Implementing Impact-based Forecasting for Agricultural Resilience

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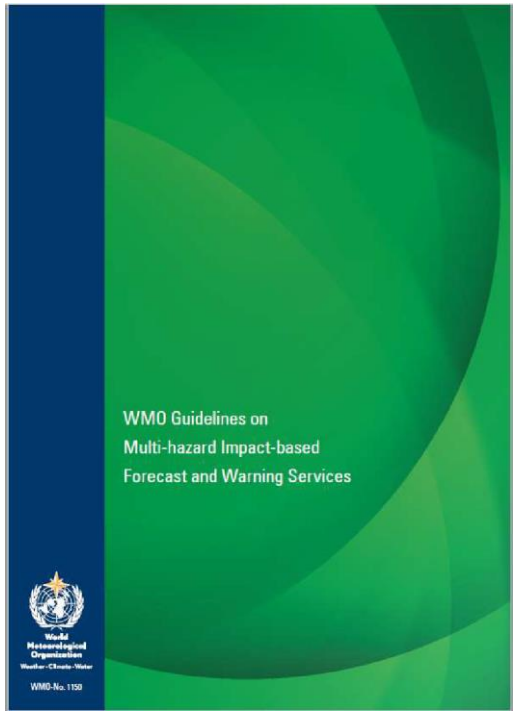
Overview

- Resources: Guidelines
- Why move to Impact-Based Forecasting?
- Understanding the Hazards across «Risk, Vulnerability, Exposure »
- Different types of Warning
- Risk matrix
- Agrometeorology: Always Focused on Impacts

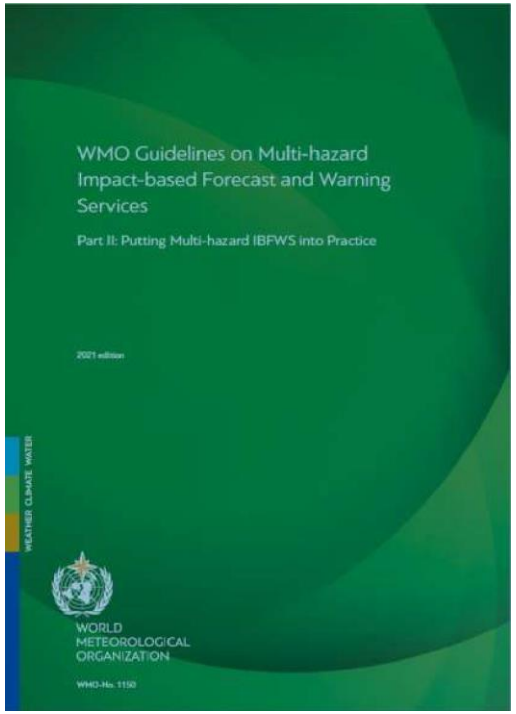
Guidelines

WMO No. 1150
WMO Guidelines on Multi-Hazard Impact-Based Forecast and Warning Services



WMO No. 1150 Part II
WMO Guidelines on Multi-Hazard Impact-Based Forecast and Warning Services

Putting Multi-hazard IBFWS into Practice



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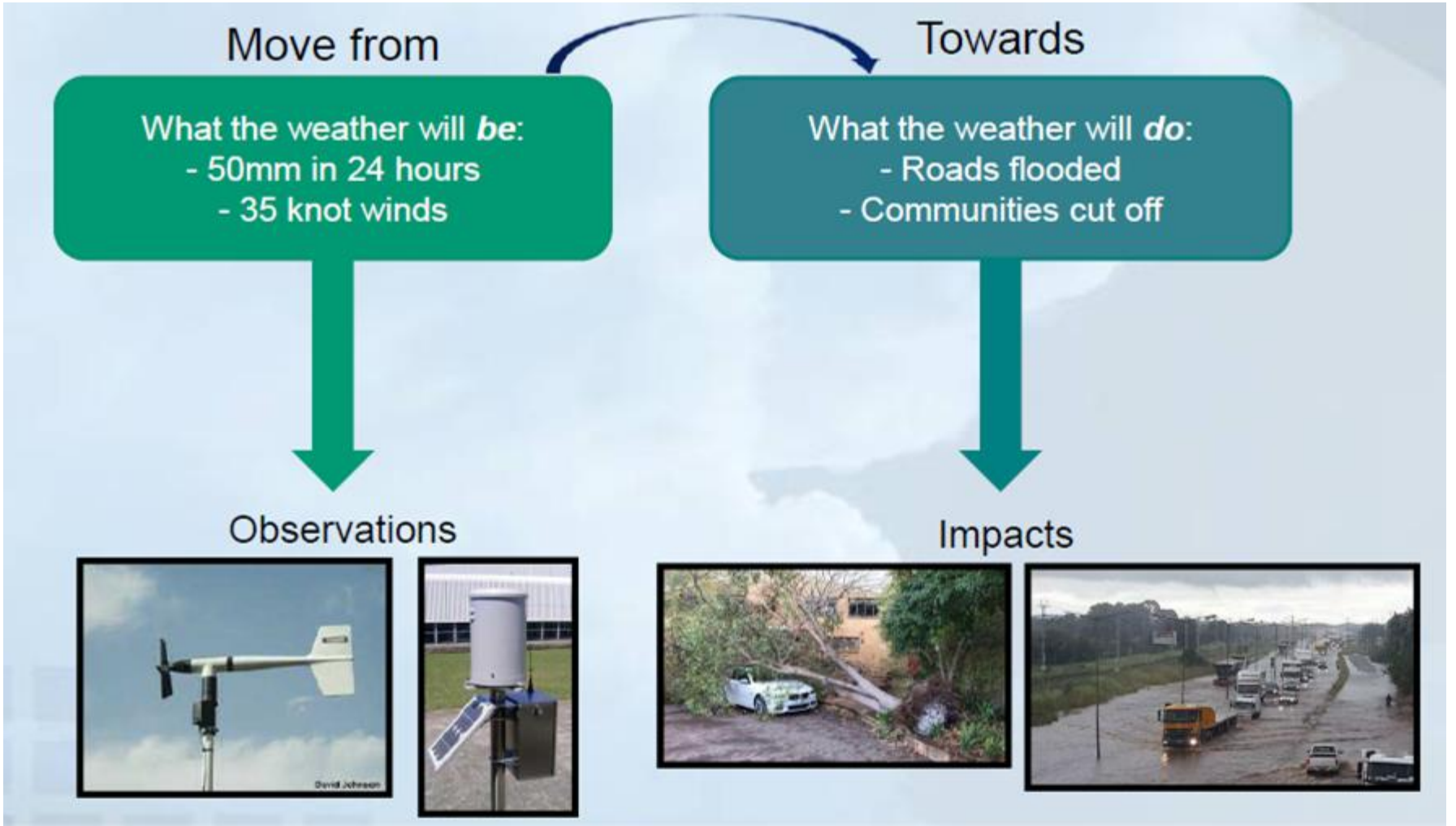
Why move to Impact-Based Forecasting??

