World Meteorological Organization
Working together in weather, climate and water

WMO

INTERGOVERNMENTAL COORDINATION FOR STORM SURGE FORECASTING & EARLY WARNINGS

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WMO Disaster Risk Reduction

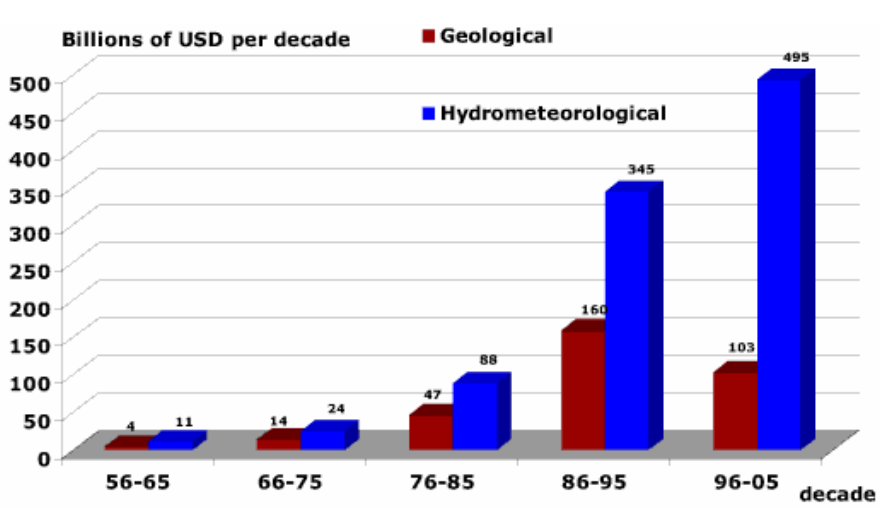
- Modernize National Met/Hydrological Services (NMHSs) and **observing networks**
- Implement national operational **multi-hazard early warning systems**
- Strengthen hazard analysis and hydrometeorological **risk assessment tools**
- Strengthen NMHSs **cooperation with civil protection and disaster risk management agencies**; and
- Coordinate **training and public outreach** programmes.

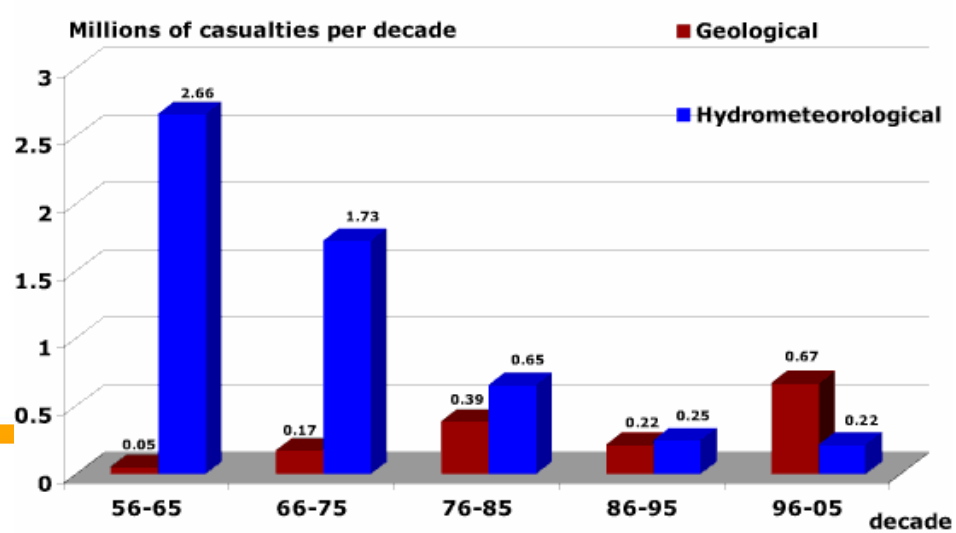
Disaster Risk Reduction

- Rising global trend in disaster occurrence /economic losses
- Remarkable decline in global loss of life associated with meteorological, hydrological or climate-related hazards

➔ preparedness and prevention, combined with **effective emergency management and early warning systems**

"Spending on improving weather forecasting and sharing data have high returns."





