disasters.

Let's now go to the next section of the course, where you will assess disaster risks.

Lesson 2: Six steps of disaster risk assessment

Hello, my name is Eric Zusman. In Part II of this course, we will discuss how to add the notion of the compound and cascading disasters in the risk assessment process as well as the issues it involves. This will allow you to better understand the overall risk of your community from such disasters.

First, let's understand that risk assessment of both, normal or single disasters and those involving compound and cascading disasters, especially those involving extreme events, are different issues. As the first step, it is a good strategy to start with conventional risk assessment approaches and then add additional elements for assessment to address more complex disasters. Building on the basic steps of disaster risk assessment, here we suggest a 6-step process to assess risks from compound and cascading disasters:

1. Hazard analysis
2. Exposure assessment
3. Vulnerability assessment
4. Risk assessment and mapping
5. Risk scenario development
6. Resources and capacity mapping

Let's walk through all of these steps.

Step one, hazard analysis.

Cascading and compound hazards follow complex patterns in space and time. Improving our capacity to recognize these patterns is helpful to better manage our responses. Studies to understand hazard patterns are still evolving and are difficult to classify. For this exercise, let's discuss the three potential spatial patterns as well as the temporal dimension that the compound and cascading hazards might originate and spread.

The first pattern is of local origin. When single or multiple hazards at the point of the primary impact happen at the local level, sometimes a cascading hazard also occurs at the local level. Then, there are secondary and tertiary impacts that spread to sub-national and national levels. Sometimes, it could even spread beyond national territory, regional, and global levels. Like when one of the worst floods in the history of Thailand struck in 2011 and caused shortages of components crucial to Thailand's electronic industries, which, in turn, affected computer hardware production and its supply chains across the world.

The second pattern of multi-hazards is when they have an external origin. When compound or cascading hazards happen at a distant location, the primary, secondary, or tertiary impacts will cascade or simultaneously spill over to the local level.

And the third pattern is when multi-hazards have distributed or complex origins. When combined or cascading hazards occur at multiple locations, the impacts influence each other in very complex ways. And then, different impacts will happen in different places at the local level.

To better understand the spatial patterns of multi-hazards, it is helpful to draw a hazard map. Here, concerned stakeholders can map in the territory of your community the possible hazards and the

locations where they might occur.
A good example is this “multi-layered hazard map” created by Japan’s Ministry of Land, Infrastructure and Tourism. This map allows us to easily overlay the multiple disaster risks in the specific location including flood risk, landslide risk, and, in coastal areas, tsunami risk. However, we have to be mindful that this multi-layered hazard map includes only natural hazards and not others, such as technological or biological disasters, as well as might not adequately consider the compound and cascading impacts.
Next, let’s examine the temporal dimension of compound and cascading hazards such as time, seasons or even years.
Different types of climate-related hazards can occur in different seasons. For example, in this seasonal calendar, torrential rains and floods occur during the rainy season, whereas heat waves, drought, and wildfire can happen in the dry season. Wildfires on the other hand, can mostly happen during the hot season.
Some hazards can repeat or persist throughout the year, for example, infectious diseases. So, by visualizing spatial hazards patterns into the seasonal calendar or timeline, communities can identify and better understand the potential cascading and compound hazards. One crucial point here is the consideration of the impact of climate change in hazard assessment. Due to the impact of climate change, communities cannot simply rely on historical data. Uses of climate impact assessment or decision support tools like Impact Viewer and Climo Cast, which are freely available on the AP-PLAT website, become quite helpful in this regard.

Step two, exposure assessment.
Exposure is the presence of people, infrastructure, or assets in places that the hazard could affect. In other words, these are the ‘elements under risk’. When dealing with compound and cascading hazards, the most important aspect to consider is the scope of exposure assessment, where the number of elements under risk could grow significantly.
For instance, let's assume an existing hazard map of a hypothetical town which may only include common exposure elements such as buildings, bridges, farmlands, and people located near a particular hazard impact area such as flood plains or near coastal areas. However, under compound or cascading hazards condition, the elements that were considered safe (such as critical infrastructures like hospitals, schools, major highways, airport or industrial establishments such as chemical factories) or even located outside the main hazard zone (supply chain of food, export goods) could now fall under the scope of exposure assessment.