Weather Forecasts
and
Warnings

Impact-Based
Forecast
and
Warning Services



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The goal is to change from this type of forecast …

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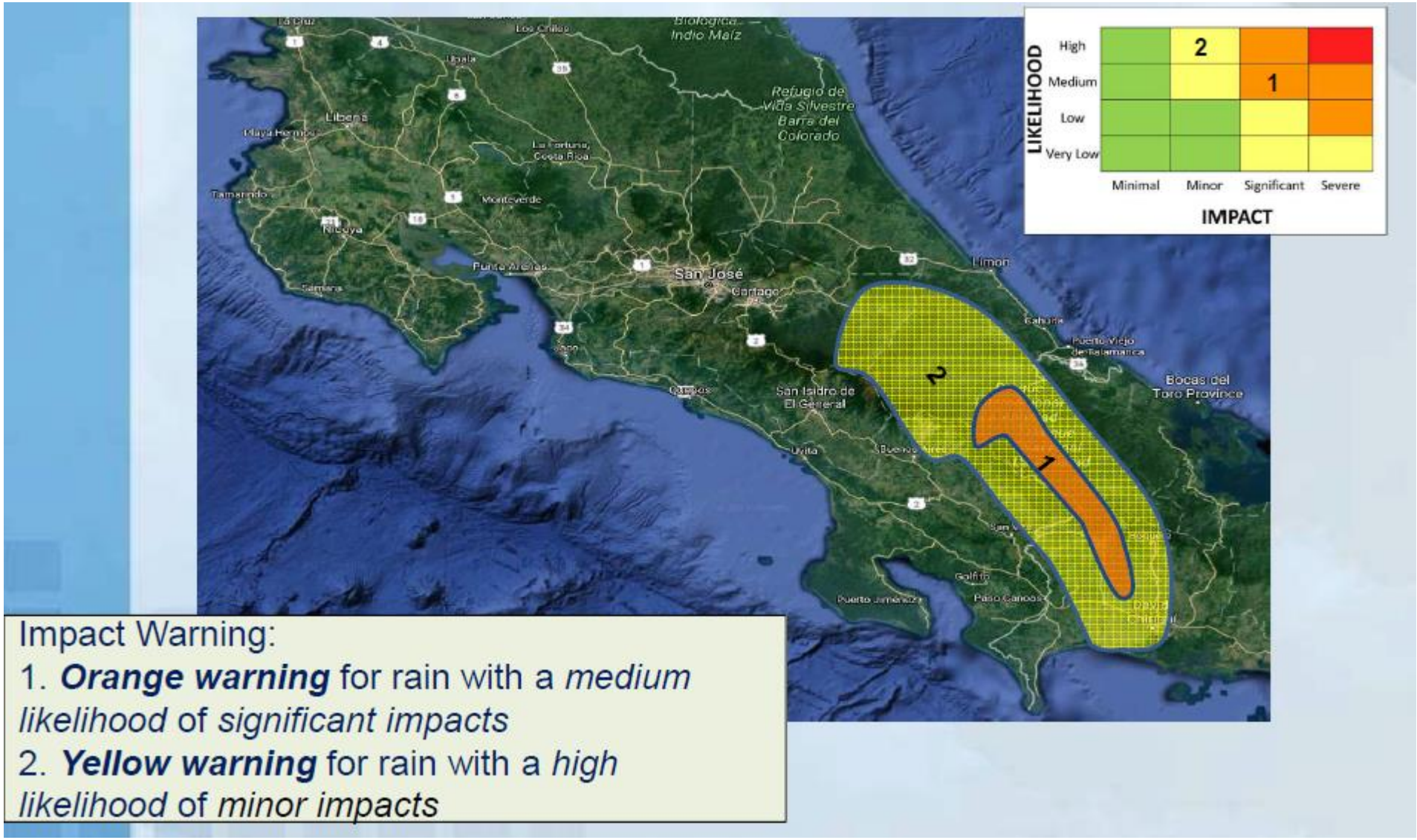
To an Impact-based Early Warning Forecast System



Impact Warning:

1. ***Orange warning*** for rain with a *medium likelihood* of *significant impacts*
2. ***Yellow warning*** for rain with a *high likelihood* of *minor impacts*

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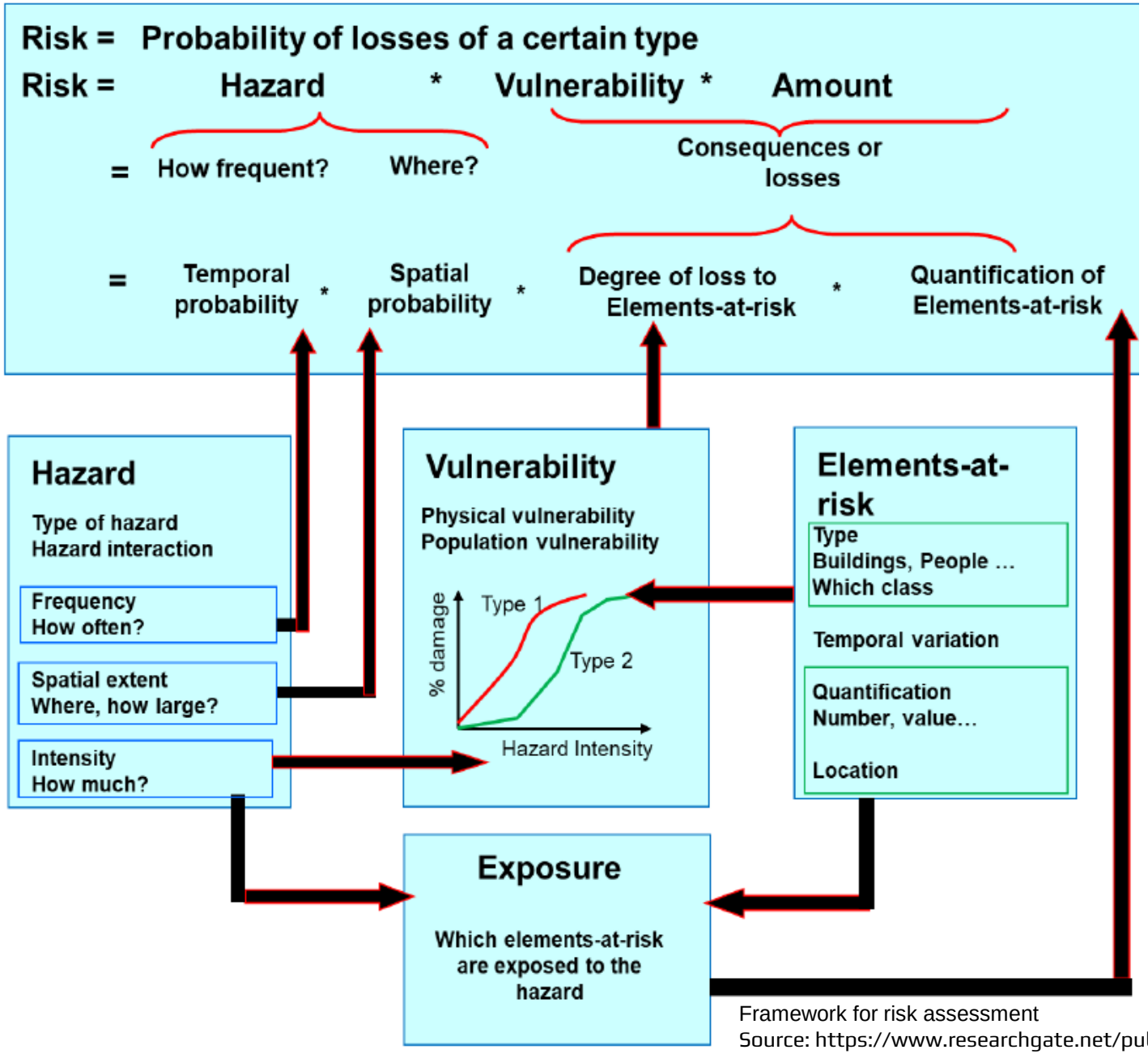
Understanding the Hazards across «Risk, Vulnerability, Exposure »