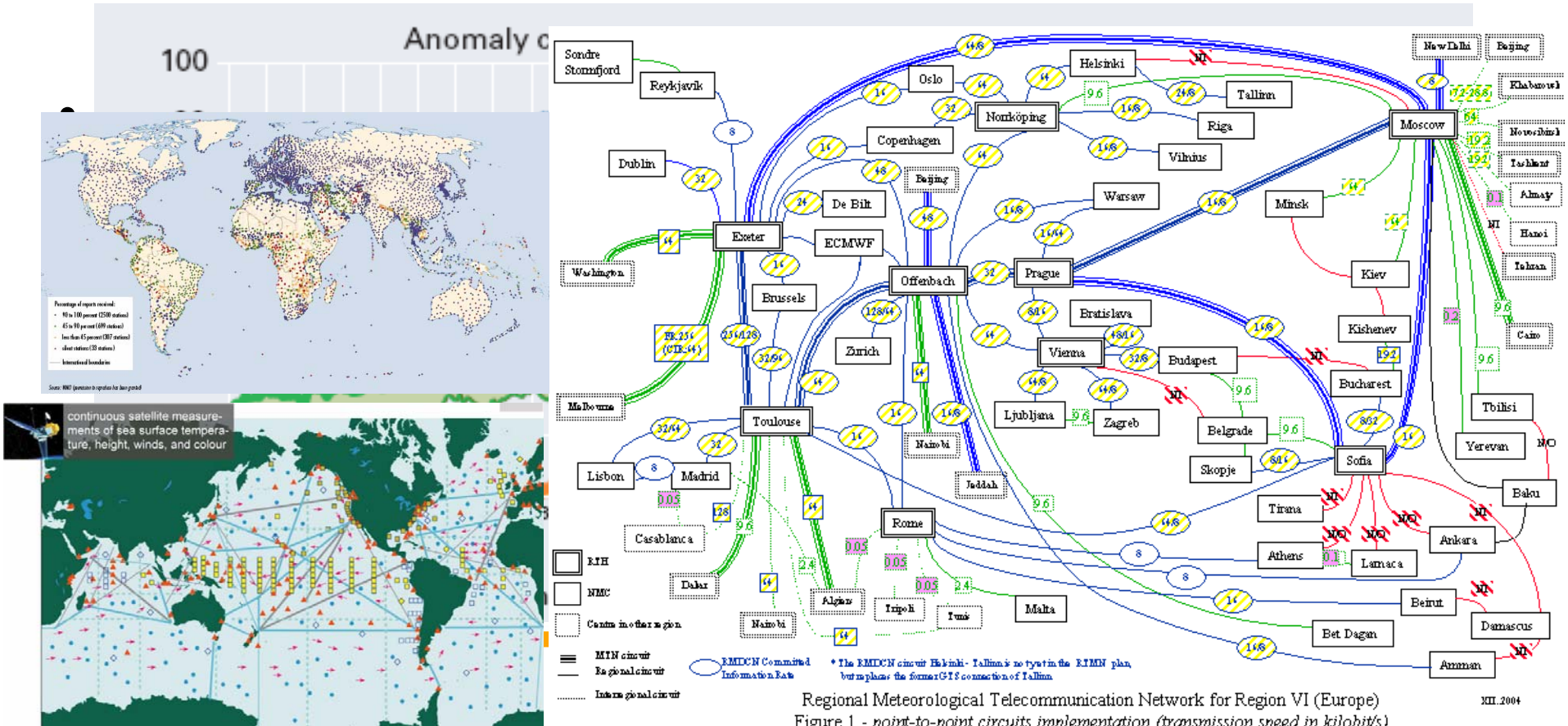
Effective Early Warning Systems

… require **coordination across many agencies**

… require **scientific & technical support** for standardized/agreed approach

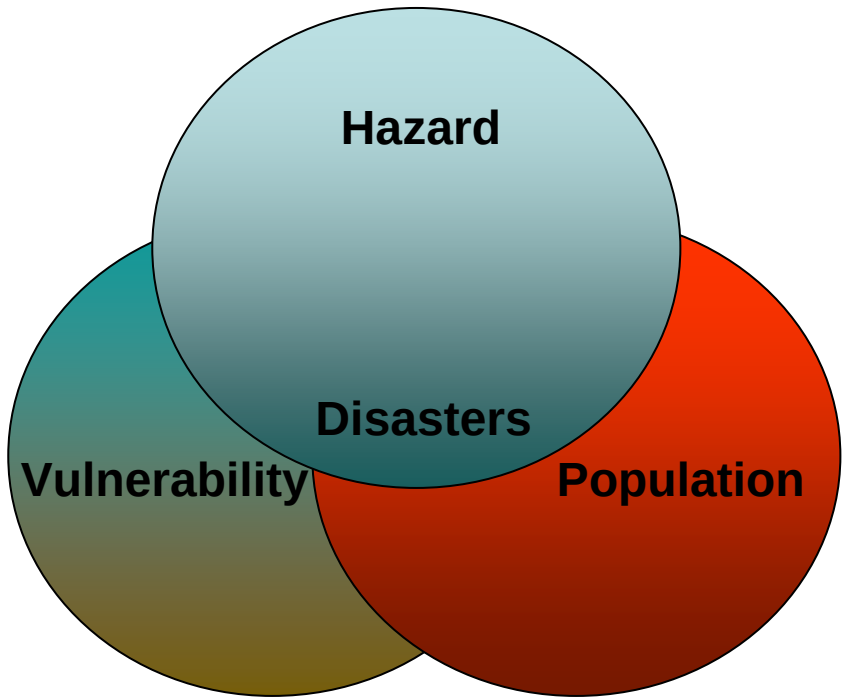
Detecting, Monitoring, Forecasting…

- Increasing accuracy of forecasting
- Data sharing through Global Telecommunication System



Disasters are more likely when Hazards and Populations overlap with Vulnerability

