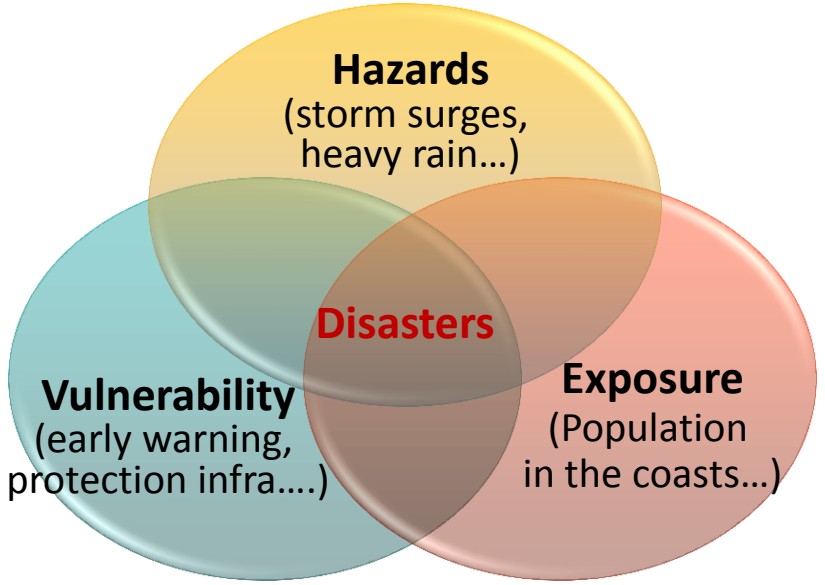
World Meteorological Organization
Working together in weather, climate and water

WMO Coastal Inundation Forecasting Demonstration Project (CIFDP)

Exposure to coastal inundation is large and growing

- Population is attracted to coasts by an abundance of local resources
  - Growing coastal population
  - Urbanising coastal zone
  - Tourism, recreation, retirement…
- In many parts of the world, the population is directly exposed to the coastal hazards and this will increase with Climate Change and Sea Level Rise.

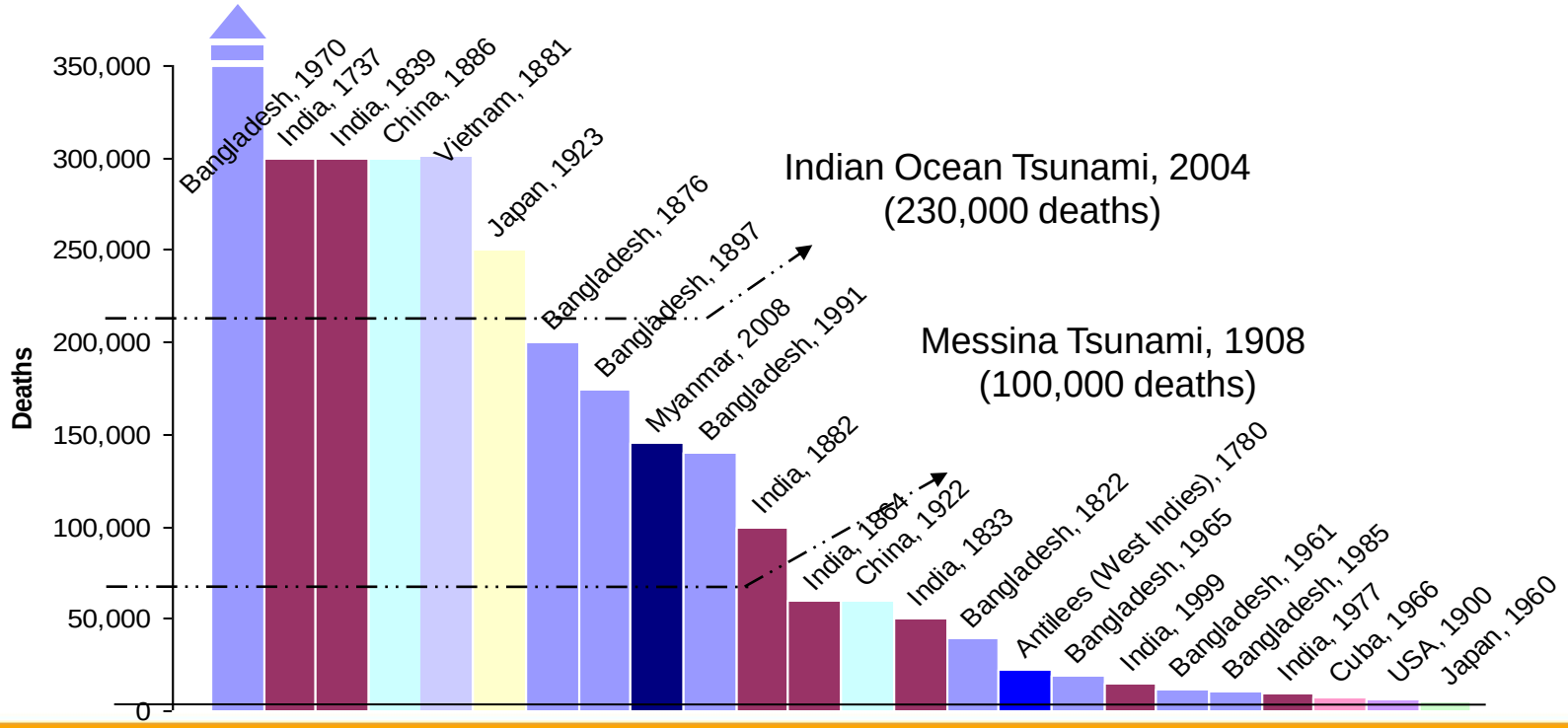


Disasters are more likely when Hazards and exposed population overlap with Vulnerability.

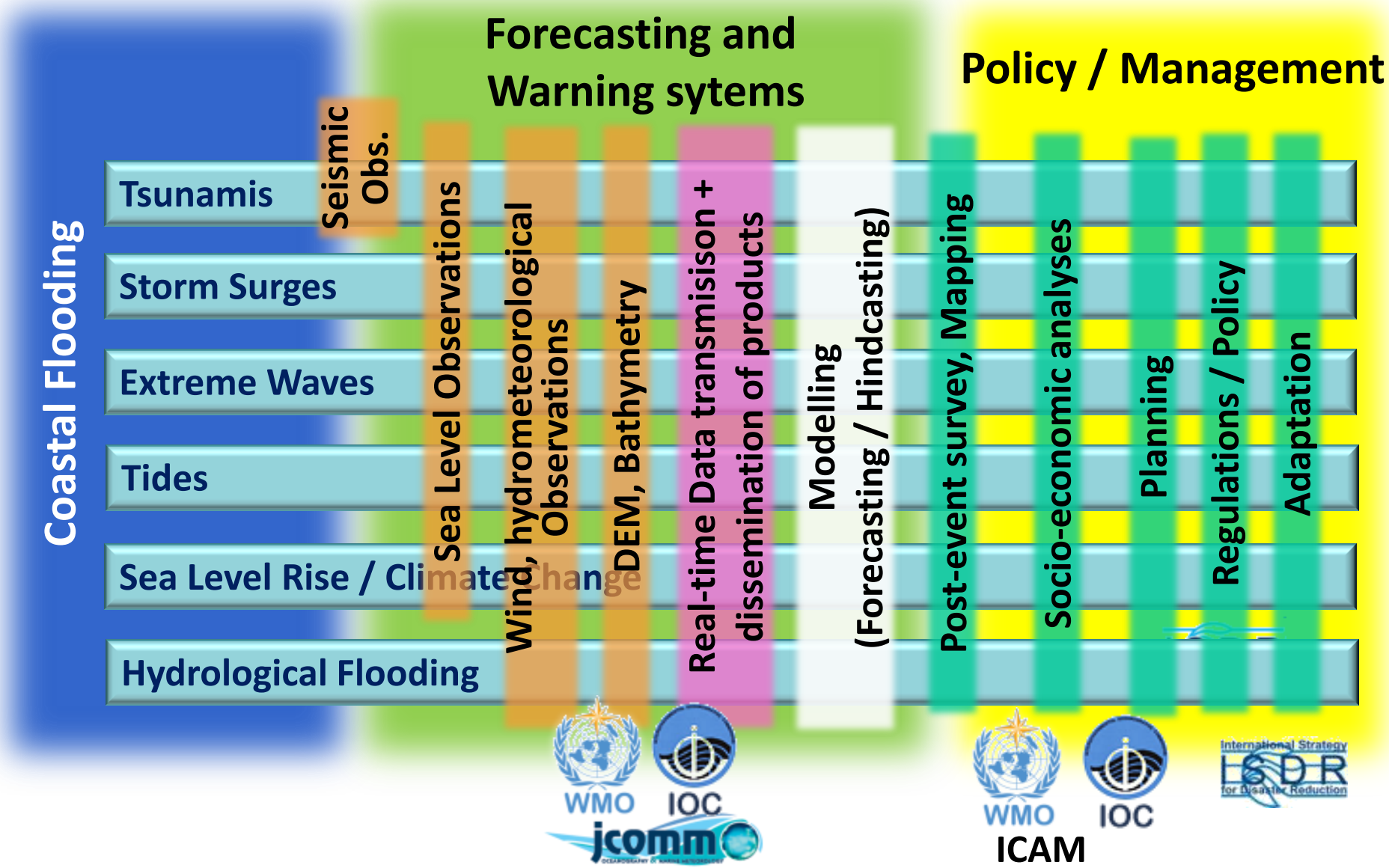
- A reactive approach to adaptation increase the vulnerability.