Framework for risk assessment
Source: https://www.researchgate.net/publication/344172871_ICT_for_Disaster_Risk_Management

Source: ESCAP
https://www.unescap.org/sites/default/d8files/knowledge-products/IBFWS%20Manual_FINAL.pdf

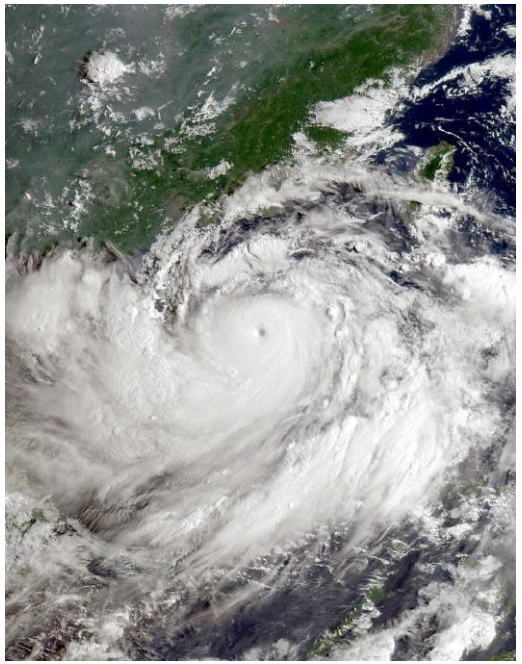
Key Ideas in Impact Based Forecast and Warning Services

Hazard

—Meteorological or hydrological element that poses a threat

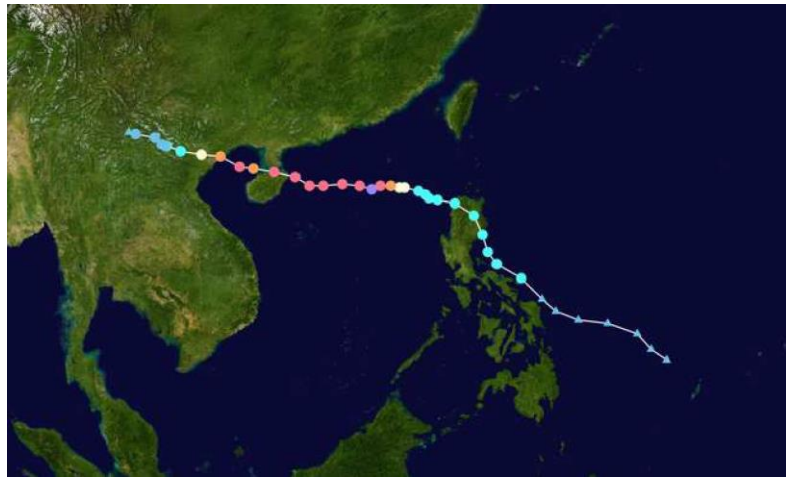
Forecast Uncertainty

—The current state-of-the-art in weather forecasting defines the limit of predictability.



- A natural event that has the **potential to cause harm or loss** to people, human activity, property and environment

- Characteristics for hazard analysis
  - ➢ Magnitude of the hazard
  - ➢ Frequency/recurrence of the hazard



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Key Ideas in Impact Based Forecast and Warning Services

Exposure

—Who or what may be affected in an area where a hazard may occur

• The **situation** of people, infrastructure, housing, production capacities and other tangible human assets **located in hazard-prone areas**

• Exposure increases when urbanization places more people/assets in hazard-prone areas, and vulnerability increases when planning, infrastructure, or services are inadequate.

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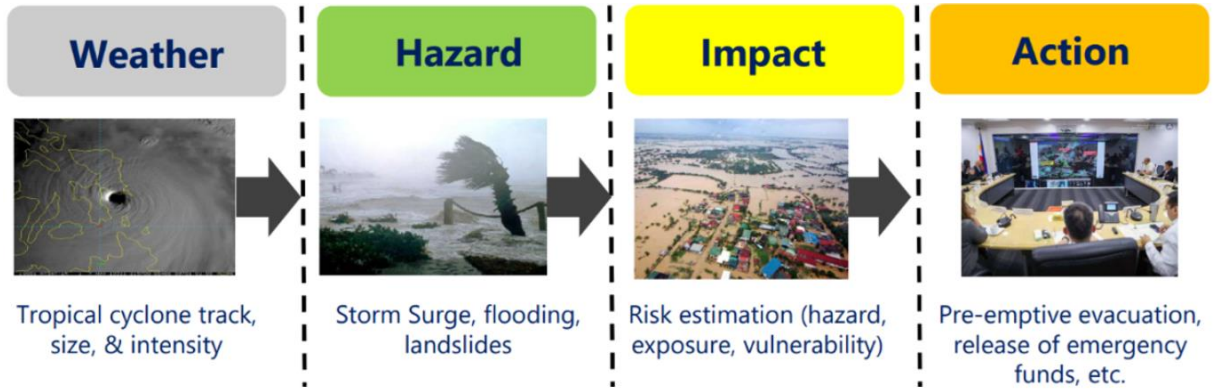
Key Ideas in Impact Based Forecast and Warning Services

Vulnerability

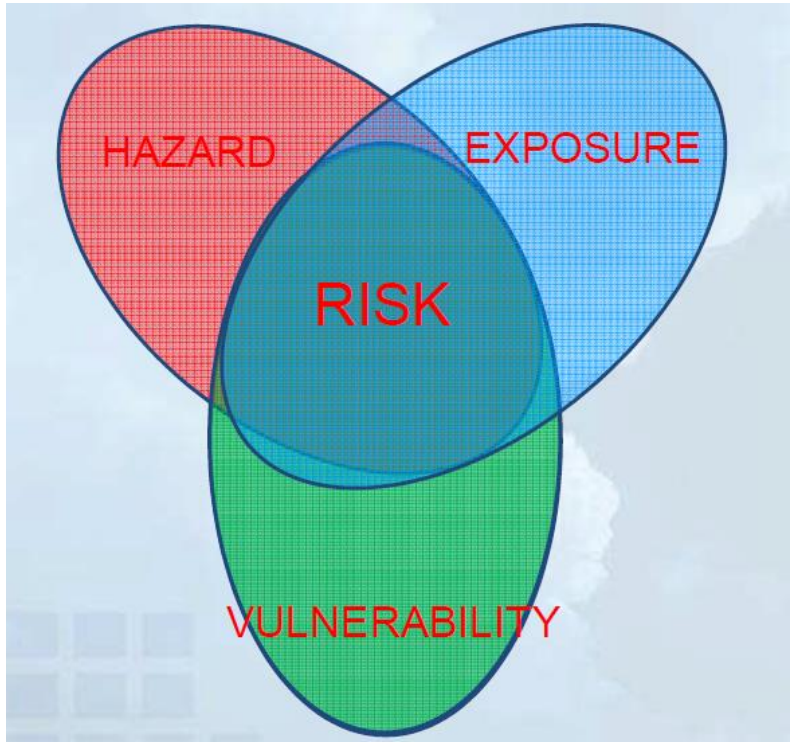
—The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Risk