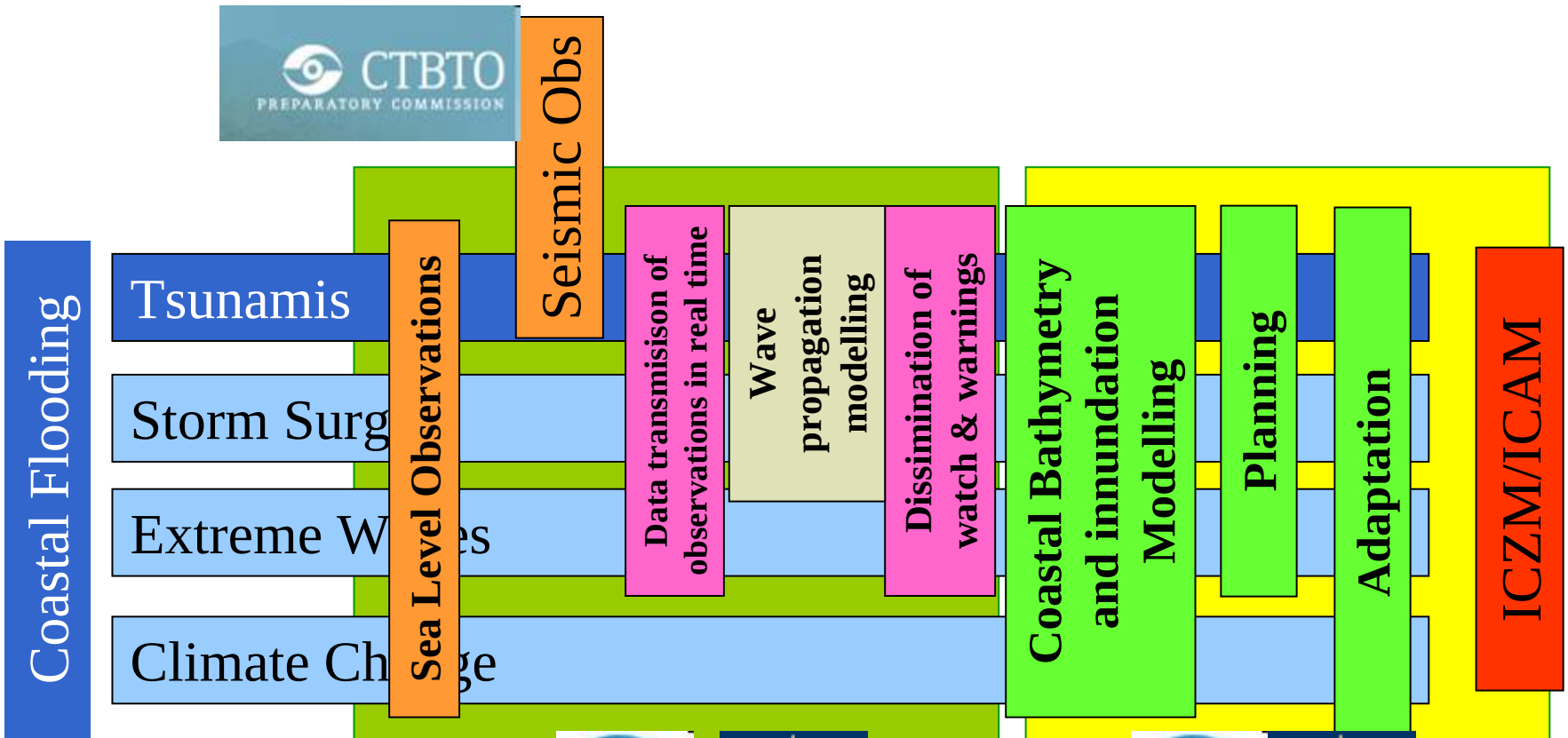
- Critical risks in coastal areas are related to storm surges, tsunamis and river flooding
- Population is attracted to coasts by an abundance of local resources
- In many parts of the world, the population is directly exposed to the coastal hazards and this will increase with Sea Level Rise



Multi-Hazard Approach

Hazard	Tsunami	Storm surge	Wind-driven waves	Sea level rise	Coastal erosion
Frequency	Decades to centuries	Annual to decadal	Annual to decadal	Ongoing but accelerating	Ongoing but accelerating
Magnitude (run-up)	From cm to meters	1-2 meters or more	1-2 meters or more	Average +0.5-1.7 cm	Several m/yr
Duration	Hours to 1 day	Few hours to few days	Hours to many days	Ongoing	Ongoing
Impact	Inundation and drainage surges	Single event inundation	Multiple localized inundations	Progressive sea level rise	Progressive
Area	Local run-up	Hydrological modelling	Terrain modelling	Terrain modelling	Long-term trends
Warning	Minutes to hours	12 hours to 2 days	1-3 days	Decades	Decades