Casualties by Cyclones and Storm Surges

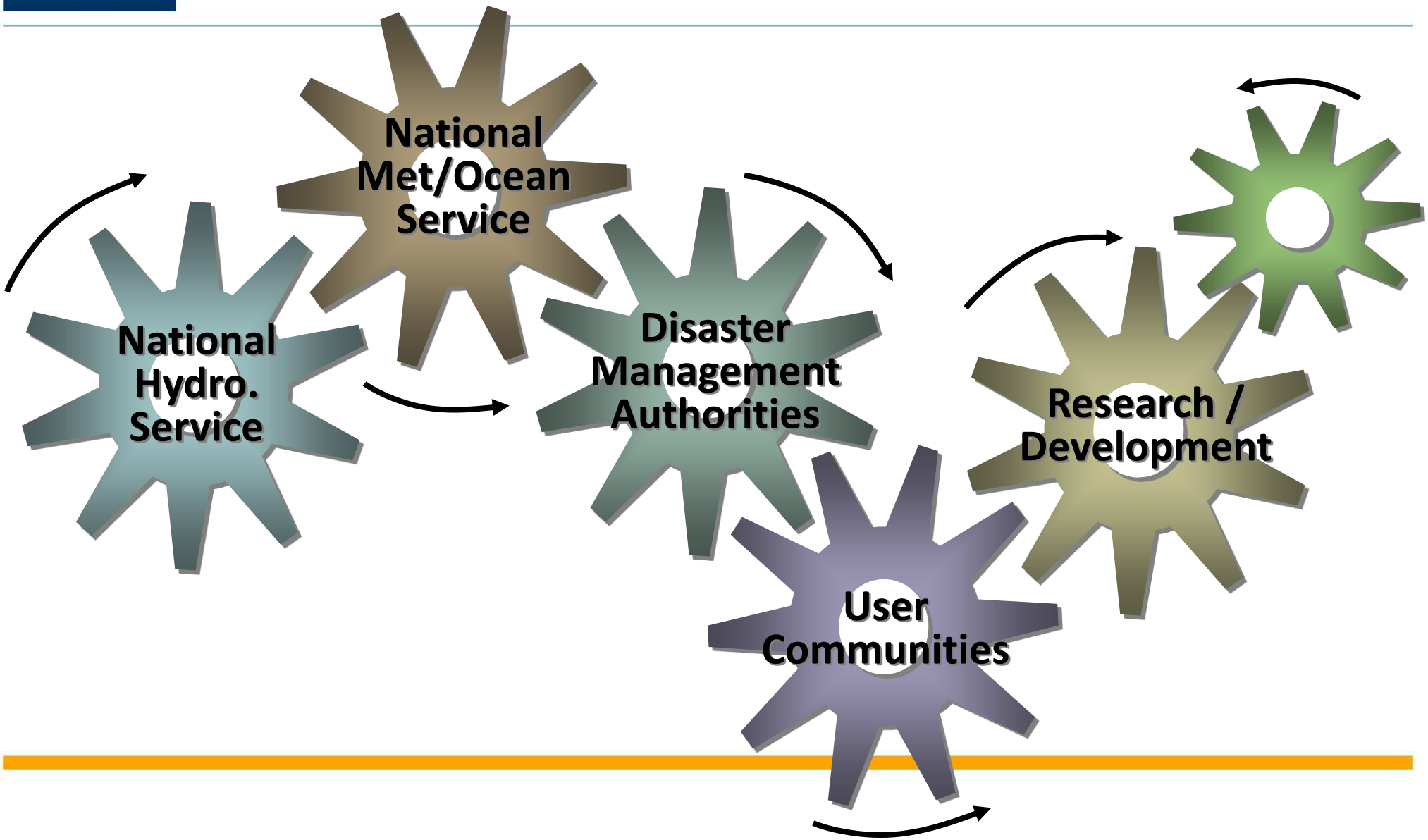
- Deaths in tropical cyclones in each year, for highest ranks in the history (with indication of relative level of casualties by major tsunami events). Most of fatalities in tropical storms are due to storm surges. All casualty figures are estimates and vary widely according to sources (Dube, 2007).



End-to-end Coastal Inundation Management



A Challenge: Institutional Collaboration for Coastal Inundation Warning/Management



Demonstration Project: CIFDP

http://www.jcomm.info/CIFDP

To meet challenges of coastal communities' safety and to support sustainable development through enhancing coastal inundation forecasting and warning systems at the regional scale.

*: building **improved operational forecasts and warnings capability for coastal inundation**, that can be **sustained by the responsible national agencies***

- Identify and support end-user needs;
- Encourage full engagement of the stakeholders and partners in the CIFDP from early stages, for the successful development and implementation of this project;
- Transfer technology to the adopting countries;
- Facilitate the development and implementation of warning services;
- Support coastal risk assessment, vulnerability and risk mapping;
- Assist improved and informed decision-making for coastal inundation management

CIFDP: Benefit for Implementing Countries

http://www.jcomm.info/CIFDP

- Upon completion of national sub-projects of CIFDP:
  countries will implement an **operational system for integrated coastal inundation forecasting and warning**, providing objective basis for coastal disaster (flooding) management; contributing to saving lives, reducing loss of livelihood and property, and enhancing resilience and sustainability in coastal communities.
- Upon completion of each Phase of the Project:
  countries will be provided with valuable **input to the assessment and awareness of the issues of coastal inundation management** within its governments. It would also assist the countries to advance steps toward the integrated forecasting and warning services.