—The probability and magnitude of harm possible to humans, their livelihoods and assets because of exposure and vulnerability to a hazard



Courtesy from PAGASA



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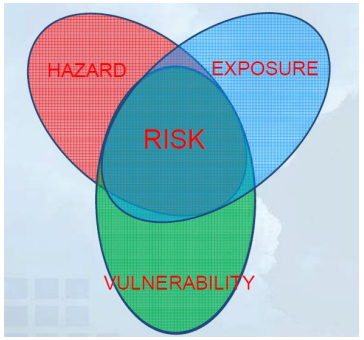
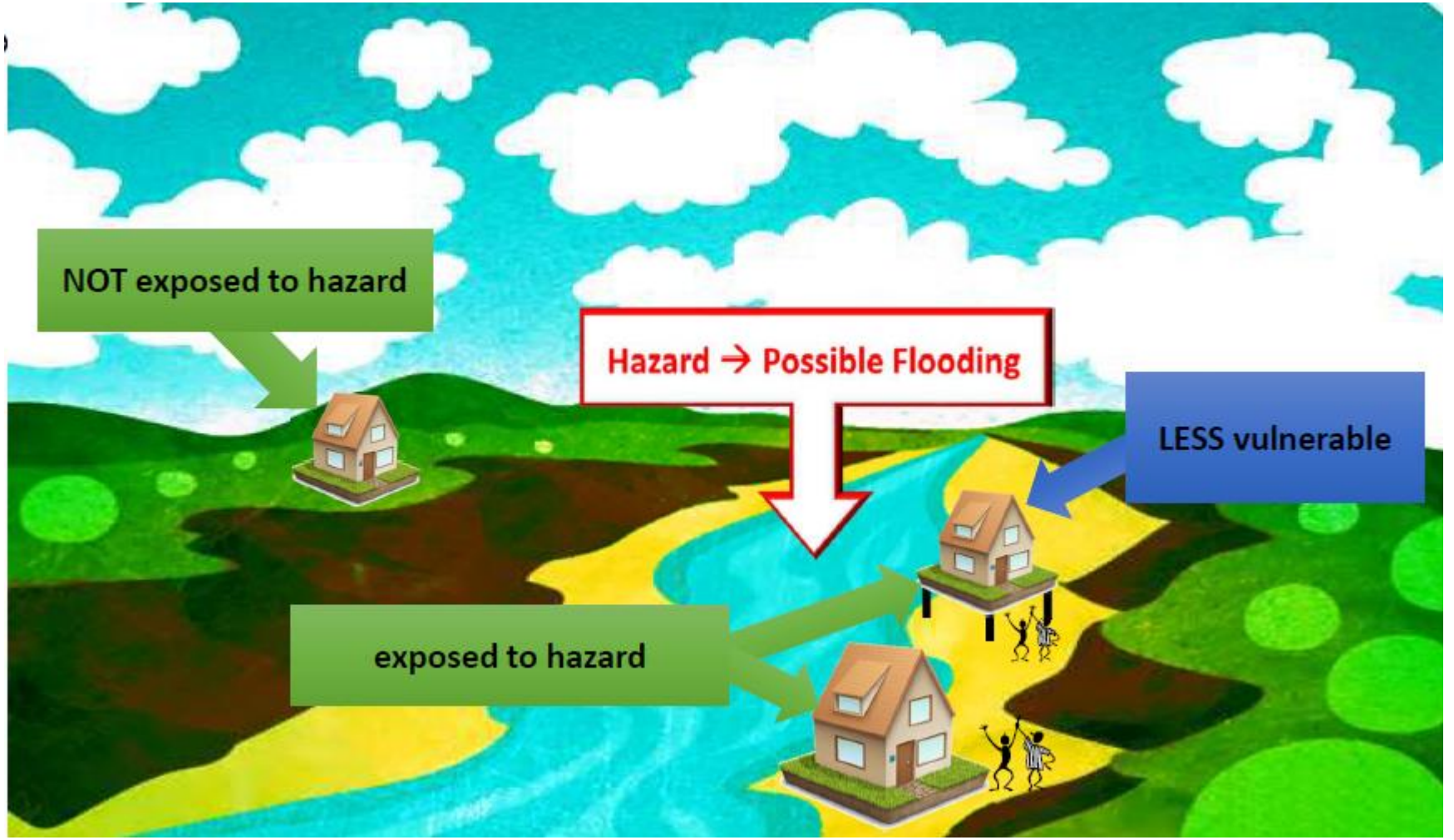
Flood risk





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Key Ideas in Impact Based Forecast and Warning Services

Weather Warning:
—"*Strong winds are expected tonight with wind speeds of 20m/s likely*"

Impact-based Warning:
—"*Strong winds are expected tonight which may result in delays or cancellation to ferry services and keep small fishing boats tied up*"

Different types of Warning

1. Warnings with fixed thresholds.

2. Warnings with user-defined thresholds

3. Warnings with variable thresholds

Different types of Warning

1. Warnings with fixed thresholds.

Saffir-Simpson Scale for strength of Tropical Cyclones / Hurricanes

Category	Sustained winds
1	74–95 mph 64–82 kt 119–153 km/h

Different types of Warning

2. Warnings with user-defined thresholds.

Flash Flood Warning for City Authority

"50mm of rain expected during the next two hours which will cause problems with the street drainage system and lead to flooding on the roads"

Different types of Warning

3. Warnings with variable thresholds.

High Temperature Warning

Minimum temperature (°C)			
Osijek	20.1	21.2	22.9
Zagreb	20.2	21.3	22.9
Karlovac	20.0	21.1	22.7
Gospić	17.0	18.0	19.6
Rijeka	22.7	23.7	25.1
Knin	20.5	21.6	23.1
Split	25.8	26.8	28.2
Dubrovnik	25.4	26.3	27.6

Maximum temperature (°C)			
Osijek	35.2	36.7	38.8
Zagreb	33.7	35.1	37.1
Karlovac	34.5	35.9	38.0
Gospić	32.1	33.4	35.4
Rijeka	32.7	33.9	35.5
Knin	35.5	36.9	39.0
Split	33.9	35.1	36.7
Dubrovnik	32.3	33.2	34.7