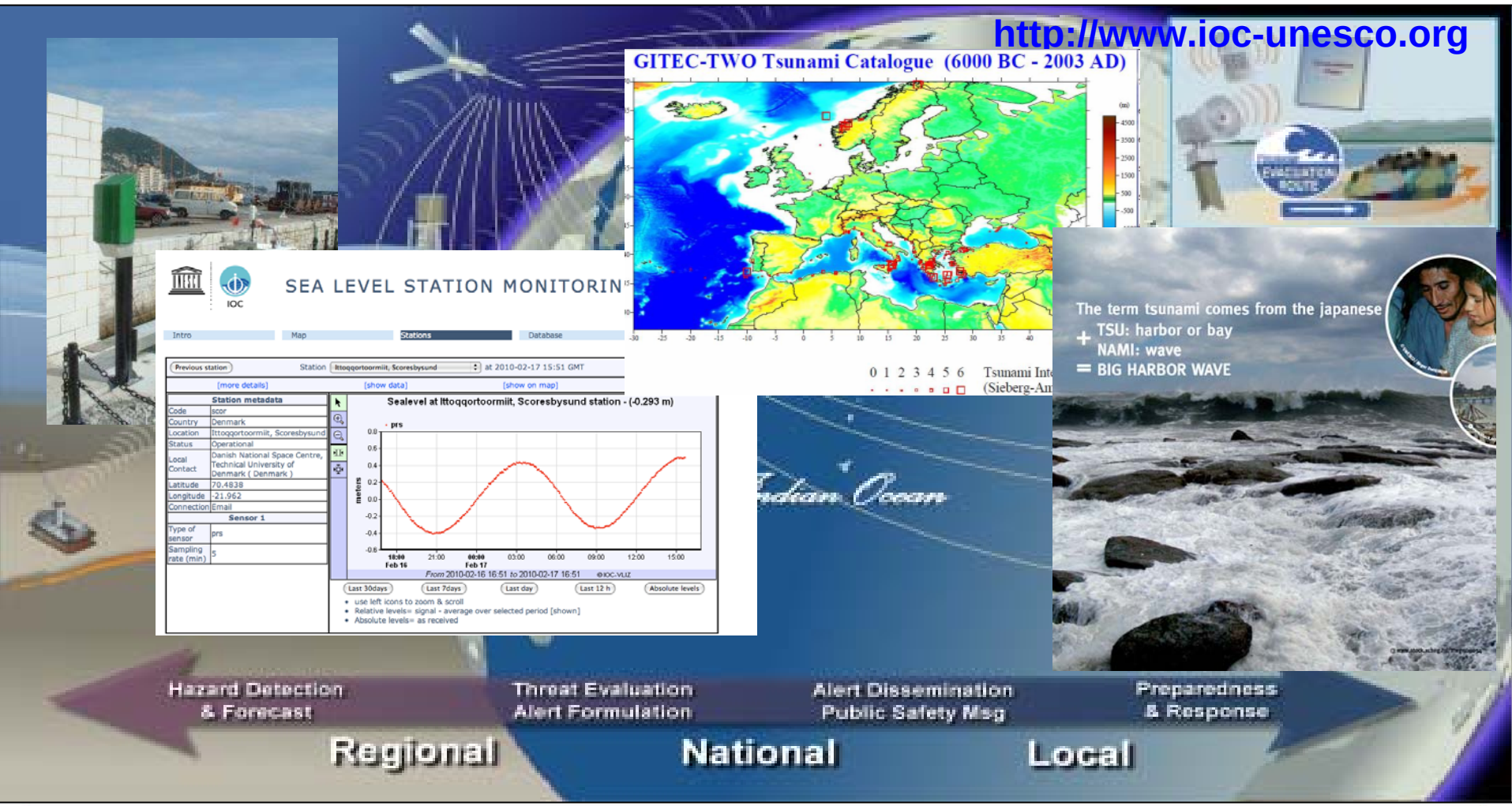
Collaborative Efforts for Coastal Inundation Early Warnings



jcommops
JCOMM in-situ Observing Platform Support centre

ISDR

Global End-to-End Early Warning Systems



Focus on benefits for Coastal & Marine community

http://www.ioc-unesco.org

- **Integrated Coastal Area Management (ICAM) Hazards Awareness and Mitigation**
  (IOC Manuals and Guides No.50 / ICAM Dossier No.5)