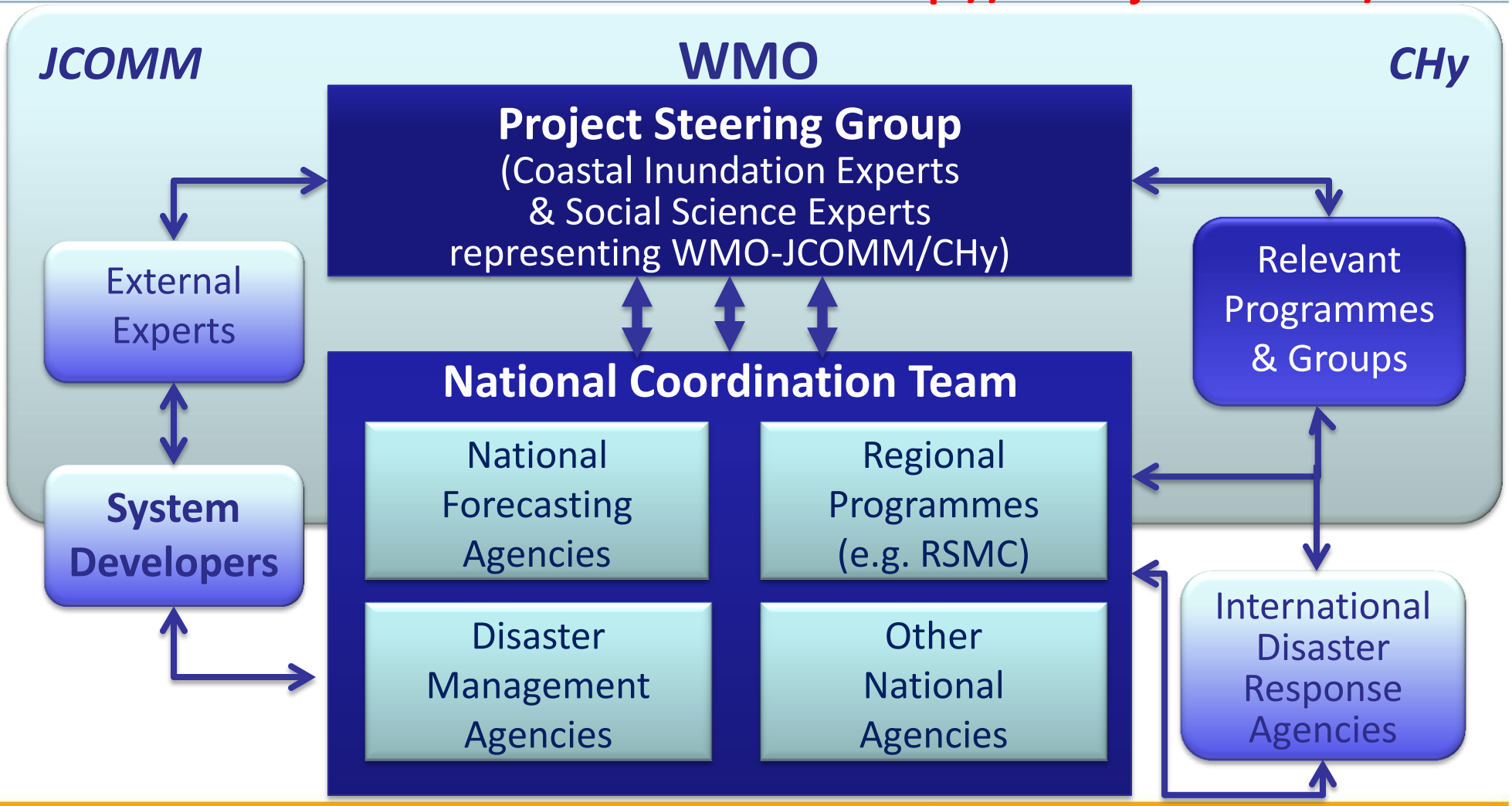
Strategy for CIFDP implementation

http://www.jcomm.info/CIFDP

- CIFDP is implemented through **national sub-projects**, launched for a country that meets the essential requirement: national agreement;
- CIFDP sub-projects are **designed based on users' perspectives and requirements, considering existing and available open source techniques**. Final products of the Demonstration Project should be operated and maintained by national operational agencies which have the responsibility/authority for coastal inundation warnings;
- The procedures/best practices developed through sub-projects should be applicable to other (neighbouring) countries with common issues and interests, and should be closely linked to and cooperating with related projects and activities.

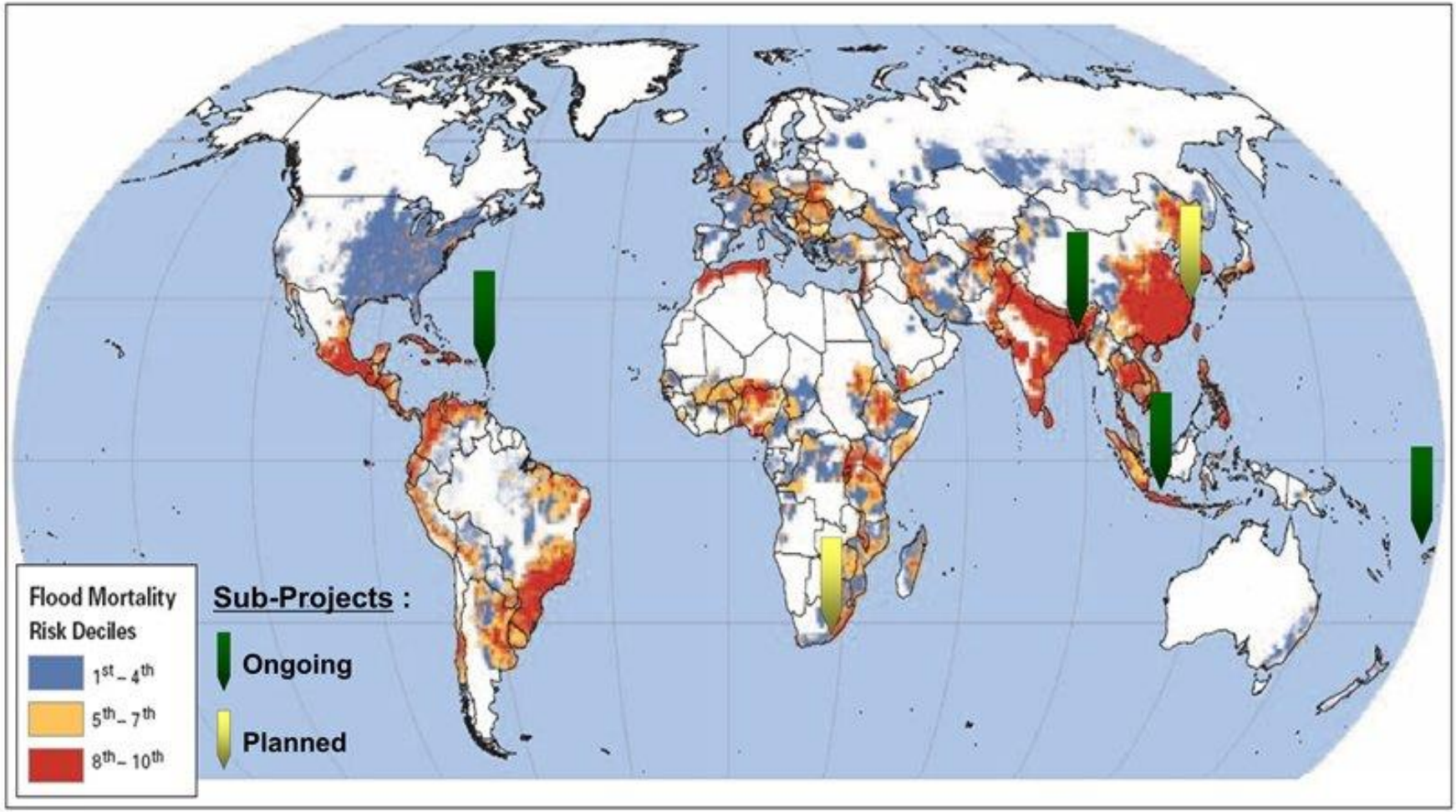
CIFDP Implementation: Key Players

http://www.jcomm.info/CIFDP



CIFDP Implementation

http://www.jcomm.info/CIFDP



Natural Disaster Hotspots: A Global Risk Analysis. World Bank, 2005

CIFDP: Technical foundation

Applying available techniques for integrated operational forecasting/warning

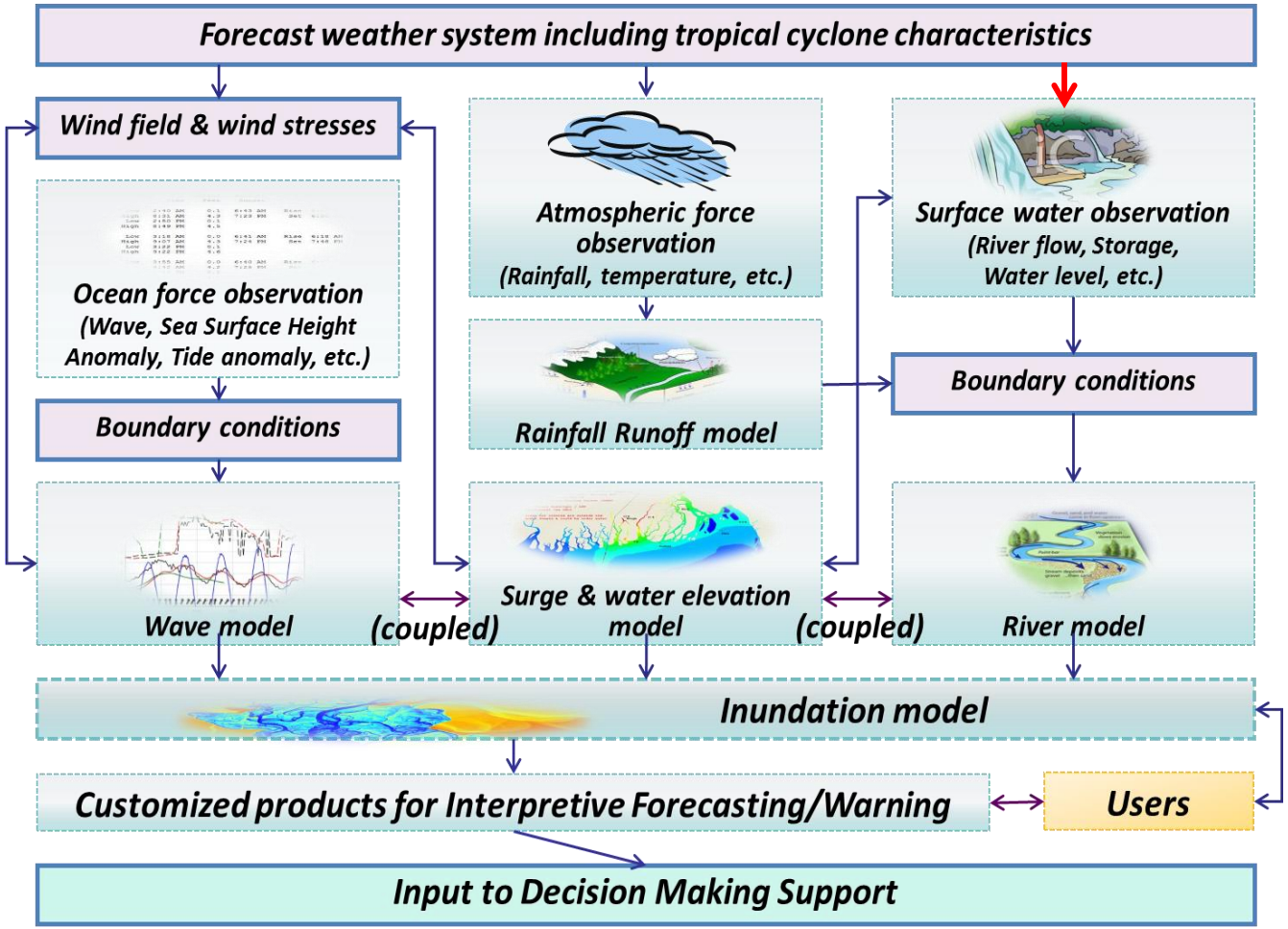
- Assessment of the regional coastal inundation forecasting/warning **capacities**
- Identify **gaps**
- Provide an **overview on the technical aspects** for definition