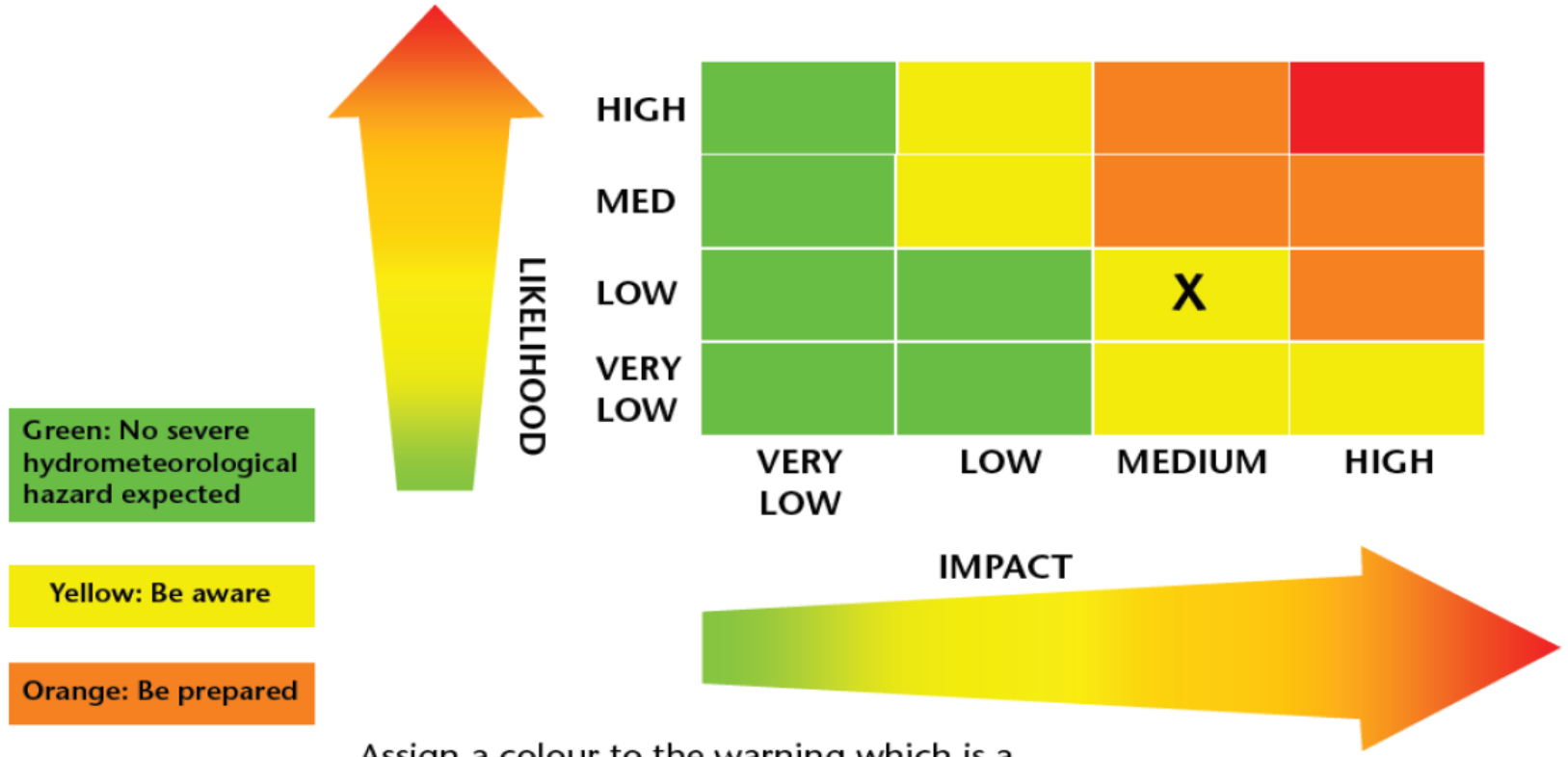
Different types of Warning

Warnings with fixed thresholds	Rainfall accumulations of 30 mm to 40 mm expected tomorrow between 1400 and 2300.	Hazard
Warnings with user-defined thresholds	Heavy rain expected tomorrow afternoon with rainfall intensities of 3 mm/10 mins possible, leading to overflow in the drainage system.	Hazard + Vulnerability
Warnings with variable thresholds (time to time)	Weather warning – rainfall accumulations of 15 mm to 20 mm expected tomorrow afternoon during rush hour.	Hazard + Vulnerability
Impact Warning	Expect journey times on the A11 Highway to be lengthened by an hour because of significant traffic disruption in the south-east tomorrow afternoon due to localized flooding which is expected to follow a heavy rain event.	Hazard + Vulnerability + Exposure

Risk matrix

Weather Warnings have always had a focus on **SEVERITY**

Now also need to look at **UNCERTAINTY**



Assign a colour to the warning which is a combination of potention impact and likelihood

(Source: Met Office, United Kingdom)

Figure 2. Risk matrix

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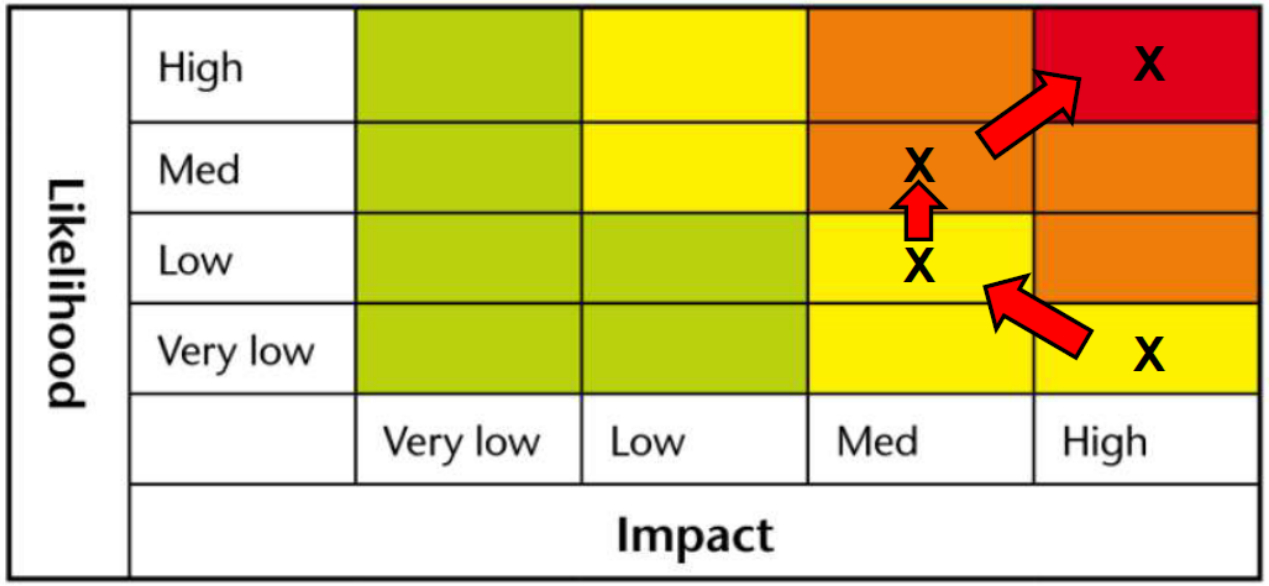
Why should we use the risk matrix??