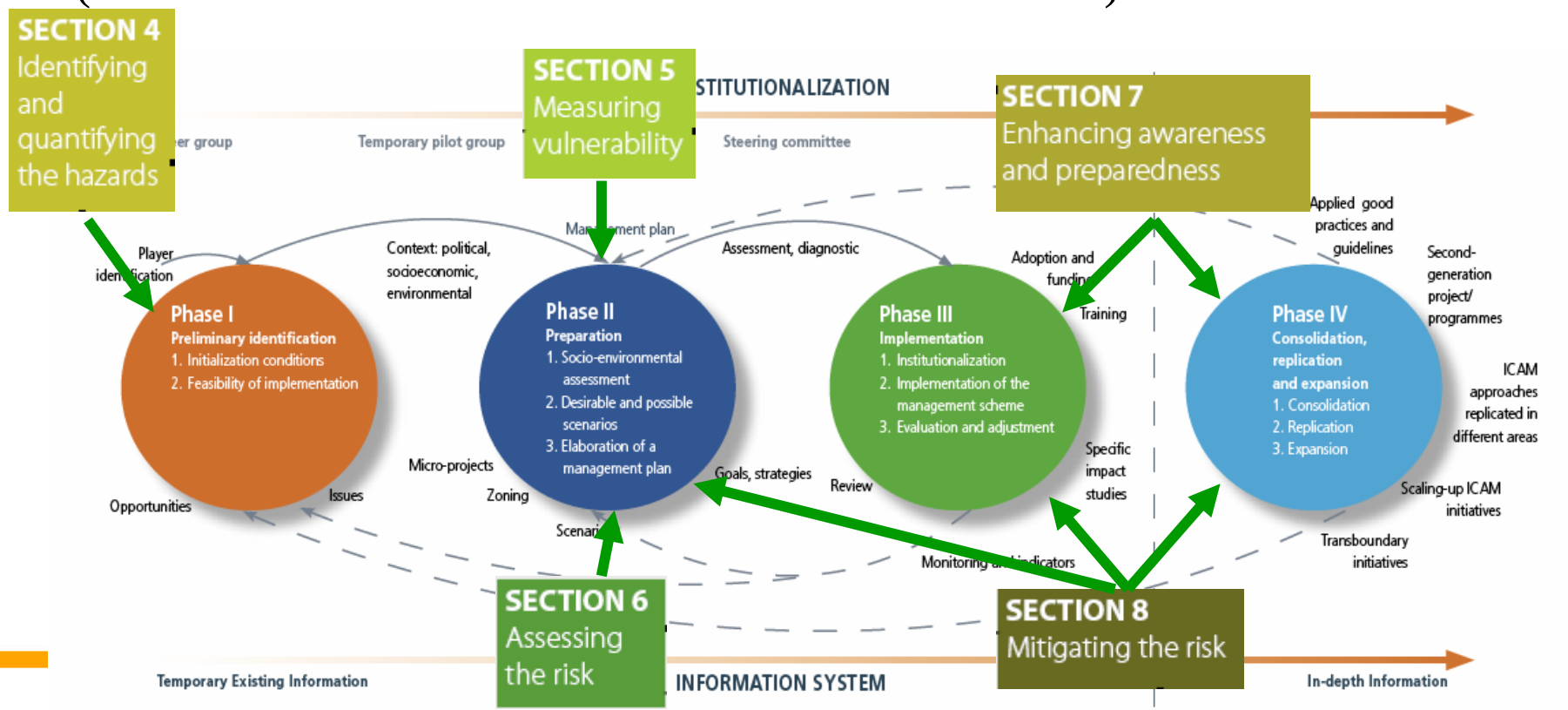
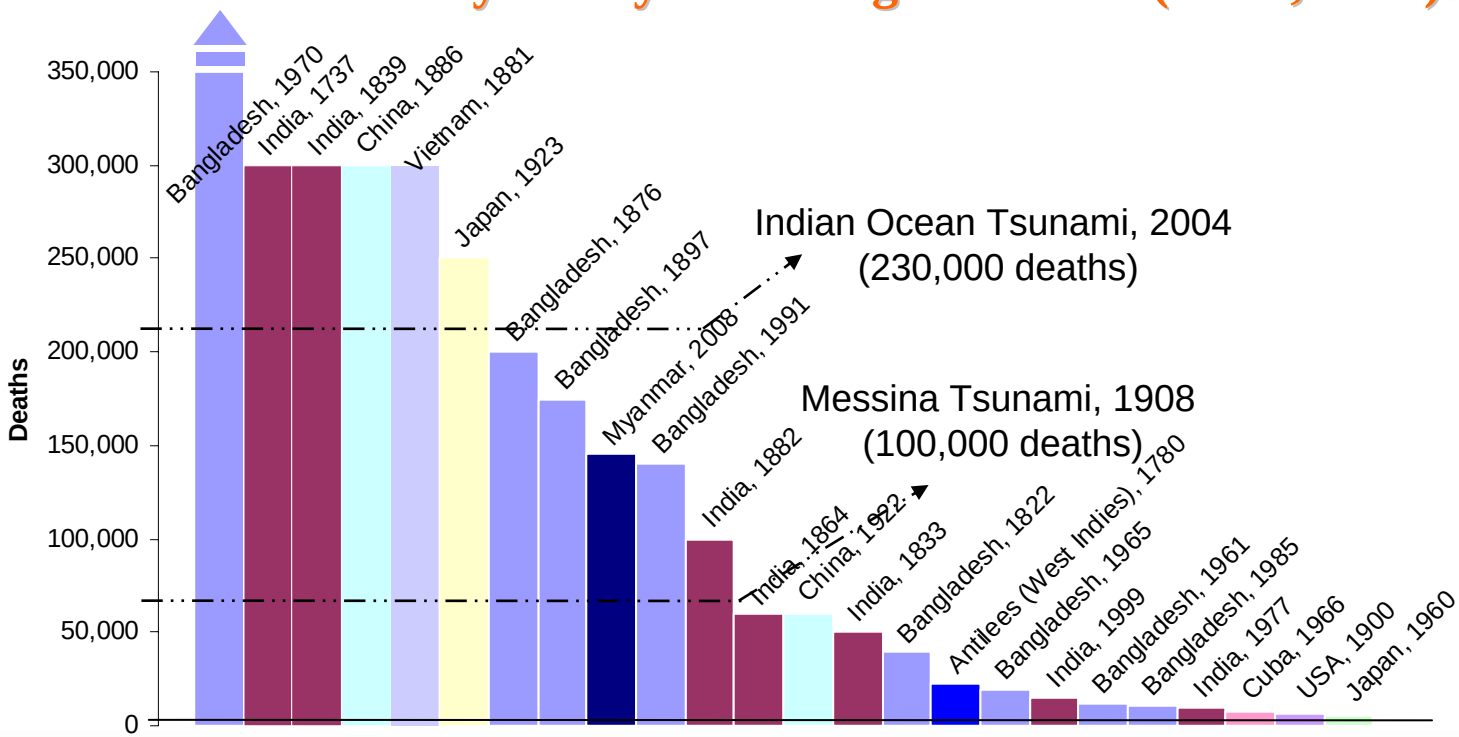