Each Sub-Project Plan and following documentation will include:

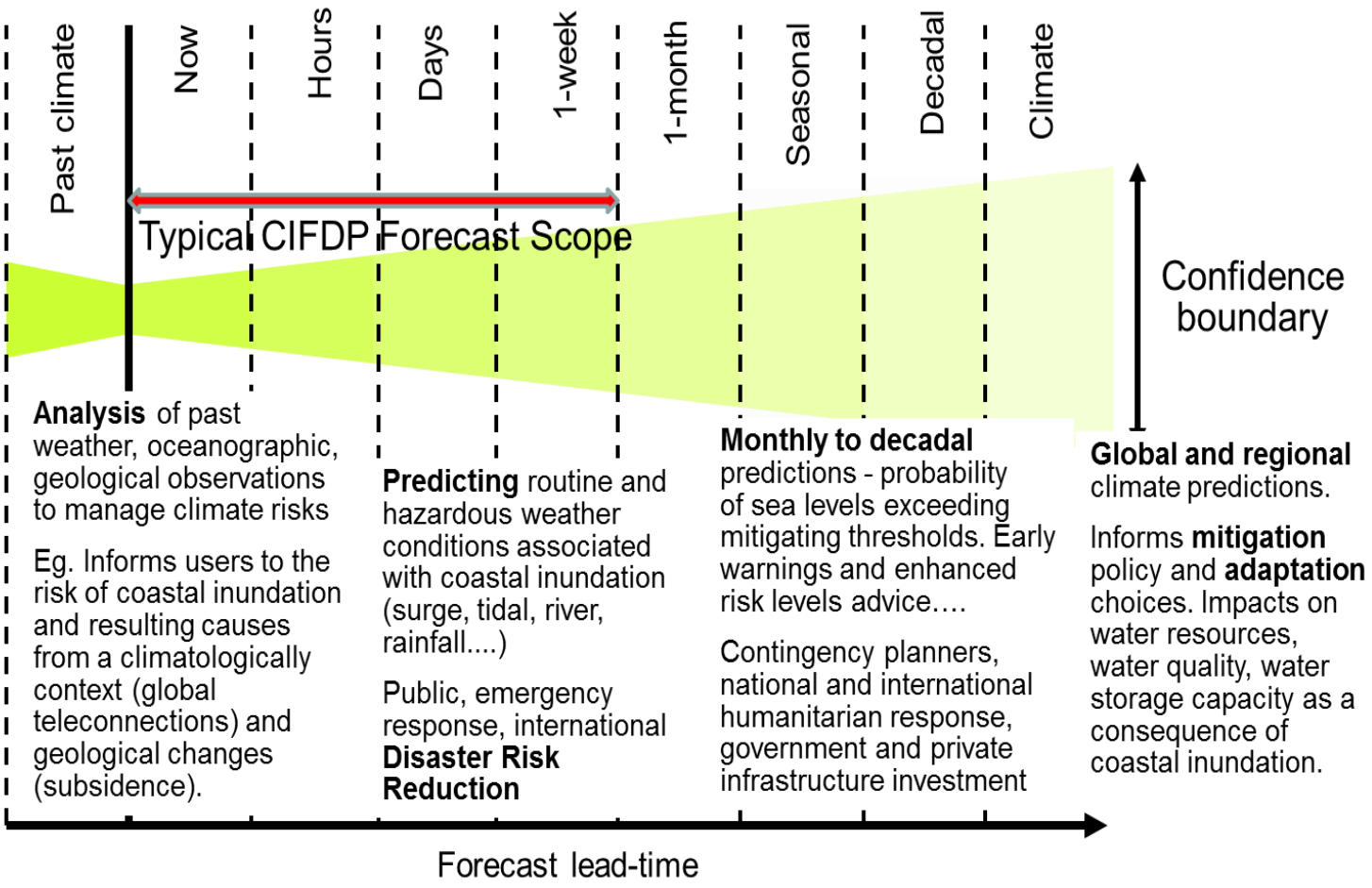
- Existing models and modeling capabilities
- Communication / access to real-time data and quantitative forecast data
- Boundary (Bathymetry, DEM…), GIS Data and data for Validation
- Organizational aspects

The project will focus on integrating the forecasting models already in operational use as 'plug-and-play' modules. The modelling components will be developed and adapted to fit in an **open, flexible and easily extendable forecasting system**: the future CIF system.

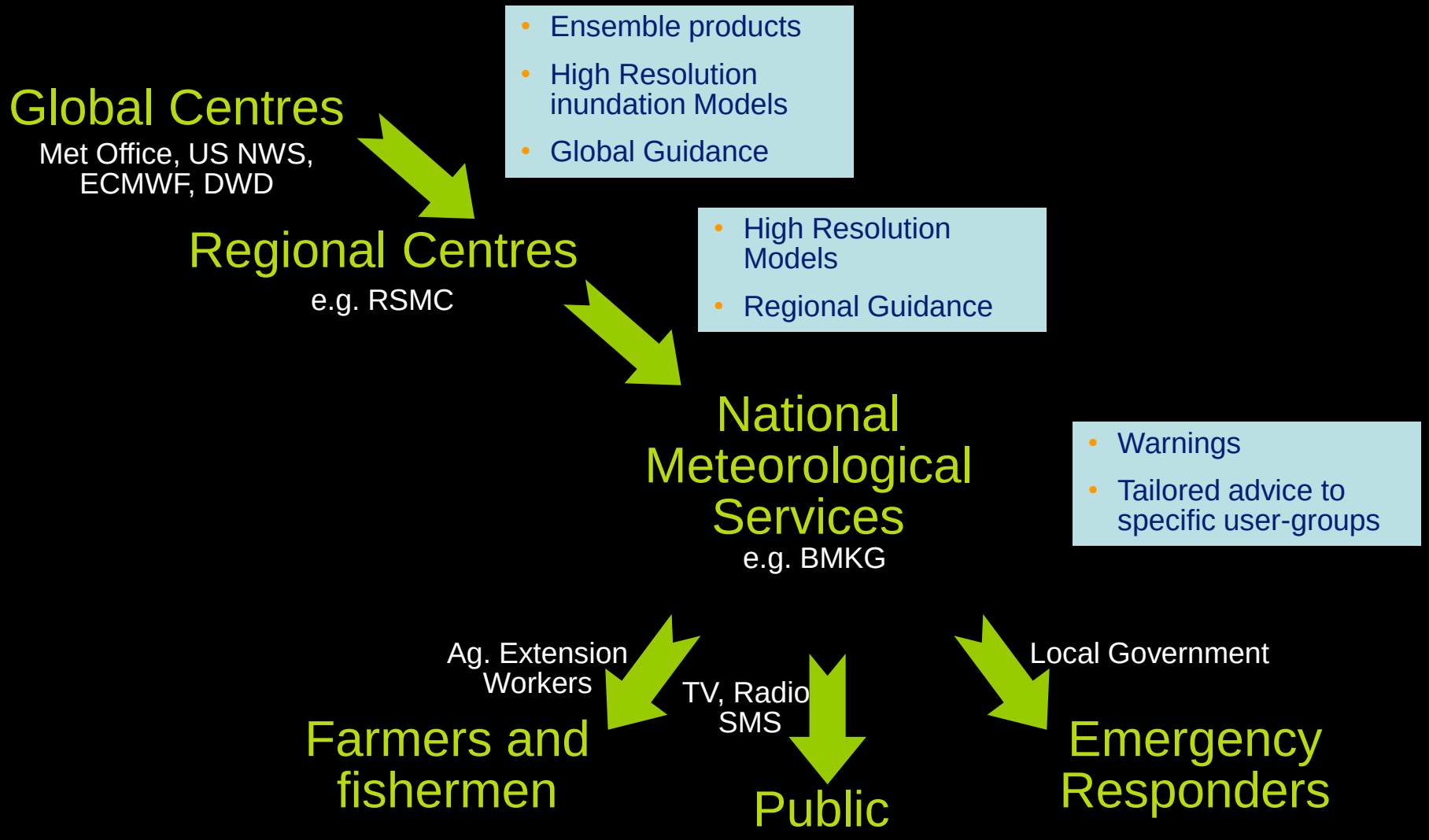
Conceptual diagram of CIFDP forecast systems