Step three, vulnerability assessment.
Vulnerability is the propensity of a community, system, or asset to be adversely affected by a certain hazard. High vulnerability usually correlates with a low capacity to respond and recover.
Therefore, a vulnerability assessment involves the estimation of damages as well as capacities to reduce such damages.
Damage can be both, tangible and intangible. Tangible damages can be measured directly, such as the number of deaths, destroyed infrastructure or houses demolished. Meanwhile, intangible damages are harder to measure, such as the economic losses due to the closure of business, psychological impacts, and trauma.
Capacity assessment involves the identification of available physical, social, and economic measures acting against hazard impacts.
Damage assessment of cascading and compound hazards is rather complex. Damage information is usually unknown, especially since such hazards might not have occurred so far. Damage and capacity assessment, therefore, can be based on the identified exposure elements as well as damage information from past disasters.

Since exposure and vulnerability are closely related, let's try to understand the assessment of exposure and vulnerability in a more concrete way by referring to two recent examples involving compound and cascading disasters in Japan and Myanmar.
The first case is of heavy rains, floods, landslides and factory explosions in July 2018 in Okayama, Japan. In July 2018, torrential rains across the Chugoku region caused widespread and simultaneous river flooding, inland water inundation, and mudslides, resulting in 224 deaths, eight missing persons, and extensive damage, including the destruction of houses.
An aluminum furnace at the plant in Soja City, Okayama Prefecture, exploded on July 6th. Several residents were injured and three buildings burned down. The incident also damaged roofs and windows of homes across a wide area. City authorities say the plant had been inundated due to the heavy rain before the blasts, prompting its workers to suspend the furnace's operation and leave.
In this case, what are the exposure and vulnerabilities that contributed to the factory explosion disaster? The exposure was the location of the factory near the river, a location that could flood if the river overflowed its banks as it did. And in this case, the vulnerability assessment could consider lives lost, people injured, damages to houses, damage to the aluminum in the factory, indirect economic impacts to disrupted services or losses on the side of clients of the aluminum factory.
So, let's review our second example from Myanmar. Between April and October 2015, central and western Myanmar experienced floods and landslides caused by heavy monsoon rains, resulting in more than 200 deaths, more than 1,200 people displaced, and a massive human life toll of more than 1.6 million affected people. The floods also had long-term health consequences. 285 health facilities were also damaged that could not provide services to people suffering from water-borne diseases from contaminated water or those affected by vector-borne diseases such as dengue fever and malaria. Mosquito and snake-borne malaria spread among people who were forced to live in temporary huts after losing their homes. These are endemic in Myanmar and are responsible for high mortality rates, especially among children in rural areas. So, while more and more people were catching water- and vector-borne diseases, health facilities were damaged, making treatment difficult or impossible.
In this case, what are the exposure elements and the vulnerabilities? The exposure was: Hospitals with limited infrastructure and village houses weak to flooding / limited infrastructure at the evacuation center. The vulnerability was: Hospital patients and children and the elderly who are prone to catching these diseases.

Now, let's move on to **step four, which is risk assessment and mapping.**
So, after assessing potential hazards, exposure elements, and the resultant vulnerability, we can now turn to conducting the risk assessment and mapping. When we're mapping risks, it is crucial to classify that level of risk. The risk map is an extension to a hazard map that includes exposure elements and vulnerability levels.
For example, in this risk map, you should be able to identify which elements are high risk, which are medium risk, and which are low risk based on the assessment you've conducted so far. You can also develop different risk maps by seasons.

In step five, the community will build risk scenarios based on the identified level of risks. A "scenario" is a description of an event that may occur in the future, leading to a specific outcome. Scenarios are based on assumptions about key factors and their causal relationships. There are varieties of methodologies to develop risk scenarios for different levels of stakeholders.
Here, we show the example of a risk scenario development in Koriyama City, Fukushima Prefecture, Japan attended by a wide range of sections from the Koriyama city office with the

support from the regional environmental research institutes. Experts attending the workshop developed risk scenarios using the “Impact Chain methodology”, a tool to visualize the chain of impacts of climate change that was developed by the GIZ from Germany. Together, they developed risk scenarios for complex chain of disasters such as how heavy rain caused landslides and subsequent chain of impacts to vulnerable and exposed areas such as roads, farmlands, and residential areas near the mountain slopes. After the workshop, this impact chain risk scenario was included in Koriyama City’s Climate Change Adaptation Strategy. Similarly, communities can develop one or more scenarios for future planning and actions through interaction and participation of key stakeholders, most importantly, the vulnerable groups or sectors.

And finally, **step six is a resource and capacity mapping**.
So, after risk assessment and mapping as well as developing risk scenarios, communities can assess the available resources and capacity that could be mobilized in the event of a disaster. The community should prepare an extensive list of available resources and existing capacities. The condition of the resources and capacities should be assessed, making sure they can be used during a disaster. This process allows communities to identify gaps in resources and capacities.
And this step concludes the disaster risk assessment process and ends part two of the course.