- We can now have an earlier expression of potential impact, well before a significant hydrometeorological event.

- We can from day to day show the changing expectation of risk, depending on changing exposure, vulnerability and hydrometeorological likelihood.

Example: Path of Risk over many days



Agrometeorology: Always Focused on Impacts

Agrometeorology has never just been about forecasting weather

It's about understanding what the weather ***does*** to the **agricultural sector.**

Modern IBF systems make this process more precise, actionable, and scalable.

Traditional & Intuitive

Modern & Systematic

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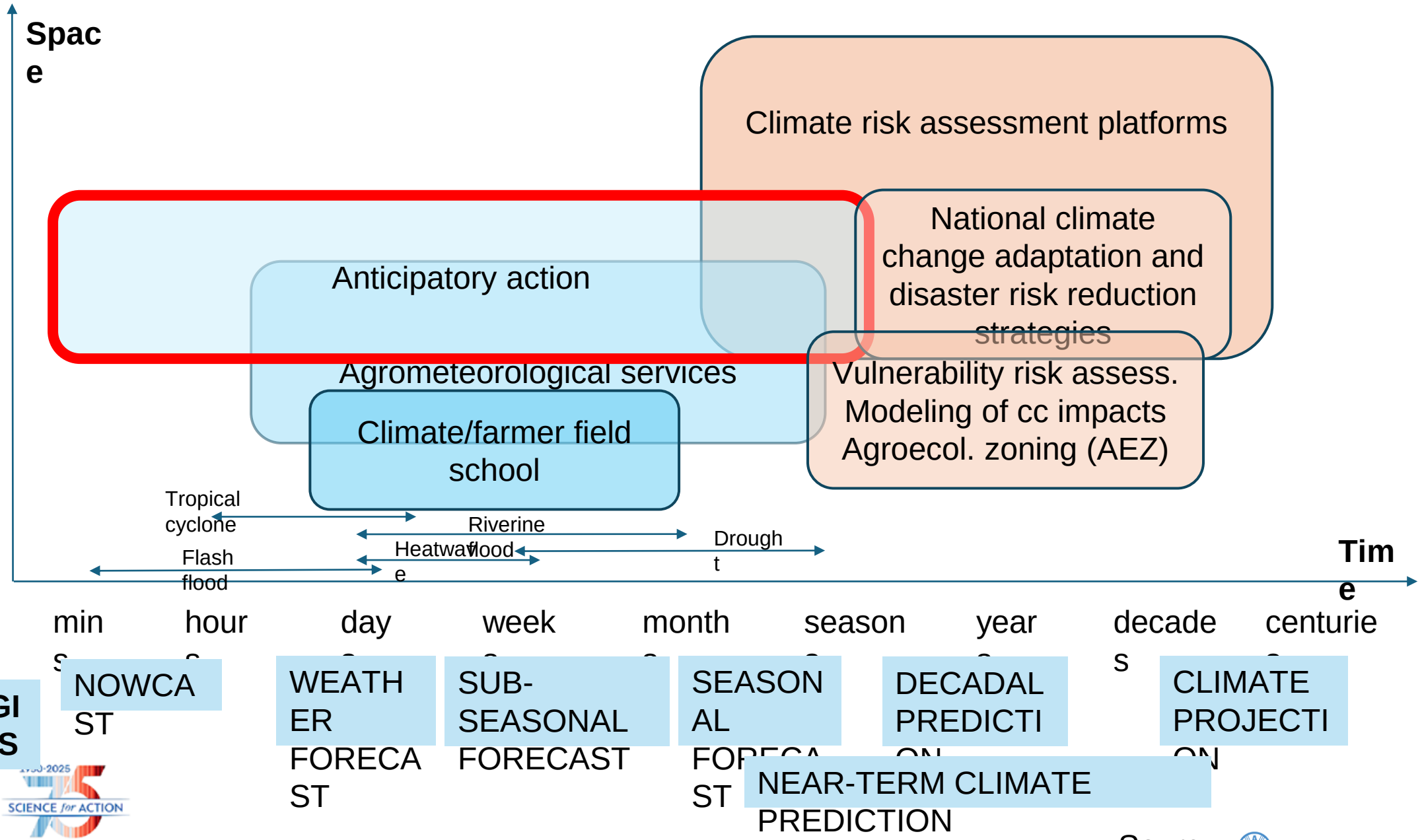
GFCS
Global Framework for Climate Services

NFCS
National Framework for Climate Services

FRAMEWORK

METEOROLOGICAL SERVICES



Source

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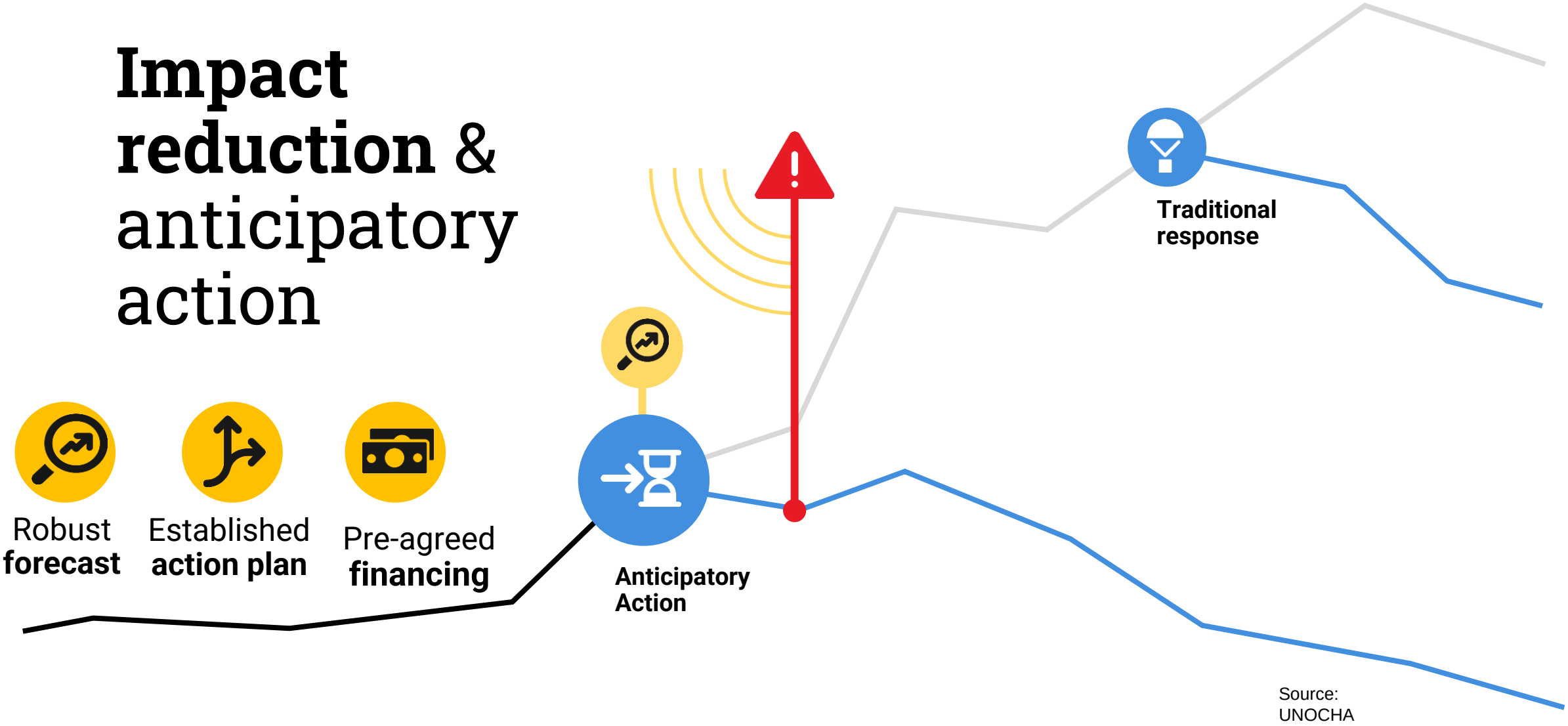
Food and Agriculture Organization of the United Nations