Typical forecast scope in the implementation of CIFDP



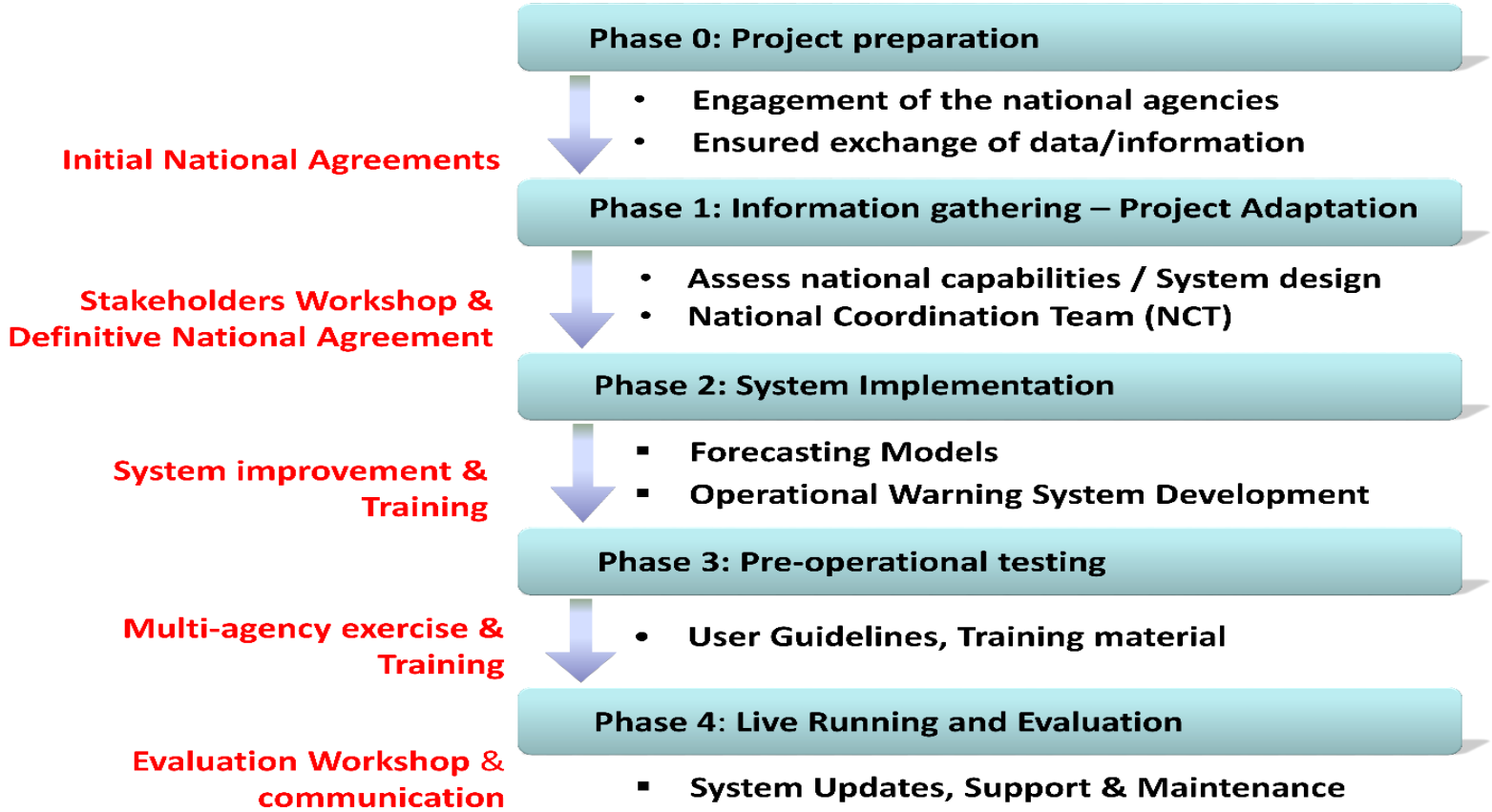
WMO CIFDP cascading framework



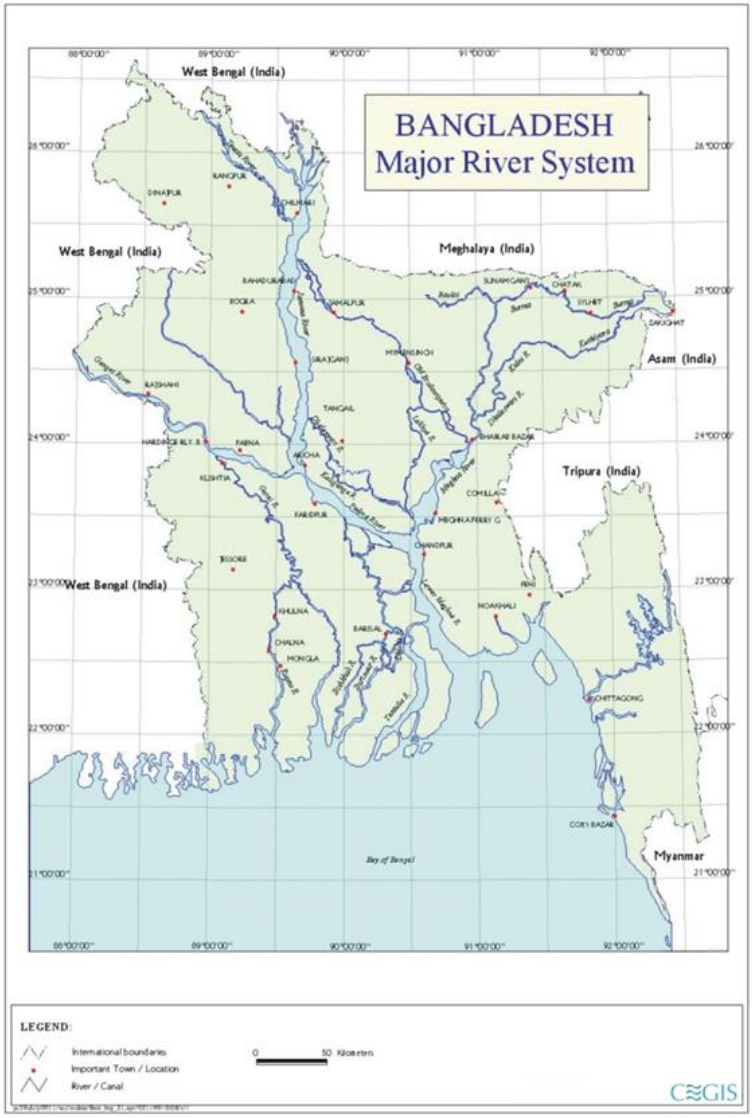
CIFDP Implementation

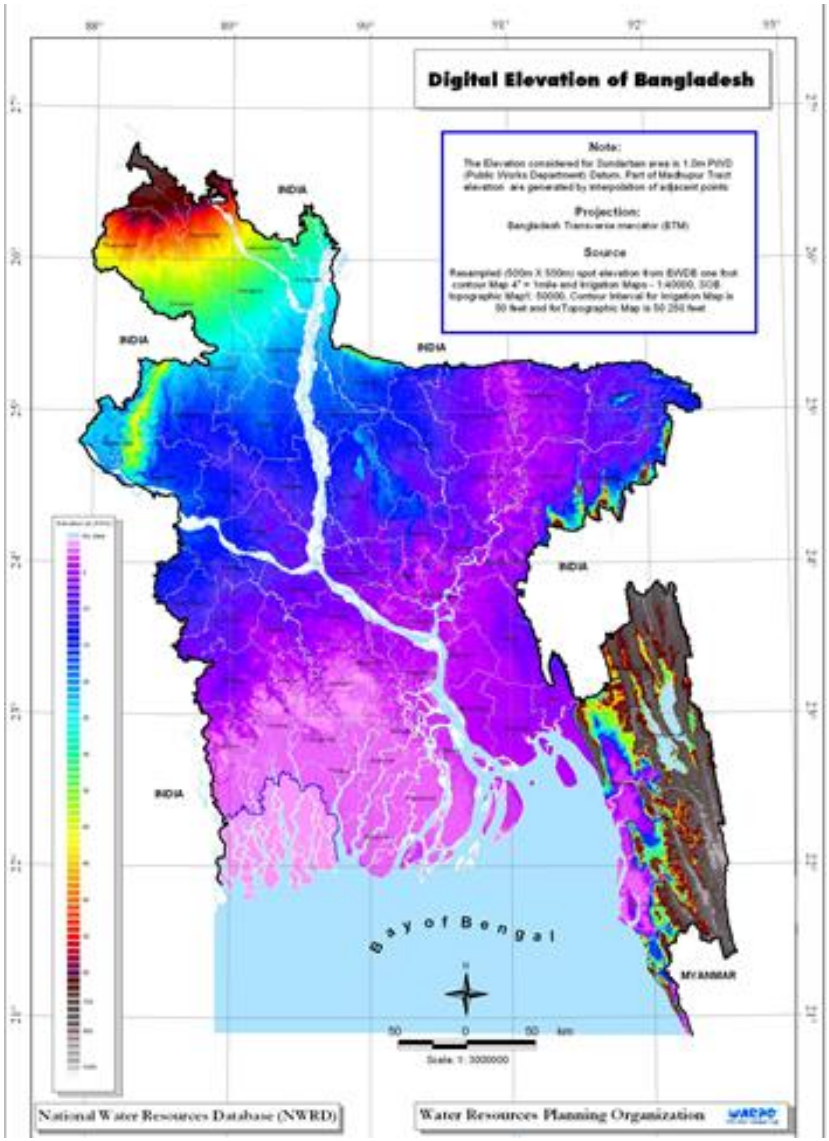
http://www.jcomm.info/CIFDP

The project will be implemented in a **phased approach** that leaves scope for adjustment in the next phases to fit the prevailing requirements:

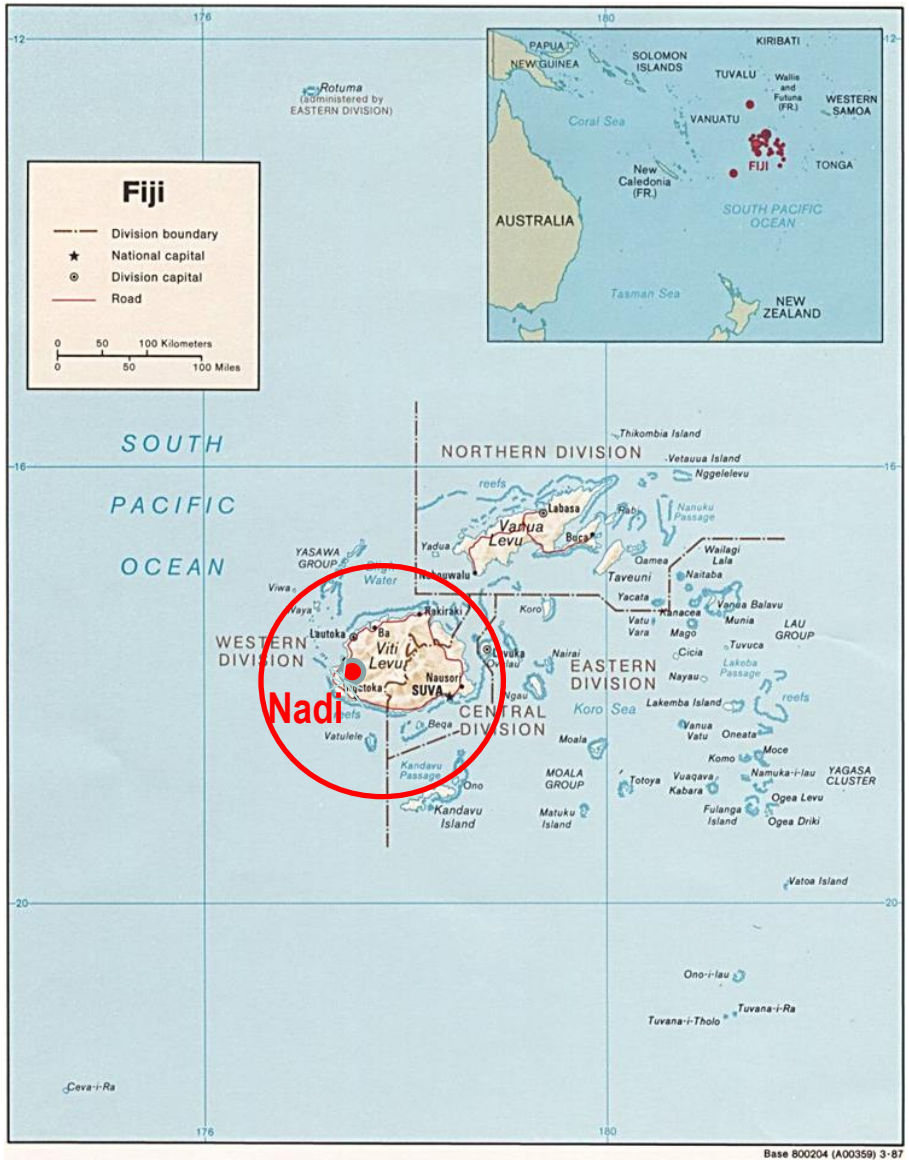


CIFDP-B


BANGLADESH
Major River System
West Bengal (India)
Meghalaya (India)
Asam (India)
Tripura (India)
Myanmar
Bay of Bengal
LEGEND:
International boundaries
Important Town / Location
River / Canal
CEGIS


Digital Elevation of Bangladesh
Note:
Projection:
Source
INDIA
MYANMAR
Bay of Bengal
National Water Resources Database (NWRD)
Water Resources Planning Organization

CIFDP-F


Fiji
Division boundary
National capital
Division capital
Road
0 50 100 Kilometers
0 50 100 Miles
PAPUA NEW GUINEA
SOLOMON ISLANDS
KIRIBATI
TUVALU
Wallis and Futuna (FR.)
WESTERN SAMOA
VANUATU
FIJI
TONGA
New Caledonia (FR.)
AUSTRALIA
NEW ZEALAND
Coral Sea
Tasman Sea
SOUTH PACIFIC OCEAN
Rotuma (administered by EASTERN DIVISION)
SOUTH PACIFIC OCEAN
NORTHERN DIVISION
WESTERN DIVISION
EASTERN DIVISION
CENTRAL DIVISION
Nadi
SUVA
Viti Levu
Vanua Levu
Taveuni
Koro Sea
MOALA GROUP
YASAWA GROUP
LAU GROUP
YAGASA CLUSTER
Kandavu Island
Matuku Island
Fulanga Island
Ogea Levu
Ogea Driki
Vatoa Island
Ono-i-lau
Tuvana-i-Ra
Tuvana-i-Tholo
Ceva-i-Ra
Base 800204 (A00359) 3-87

CIFDP- I


Bangkok
กรุงเทพมหานคร
Vietnam
Cambodia
Philippines
Andaman Sea
Ho Chi Minh City
Kabisayaan
Palawan
Negros
Gulf of Thailand
Sulu Sea
Basilan
Malaysia
Kuala Lumpur
Celebes Sea
Singapore
Indonesia
Jakarta
Java Sea
Banda Sea
Surabaya
Semarang
Arafura Sea
Timor Sea

Scope – CIFDP Sub-Projects

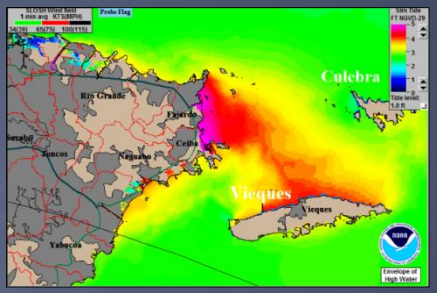
	Bangladesh	Fiji	Indonesia
Area of interest	Whole Bangladesh coast	Viti Levu	Jakarta; Semarang
Sources of inundation			
- Storm Surge	Yes	Yes – primarily on NW coast (Nadi)	No
- Waves	Not independently	Yes – primarily on south coast	Yes
- River Discharge	Yes	Yes	Yes + Heavy rainfall
- Tides	Yes	Yes	Yes
- SSHA	Not at this time	Yes	Yes
- Other issues		Flash flooding*	Kelvin Waves; wind setup; subsidence*

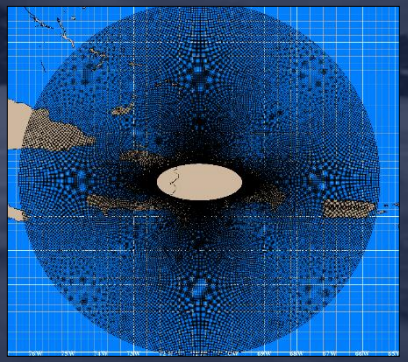
System Design Outline – CIFDP Sub-Projects

	Bangladesh	Fiji	Indonesia
SS Model	JMA-MRI	TBD (MRI, Delft3DFM, BoM)	Delft 3D (hydrodynamic)
- Wave Input	Included in MRI model	Fixed value (TBD)	N/A
- Wind Input	Parametric - BMD	Parametric – FMS (RSMC Nadi)	GFS/WRF; parametric TC
- Ensembles	Desirable - testing	Desirable - testing	Desirable - testing
Wave Model	N/A – (JMA-MRI model includes wave aspects)	BoM model boundary conditions; SWAN, XBeach	WaveWatch3, nested* SWAN; coupled*
River Discharge	Parameterized from upstream forecast (FFWC)	River Discharge model (TBD)	SOBEK – Jakarta W-FLOW – Semarang* QPF, TRMM, radar
Tides	Included in MRI model	Model forecast BoM or global	TBD: SCS, BoM, global model; 1/12 deg TMD
SSHA	N/A	BoM operational forecast	BoM operational forecast
Integrating System	Delft FEWS	Delft FEWS	Delft FEWS
Bathymetry	Best Available - Navy	Best Available – Navy, SPC	J-FEWS + best available – NCA
DEM	Best Available – SOB (*2016)	Best Available – SRTM, Nadi basin	J-FEWS + best available – NCA