We introduced the six key steps to assess risks considering compound and cascading disasters. The six steps of disaster risk assessment are:

1. Hazard analysis
2. Exposure assessment
3. Vulnerability assessment
4. Risk Mapping
5. Risk scenario development
6. Resources and capacity mapping

In the next lesson, we will learn about designing resilience enhancement measures that could help reduce the identified disaster risks

Lesson 3: Designing resilience enhancing measures

In the previous lesson, we learned the key processes involved in the assessment of cascading and compound risk at the community level. Now by utilizing these outcomes, we will move on to conceive measures to address the compound and cascading disaster risks and vulnerabilities.
In this lesson, you will learn a 3-step process to design resilience-strengthening measures so your community can withstand compound and cascading disasters. You will be building your capacities based on your existing disaster risk reduction practices, available capacities and needs. Let's get started with this lesson!

Resilience enhancement measures against compound and cascading disasters will consider the prevention and minimization of damages as well as preparation for “better reconstruction” to ensure adaptive recovery. They will build on the existing disaster risk management framework progressively. In other words, there should be additional approaches to conventional disaster risk reduction measures. Identified options will be multi-functional, generate multi-outcomes, and be flexible enough to be utilized under various circumstances. Ultimately, the identified resilience enhancement measures will form the building blocks of a systemic disaster response mechanism.
So, why do we need to take additional approaches to compound and cascading disasters? This is because compound and cascading disasters often affect a larger territory and last for a more extended period than single disasters. It also creates additional pressure to an already stressed area. And if one of them is a slow onset, then the whole system has deep impacts. Therefore, the disaster risk management framework should consider these extended effects for the preparedness, response, and recovery processes.
The identified risk enhancement measures should address the systemic risks and impacts caused by potential compound and cascading events along space and time. Resilience enhancement measures will address all the elements of the disaster management cycle. The disaster management cycle has three steps: pre-disaster preparedness, response, and post-disaster recovery.
The first step is comprehensive preparedness based on understanding the mechanism of compound and cascading disasters in proactive and inclusive ways. The second step is preventive response measures to break the chain of impacts of a particular disaster. The last step is the post-recovery stage, where decision-makers should take into account the “adaptive recovery” or build-back-better approaches.
So, let's dive more deeply into each of these three steps of the disaster management cycle and learn how we can create resilience enhancement measures against compound and cascading disaster risks.

Step one is preparedness to prevent losses, damages and impacts of compound and cascading disasters. Most importantly, local people must understand what is likely to happen after one or more hazards strike based on the outcome of risk assessment, which was illustrated in Part 2. Then, communities and stakeholders can take measures to reduce exposure or vulnerability.
For instance, local authorities can reduce exposure by preventing people from accessing places or engaging in business or development activities in high-risk areas.
Similarly, communities can consider reducing vulnerability to disasters by approaching vulnerable populations or communities prior to disasters. The case of Iloilo City in the Philippines is an example of good practice on how to decrease vulnerability to COVID-19. Iloilo City created a vaccine prioritization matrix to visualize high-risk communities within the city. Prioritization is based

on the fact that high-risk communities have low vaccination rates, especially among the elderly, and also have high incidence of COVID cases. The vaccination starts from the highest-risk community, which will reduce the deaths in the quickest time possible. The Philippines is regularly affected by multiple natural disasters, including typhoons, volcanic eruptions, and earthquakes. This vaccine prioritization map will also mitigate the city's vulnerability to the potential compound occurrence of natural disasters.

The second step is response to compound and cascading disasters.

Once a disaster occurs, the priority of response is to prevent further cascading of effects and stop secondary disasters from happening. It is crucial to take timely action to stop a chain of cascading impacts such as by providing timely alerts to populations at risk so that they can evacuate and take necessary safety measures before the potential secondary impacts.

An example of good practice is the Multi-Hazard Early Warning System. Multi-hazard early warning systems address several hazards and impacts in situations where disasters may occur alone, simultaneously, cascading or cumulatively over time, and consider the potential interrelated effects. As an example, Cyclone Amphan in 2020 highlights the value of multi-hazard early warnings in India. Accurate advance forecasts of tropical cyclone Amphan in India and Bangladesh underpinned a successful disaster mobilization campaign, including the evacuation of more than 3 million people, which has been praised for limiting casualties and serving as a textbook example for multi-hazard early warning systems.

A good example to illustrate this is the case of Matsuyama city, and their volunteer disaster response that worked well under a disastrous situation. Resilient communities can break the chain of influence when the time comes because they have a good understanding of cascading and compound risk, strong social capital, and community leaders with knowledge and networks. Matsuyama city not only has a strong leader but the city residents also showed leadership by voluntarily responded to disaster and the aftermath of heavy rain in 2019. Their activities saved lives when facing the risk of landslides. This example illustrates that the framework of the measures to single hazards can also be effective for multi-hazards.