Impact reduction & anticipatory action



Source:
UNOCHA

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Examples of Anticipatory Actions

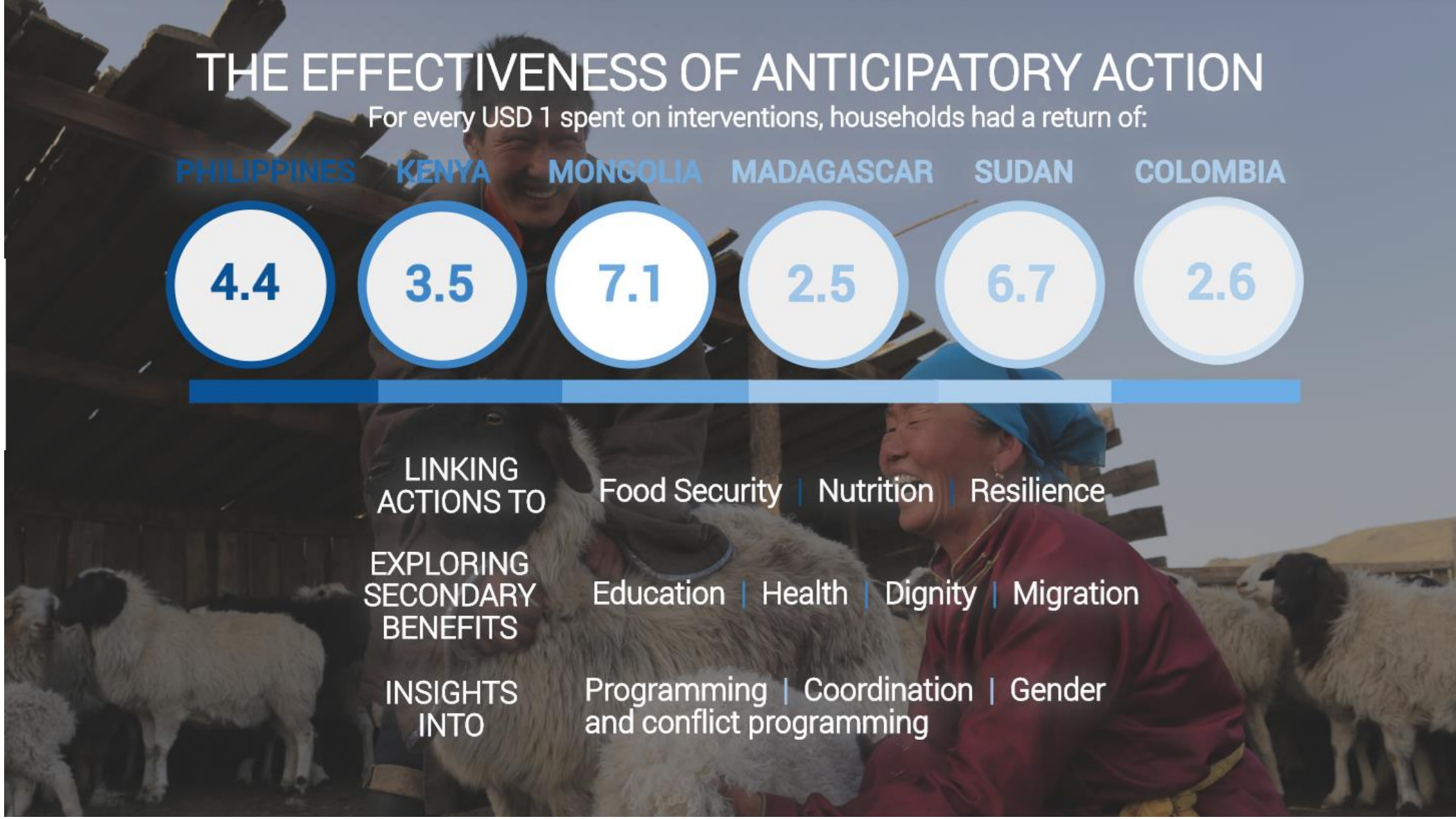
- Ahead of a warning of a severe winter season in Mongolia, **destocking-for-cash and health kits** were provided to herders to keep their animals alive and healthy

- **Before a peak** of drought in Afghanistan provide drought-tolerant seeds, cash and livestock health kits/feed to protect livelihoods

- On a flood trigger warning in Bangladesh, **distribute cash, water proof drums, animal feed and dignity kits** to safeguard food security, livelihoods and ~~vulnerable women and girls~~