Hispaniola Demonstration Project Scope

- Implement a coupled storm surge and wave modeling system
  - SLOSH hydrodynamic model
  - Wave model recommended by IOOS modeling testbed
- Develop products for planning, preparedness, and forecasting
  - SLOSH MOMs and MEOWs
  - Same display system as employed by RSMC-Miami (SLOSH Display Program)
- Provide specialized training programs on how to use the storm surge products for planning and preparedness





Impact- Based Forecasting

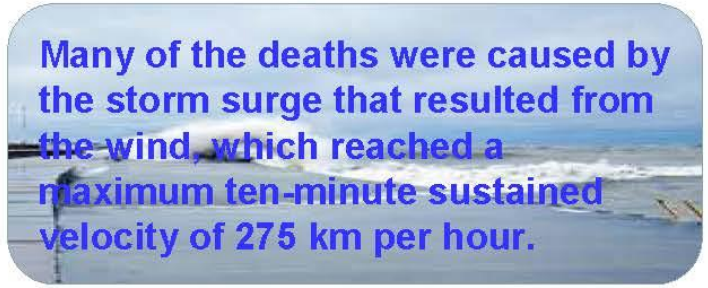
Background – why do good forecasts result in a poor response

Tropical Cyclone **Haiyan (Yolanda),** which struck the Philippines as a Category 5 storm on November 7 2013, as of 14 January 2014:

- 6,201 dead, 28,626 injured and 1,785 missing.
- More than sixteen million affected and more than US$827 million estimated for the damage of infrastructure and agriculture (NDRRMC 2014).

1. Accurate warnings were issued by the meteorological agency – PAGASA – for heavy rain and winds in time.

2. The government deployed planes and helicopters to the regions most likely to be affected.

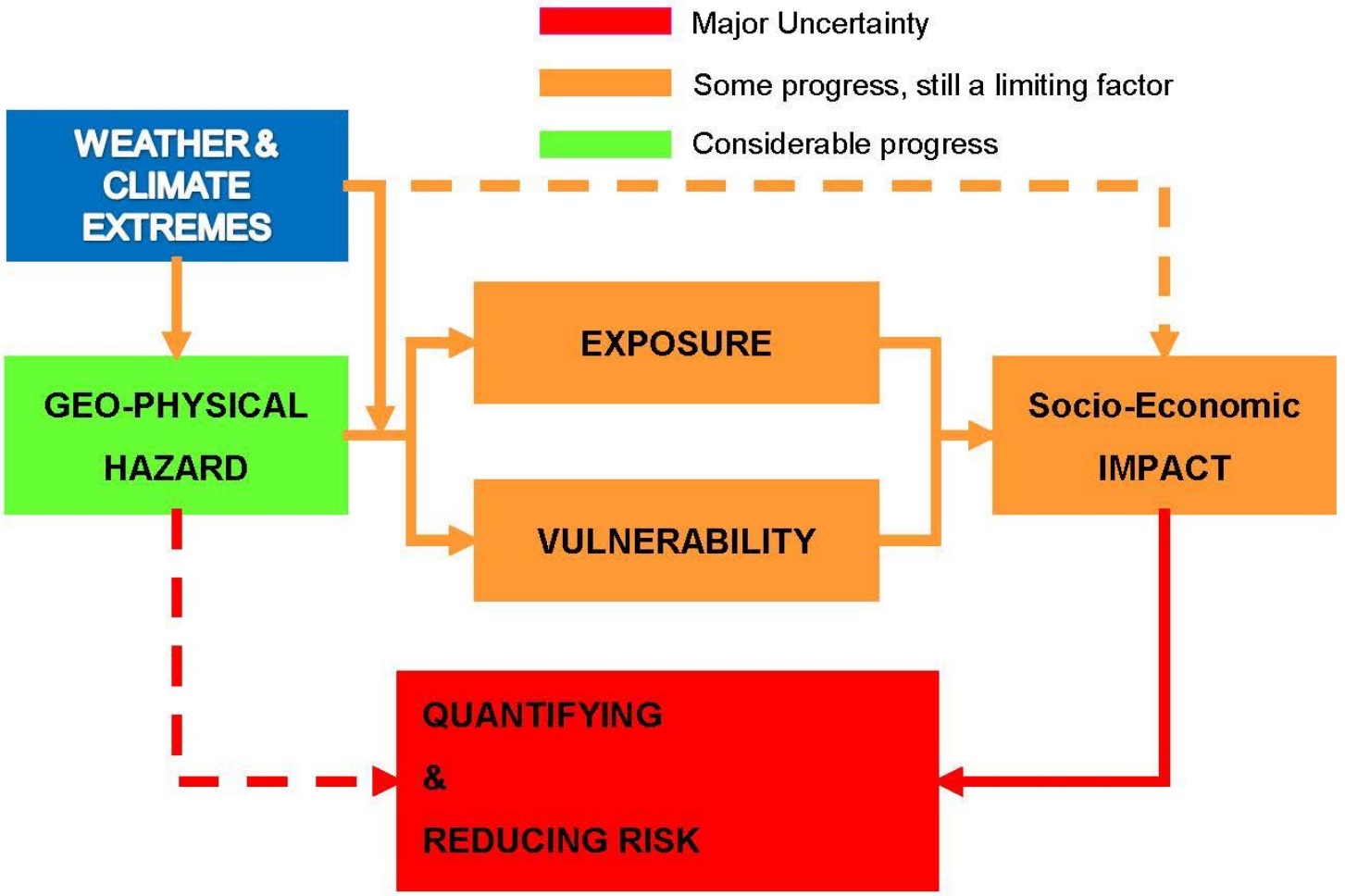


- Accurate warnings issued
- Good indication of storm surge

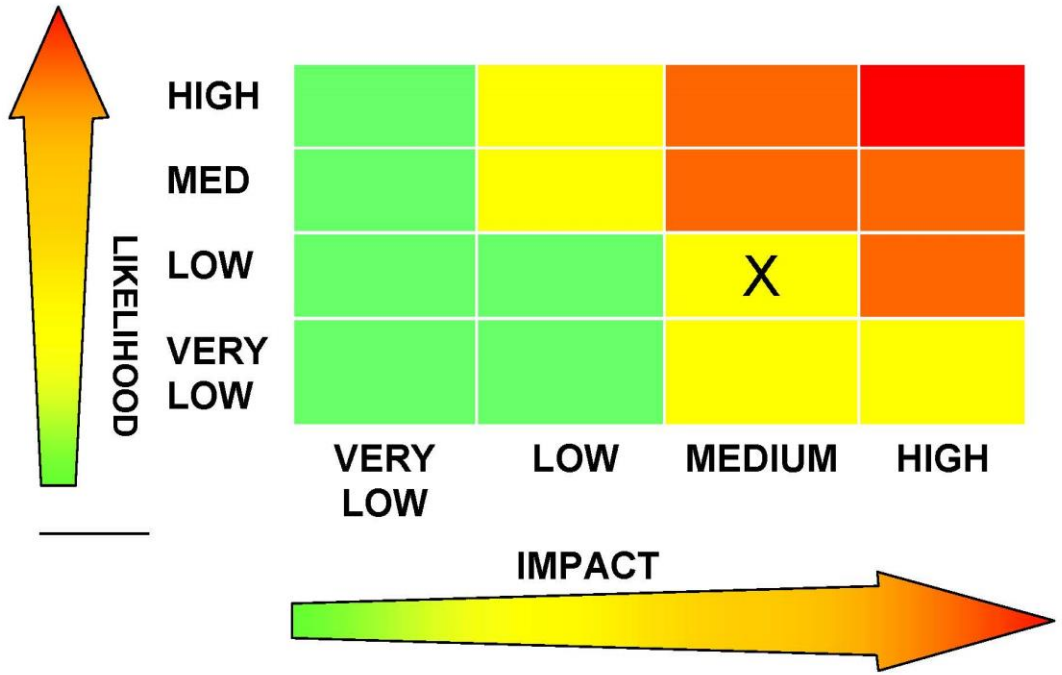
Not enough knowledge of storm surge impacts


Impact- Based Forecasting
Holistic approach to impact and risk based forecasts
"…bridging the Valley of Death…through effective translation and application of science from multi-hazards to impacts"