Step 3 is Recovery.

Flexible relief and recovery efforts are also of considerable importance.

To provide people with a safety net for large shocks, social protection measures are necessary. Such “adaptive social protection” measures require flexibility and a well-targeted delivery to transfer resources to disaster victims in a timely fashion.

Compound disasters may cause people to face multiple challenges and difficulties for an extended period of time. Local governments need to provide additional social protection for such victims. In the long run, designing a seamless recovery process and preparedness should be considered comprehensively and systematically.

Considering Building Back Better and beyond is critical for “**adaptive recovery**”. While Building Back Better involves a short- and mid-term response to recovery from disasters, resilience should be enhanced with long-term, continuous economic and social measures. Economic measures include revenue diversification, market insurance and financial inclusion. Through disaster risk financing, governments need to tap various financing sources to support these protection mechanisms. Enhanced social capital is another important action. Resilient communities with strong social capital can break the chain of influence when a difficult time comes, because they have a good understanding of cascading and compound risk, and community leaders with knowledge and networks. For the implementation of these measures, we should have a better and more adaptive risk governance structure.

In this lesson, we learned how resilience enhancement measures could be considered under three

steps:
Step 1 – Preparedness. Here, the key is to know where the most vulnerable spots and populations are situated, and to do that, you can use a tool like multi-hazard maps.
Step 2 – Response, where the priority is to stop cascading impacts to happen after a first disaster strikes and
Step 3 – Recovery. Making sure to build back better, with adaptive capacity and incorporating preparedness for the next possible disaster.

Please note that the measures should be prepared based on the local situations and communities can start from either preparedness, response and recovery without following an order.
In the next video lesson, we will introduce how to implement these measures and design an adaptive implementation framework.

Lesson 4: Adaptive implementation framework

Welcome back to our course on building resilience to compound and cascading disaster risks.
This is the fourth and final part of the course where you will see how to effectively implement the previous steps introduced so far. Implementation of the resilience-enhancement measures identified in the previous lecture should also build on existing disaster risk reduction arrangements but in a more adaptive manner. It requires a systemic and transformative thinking based on the concept of adaptive governance, which is more about multi-level collaboration, collective decision making, and continuous learning for building knowledge for addressing system-wide impacts. We suggest three mutually reinforcing pillars for designing an adaptive implementation framework as follows:
The first pillar is the enabling environment. It is about policies, strategies, laws and institutional setup, which are the foundation for facilitating identified risk reduction and resilience enhancement measures. For adaptive governance, we need a flexible enabling environment to ensure multi-level coordination, meaningful participation of stakeholders and effective decision making resulting in gradual strengthening of institutional capacities and experiences.
The second pillar is an adaptive action plan that covers the short-, mid-, and long-term actions. A stepwise approach of implementation is always useful for continuous learning based on the local circumstances and existing capacity. However, in the case of cascading and compound disasters, the action plan essentially should have a long-term vision and adopt a systematic approach of risk management.
The third pillar is functional monitoring and evaluation processes, which are at the core of adaptive disaster risk management. It helps promote experimentation, learning and continuous adaptation with evolving uncertainties and surprises that are common in the case of compound and cascading disasters.
Let's further discuss these three pillars of the adaptive implementation framework.

Pillar #1: POLICY, LEGAL, AND INSTITUTIONAL SETUP
Inadequate policies and legal arrangements can significantly affect the whole process of disaster risk management. They provide instructions on roles, responsibility, and mandates for mobilizing different resources and capabilities during different stages of disaster management.
In the context of cascading and compound disasters, policy, strategies and legal measures have to be proactive and realistic to the changing risk profile of potential natural as well as man-made disasters.
We can see that most of the countries in Asia-Pacific usually have a National Disaster Management Acts or National Disaster Management Authority (NDMA) that provides guidelines and support to different aspects of disaster risk reduction to sub-national and local levels. It is important that cascading and compound disaster risks are well prioritized in such acts, strategies, and guidelines. A review of existing policy and legal arrangements can help identify the key gaps and accordingly revise, update, or newly formulate acts, policies, and strategies to address cascading and compound disaster risk assessment and management.
Updated legal and policy measures are critical for installing appropriate institutional arrangements that are flexible, responsive, resourceful, and with clear mandates.
For example, in the Philippines, in 2012 the City of Makati established the Disaster Risk Reduction and Management Council, the Makati Disaster Risk Reduction and Management Office, and disaster risk reduction and management committees in twelve neighborhoods. Through the City of Makati Disaster Risk Reduction and Management Council and the neighborhood's disaster risk