Fig. 1.1. *The linkages and feedbacks between the general elements of the ICAM process.*

Scientific and Technical Support for Storm Surge Forecasting & Warnings - some examples -

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 very widely according to sources (Dube, 2007).**



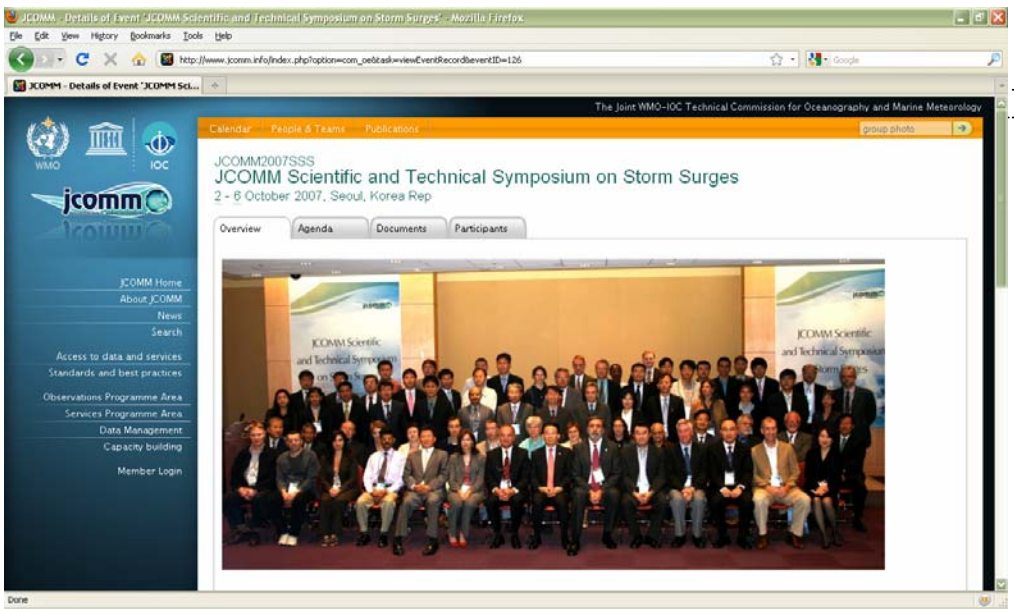
Storm Surges: considering Scientific/Technical Requirements

http://www.surgesymposium.org

- **Storm Surge Symposium** (2007, Seoul, Korea), organized by **Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)**

http://www.jcomm.info

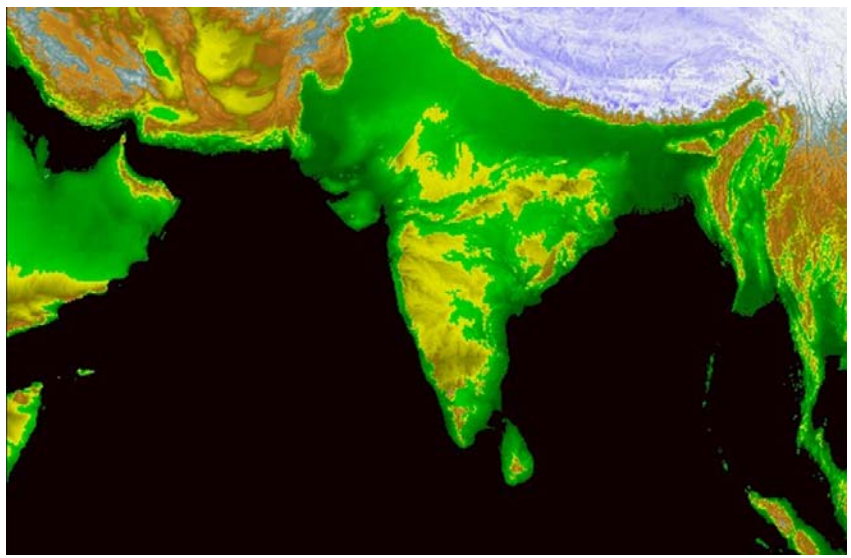
- rg, Germany)



IOC Pilot Project for North Indian Ocean Storm Surge Forecasting

http://www.jcomm.info/SSindia, http://www.jcomm.info/SSindia2

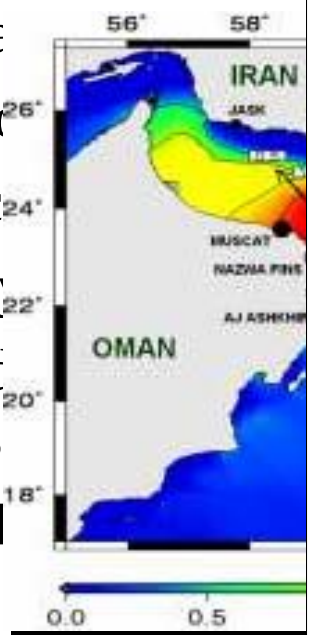
- Goals & Objectives:
  - **to support scientific/technical development for enhancing regional capabilities for storm surge forecasting** (through enhanced regional community models)
  - capacity building and technology transfer to developing countries in a high incidence of coastal disaster
- Partners :
  - **JCOMM as main coordinator**
  - India Institute of Technology (IIT)
  - WMO/ESCAP Tropical Cyclone Programme (TCP)