Source: FAORAP

EVIDENCE & LEARNING



Source: FAORAP

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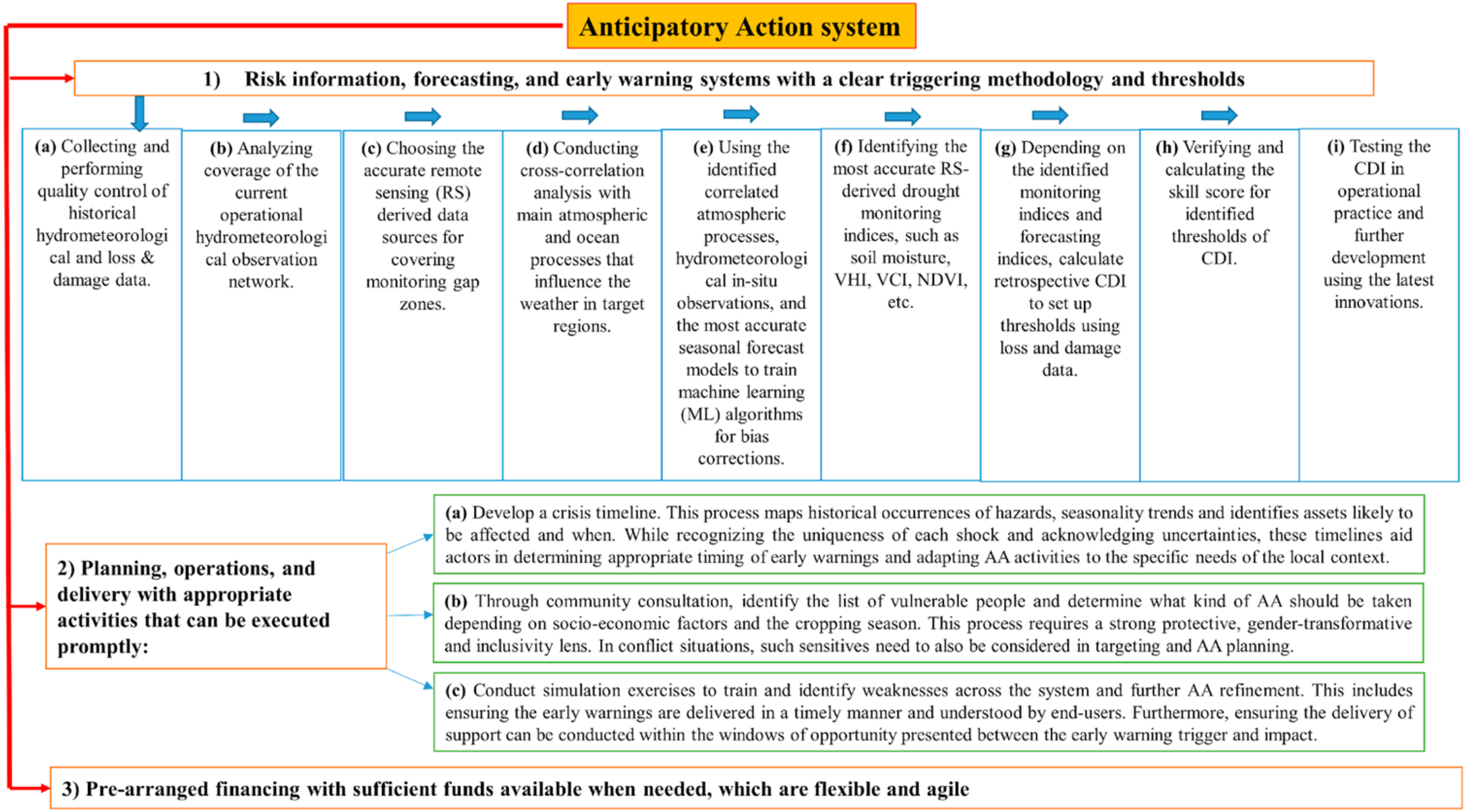
Series of general steps that can be followed to establish an effective and robust trigger mechanism for hazard outlined as follows:

1. Set up a multi-stakeholder hazard (flood, drought, landslide, frost, Dzud etc) AA trigger development working group
2. Define a theoretical framework for the AA trigger mechanism
3. Build a crisis timeline
4. Select and normalize the indicators
5. Weight and aggregate the indicators
6. Monitor and evaluate the AA trigger mechanism

Flow chart of developing the AA system for agricultural drought

PNG example:https://doi.org/10.3390/w16142009



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Algorithm for triggering the agricultural drought in PNG

PNG example:https://doi.org/10.3390/w16142009

1st week of every month calculating the CDI

Input parameters to train ML:
- 3 month total Rainfall observation
- IOD monthly
- ENSO3.4 monthly
- ECMWF 3 month total rainfall forecast

Xgboost Regressor (XgbR) algorithm with Hyperparameter Tuning (HPT)

Input for operational Bias-correction:
- IOD monthly
- ENSO3.4 monthly
- ECMWF 3 month total rainfall forecast

- SMAPI
- VHI
- SPI1

Bias-corrected 3 month rainfall forecast

CDI classes and used indices

CDI	No drought	Mild drought	Moderate drought	Severe drought	Extreme drought
SPI3	≥0.00	<0.00	≤−1.00	≤−1.00	≤−1.5
SPI1	≥0.00	<0.00	<0.00	≤−1.00	≤−1.00
SMAPI	≥0.00	<0.00	≤−0.05	≤−0.15	≤−0.30
VHI	>0.40	0.40 to 0.50	0.40 to 0.50	<0.40	<0.40

*If **CDI** => Moderate drought*

2nd step of triggering: Field validation in 3-4 days
local qualitative and quantitative observational data : soil moisture, rainfall, crop situations, water levels

If ground truthing proofed Remote Sensing monitoring data

Activation of AA

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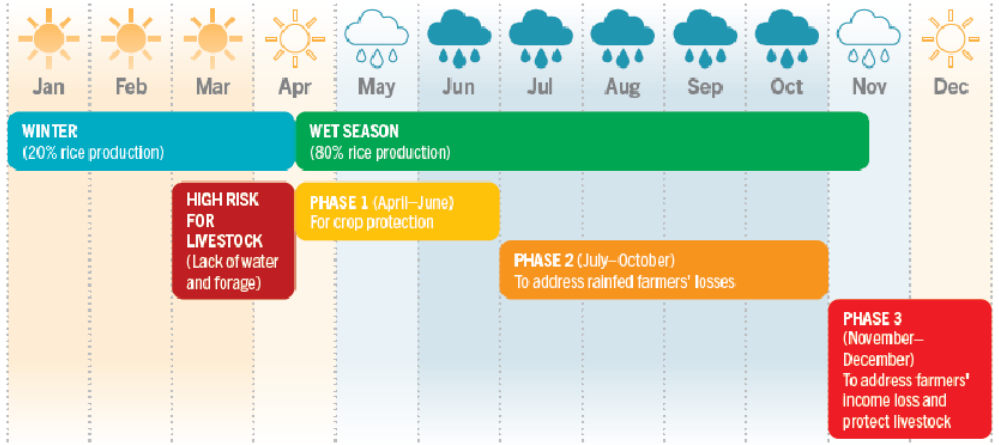
Drought anticipatory action crisis timeline for LAO PDR

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Climate related patterns												
Dry and wet seasons												
Average monthly rain-max 505 mm (South)												
Agricultural seasonality												
Lowland rainfed rice (Wet season)							Growing				Harvest	
Upland rainfed rice (Wet season)					Planting		Growing			Harvest		
Lowland irrigated rice (Dry season)	Growing			Harvest								
Impact												
Drinking water scarcity												
Drought affected crops												
Operational preparedness												
Preparedness phase		Pre-positioning of EW equipment and drought resistant seeds; ToT delivery; risk data collected										
Anticipatory actions												
Phase 1					EW, training on drought AA, rice seeds distribution							
Phase 2								EW update, training on drought AA, beans seeds distribution				
Phase 3										EW update, unconditional cash transfer		



Source: Application of artificial intelligence in anticipatory action: Drought and flood case study in the Lao People's Democratic Republic,FAO, https://doi.org/10.4060/cd2277en

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IBFWS resources

- WMO Guideline on IBFWS version 1
  - Risk equation
  - Risk matrix, impact & response tables
  - Partnerships
- WMO Guideline on IBFWS version 2
  - Risk and media charts
  - Show Case
- Manual for operationalizing IBFWS
- IBFWS self-directed eCourse
- Short-survey to tailor IBFWS implementation

Introductory online eCourse IBFWS

- An IBFWS quiz to win a souvenir at Cg-19 EW4All booth, while stocks last

Souvenir and QR Quiz IBFWS

E-Learning

https://etrp.wmo.int/course/view.php?id=416

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https://community.wmo.int/en/activity-areas/agmp/SC-AGR/Agromet_CoP

Thank you

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