reduction and management committees, relevant laws and policies are enacted for mainstreaming disaster risk reduction at the local level. One of these policies is the Philippines Disaster Reduction and Management Act enacted in 2010 that allocates at least 5% of the city's total revenue to a local disaster risk reduction and management fund.
The primary role of the institutional setups is to establish and promote a multi-level, multi-stakeholder, and multi-sector coordination mechanism down to the local level. This is crucial to manage complex types of cascading and compound disasters.
In addition to that, it is also important to provide appropriate incentives to ensure a meaningful and inclusive participation of key stakeholders in the whole preparedness, mitigation, response, and recovery processes of the disaster management cycle. Furthermore, institutional arrangements will be crucial for the effective mobilization of resources and capacity at different levels.

Pillar #2: ADAPTIVE ACTION PLAN

Establishment of necessary policies, as well as legal and institutional arrangement are essential to develop a feasible action plan that will be grounded on the local reality and identified risk scenarios. The development of an adaptive action plan is a multi-stage, multi-level, and participatory process. It involves establishing community vision and goals, setting objectives, and identifying priority areas based on the identified risk scenarios.
For instance, following the Great East Japan Earthquake of March 2011, the Japanese government did a simulation to assess the Nankai Trough earthquake and tsunami. The simulation found that the town of Kuroshio was under high risk of tsunami. Following that realization, the town started revising their local plan. They identified three guiding pillars or vision for revising the local plan. It involved stronger leadership of the mayor, work by the whole town so that they could mobilize 200 officials against seven staff at Kuroshio's DRR section, and residents and community effort to not give up and flee quickly to safer locations. Because of this well-thought process encouraging proactive approach, the town and its citizens have created an "individual tsunami evacuation chart", a tsunami evacuation plan for all 3,791 households, tsunami evacuation routes and shelters, and engagements in different forms of routine training.
In another case, Marunda in Jakarta Indonesia developed a multi-stakeholder platform to address flood and other risks through a participatory approach. They established "Marunda urban resilience in action" to carry out identified solutions during the participatory neighborhood appraisal. It is also important that communities have a complete understanding of the actions and targets to achieve objectives and realize the vision. So under each objective, communities need to explain details of all activities highlighting state, targets, indicators, relevant priorities, and outcomes. It also includes a timeline (short-, medium-, and long-term) based on priorities, required resources and available means of implementation.
While the action plan might resemble existing disaster management plans, the details differ in terms of the objectives, priorities, linkages and planning horizon involving systemic impacts and transformations when considering compound and cascading disasters.

Pillar #3: Monitoring and evaluation
Monitoring and evaluation are at the heart of adaptive disaster management and decision making. Monitoring and evaluation are critical to understand the risk landscape, which are always changing and evolving in the case of cascading and compound disasters. A well-functioning monitoring and evaluation allows an iterative process of self-learning and evaluating the progress, identify gaps, and suggest mitigation strategies. It helps detect processes and factors behind cascading and compound disasters as communities could not understand such cause and effects in the absence

of information. The monitoring and evaluation should be objective, result-oriented and based on performance benchmarks and indicators.
In Santa Fe city, Argentina, the city focused heavily on monitoring and data collection to guide risk communication and decision making. Self-assessment tools have contributed to improving the local disaster risk management process. For monitoring, the city conducted a diagnosis for the development of its resilience strategy which then guided the start of a new disaster risk reduction and resilience cycle based on the past experiences and learning.
Since monitoring and evaluation are often resource intensive, they should be designed as a part of the learning cycle, continuous, innovative, appropriate, and when possible, encouraging self-monitoring, reporting and automated utilizing information and communication technologies.

That brings us to the end of this lesson, where you learned how to implement the resilience strengthening measures into your communities' policies and plans.

Conclusion

Congratulations! You have completed the course on "How to strengthen resilience against compound and cascading disaster risks".

- You started by reviewing disaster risk reduction concepts and finding out the way compound and cascading hazards differ from other hazards.
- You then went and learned how to perform a disaster risk assessment and discovered the exposed and vulnerable elements in your community that could be affected by compound and cascading disasters.
- Next, you learned to design resilience strengthening measures to deal with the disaster vulnerabilities and exposure elements of your community.
- Finally, you learned how to implement these measures into your plans and policies.

Although these lessons are brief and introductory in nature, we hope that it will help you to better understand the importance of compound and cascading disaster risk and take the necessary steps. Now, let's go and apply this knowledge.