Holistic approach to impact and risk



Risk Matrix



Green: No severe hydrometeorological hazard is expected

Yellow: Be aware

Orange: Be prepared

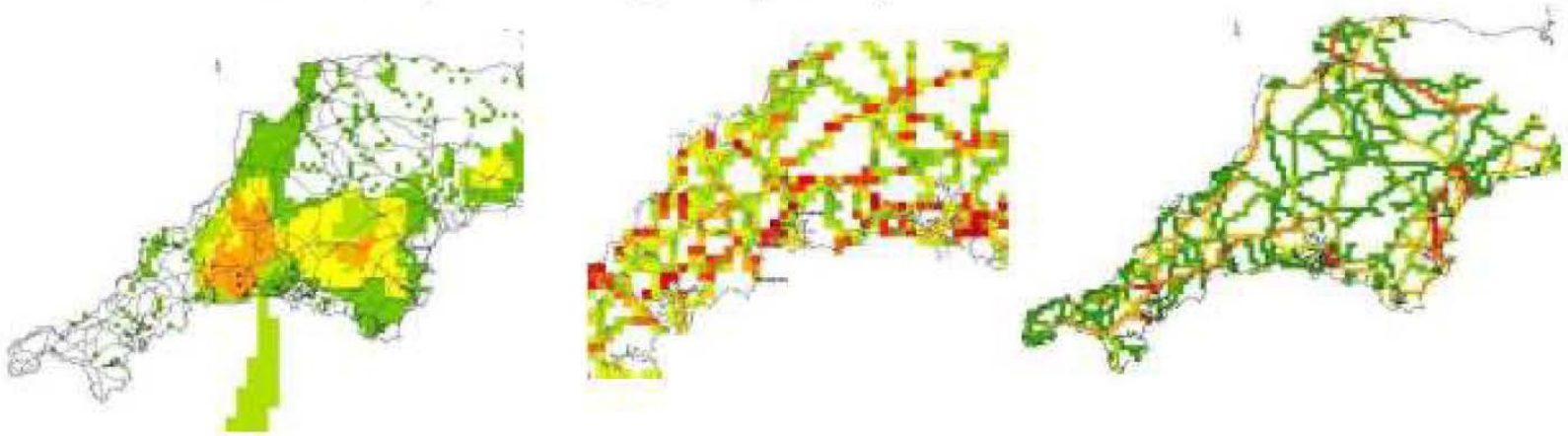
Red: Take action

Assign a colour to the warning which is a combination of potential impact and likelihood (source: Met Office)

Case Study from UK Met Office

Hazard Impact Model: Cornwall Flood 17th Nov 2010

Risk = Hazard x (Vulnerability x Exposure)

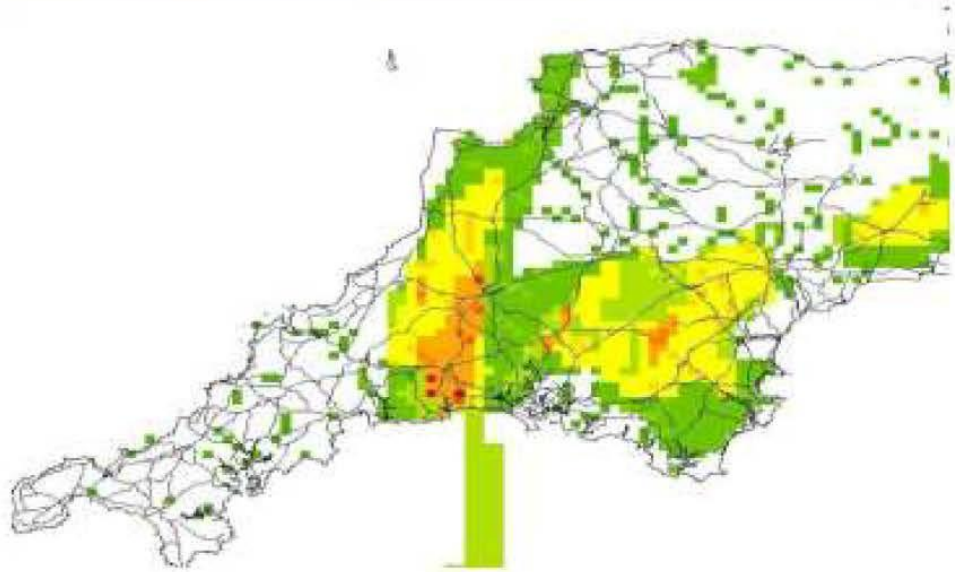


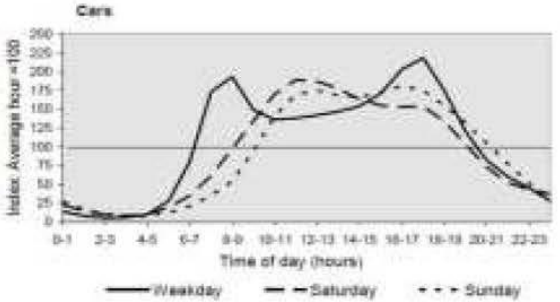
Hazard x **Vulnerability** x **Exposure**

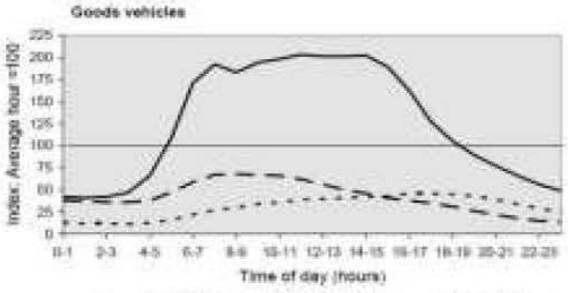
FLOODFORECASTINGCENTRE CabinetOffice Science

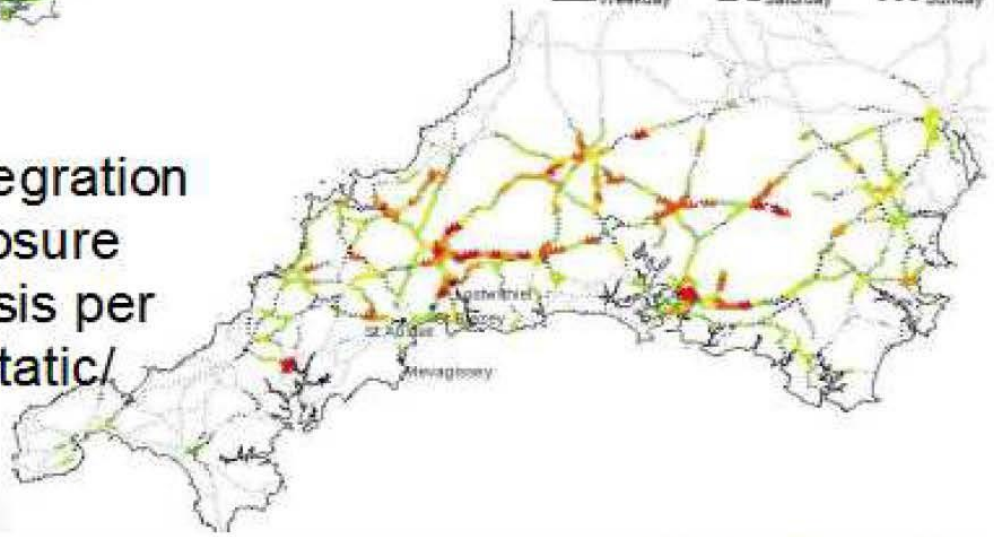
defra UK SPACE Met Office British Geological Survey National Oceanography Centre Ordnance Survey

Integration of Vulnerability and Exposure









Relative Risk – after integration with vulnerability & exposure [either via Impact Analysis per time step or individual static/ semi-static fields]


The End
Courtesy of Don Resio

CIFDP: Project Steering Group (PSG)

- Val Swail, Co-chair – Metocean modeling & forecasting expert
- Yuri Simonov, Co-chair - Hydrological modeling & forecasting expert
- Don Resio – Metocean, hydrological modeling & forecasting expert
- Linda Anderson-Berry - Social science expert
- Nadao Kohno - Metocean modeling & forecasting expert
- Jamie Rhome - Metocean modeling & forecasting expert
- Paula Etala - Metocean modeling & forecasting expert
- Monika Donner – Hydrological modeling & forecasting expert
- Deepak Vatvani - Hydrological modeling & forecasting expert
- S.H. Fakhruddin - Hydrological modelling & forecasting expert
- Paul Davies – Hydrological modelling & forecasting expert

The PSG works closely with

- JCOMM Expert Team on Waves and Coastal Hazard Forecasting Systems (ETWCH)
- WMO Working Group on Societal and Economic Research Applications (SERA)

Status – CIFDP Sub-Projects

	Bangladesh	Fiji	Indonesia
Current Status	Phase 2 Implementation and Training; Table Top	Phase 2 initiated; initial system design proposed	Phase 2 initiated; system design agreed
Definitive National Agreement (DNA); National Coordination Team (NCT)	**Signed February 2013**: BMD, Department for Disaster Management (DDM), Cyclone Preparedness Programme (CPP), RIMES	**Signed June 2013**: Prime Minister's Office, Ministry of Provincial Development and Disaster Management, and Ministry of Works, Transport and Public Utilities (FMS)	In preparation; BMKG lead
National Capacity Assessment (NCA)	Published January 2014; TR #73	Published December 2013; TR #71	Pending revisions by BMKG
User Requirements Plan (URP)	Published January 2014; Version for Phase 1	Published January 2014; Version for Phase 1	Pending revisions by BMKG
System Design Document (SD)	Published February 2014; TR #75	Published February 2014; TR #74	Draft online at CIFDP-I
Funding confirmed for Phases 2-4	Yes; USAID	No; AUSAID proposal; WMO VCP bridge funds	No (mostly internally funded)
System Developer	S.M.H. Fahkruddin JMA (Nadao Kohno)	TBD; SPC, BoM	BMKG, Public Works NOAA NCEP