IOC Pilot Project for North Indian Ocean Storm Surge Forecasting

http://www.jcomm.info/SSindia, http://www.jcomm.info/SSindia2

- **reviewed performance** of the current operational storm surge forecasting model (IIT-D Model) in the region
- **addressed requirements**
  - Observa
  - Operati
  - Researc
  - Capacit
- Encouragec Thailand, S
- Deliberated related proj



Data Requirements & Possible Sources

: Identified for North Indian Ocean (Dube and Lee, 2009)

Before a storm surge event
- Bathymetry: resolution 100 m (horizontal) / 1 m (vertical), update every 5 years, on shelf
- Coastal elevation: resolution 5 m (horizontal) / 0.5 m (vertical), update every 10 years

During a storm surge event and the preceding few days
- Met-ocean forcing and water level response, including:
  storm track and intensity, near shore wind fields, wave heights, surface water levels, surface pressure fields, surface currents, sea surface temperatures, vertical temperature profiles, sea surface height anomalies

After a storm surge event
- Surveys of inundation extent, depth and duration: resolution 25 m

Data sources:
- Altimeter, scatterometer, synthetic aperture radar, HF radar, Doppler radar
- Tide gauges, metocean buoys, dropsondes, Shoreline weather stations
- Manned and unmanned aircraft observations
- NWP and parametric models, ensemble models

Coastal Inundation Forecasting Demonstration Project (CIFDP)

http://www.jcomm.info/CIFDP

*To provide an example of cooperative work as a strategy for building **improved operational forecasts and warnings capability for coastal inundation**, that can be sustained by the responsible national agencies:*

- Implementation of open-source coastal inundation end-to-end forecasting and warning operational systems
- Developing cross-cutting cooperation of different scientific disciplines and user communities
- Building communication platforms between researchers, forecasters and disaster managers involved in Coastal Flood Management

CIFDP: Scope and Deliverables

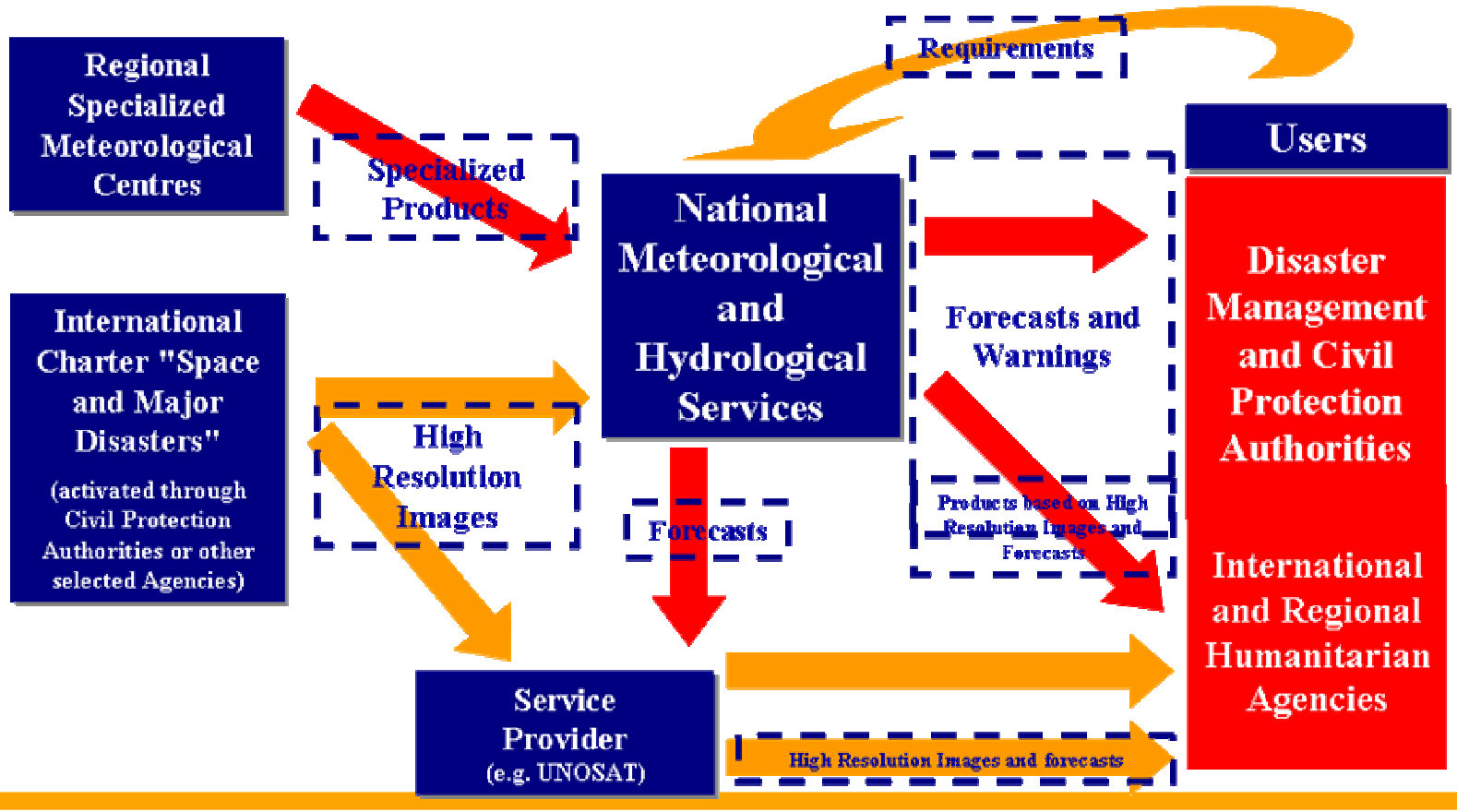
http://www.jcomm.info/CIFDP

The main focus is to **facilitate the development of efficient warning systems for coastal inundation** based on robust science and observations. The CIFDP should:

- Support informed decision-making on warning issuance and dissemination (that includes information on land-use and planning)
- Transfer and translate science and technology to communities (technology development and transfer)
- Facilitate the development of a comprehensive Storm Surge Watch Scheme (SSWS) in basins subject to tropical cyclones and storm surges
- Facilitate the development and implementation of warning services
- Provide improved science to forecasters
- Support risk assessment and mapping
- Provide a framework for Coastal Flood Management
- Identify and support end-user needs

Proposed scope of regional framework for
Coastal/Marine Forecasting & Warning

- Storm surge Watch Scheme



Coastal Inundation Forecasting Demonstration Project (CIFDP)

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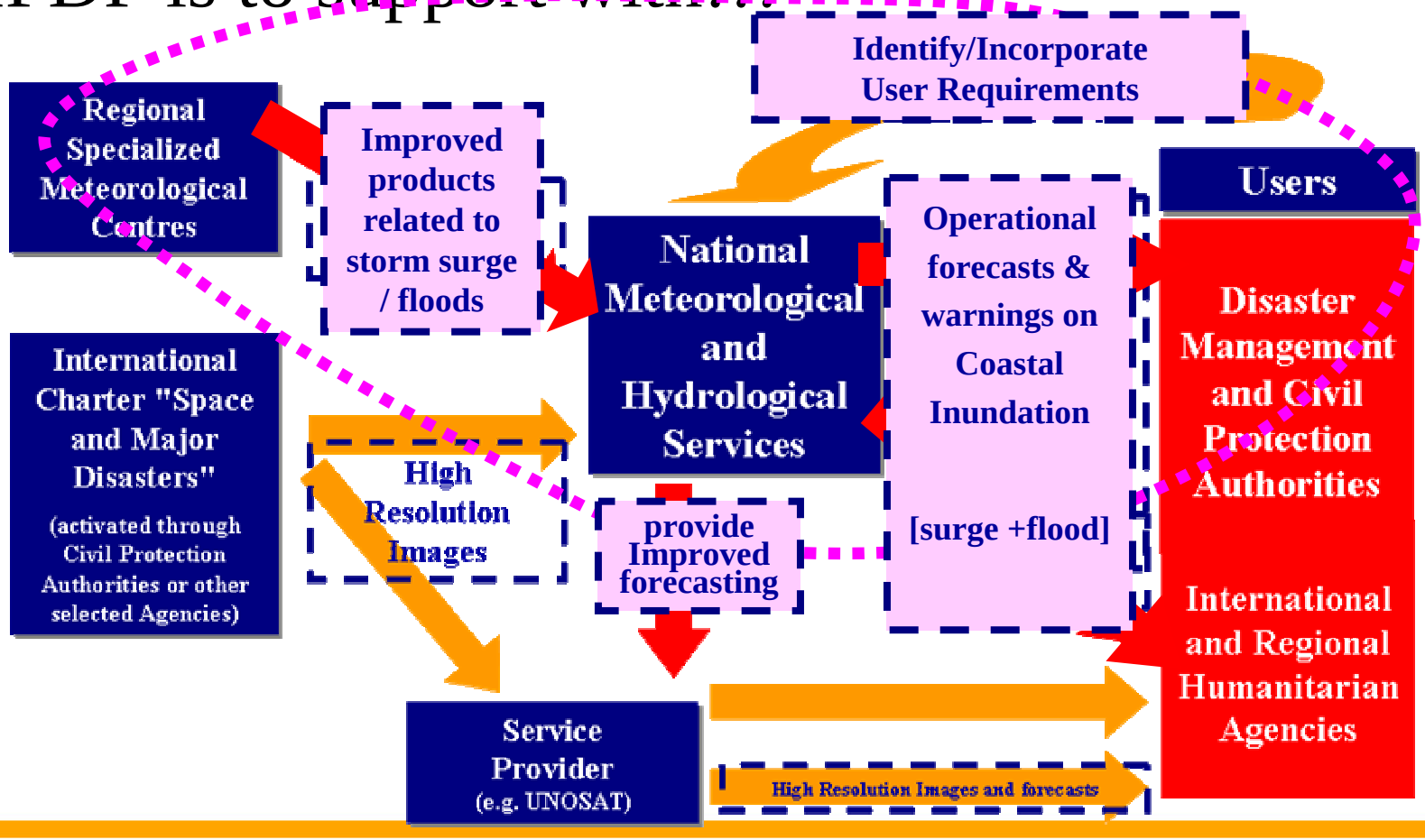
- CIFDP is to support with…



CIFDP Design & Guidance

- **NMHSs**
  to IMPLEMENT the project
- WMO Technical Commissionss
  (**JCOMM** and **CHy**)
  to provide technical
  guidance
- **Regional Programmes & Governing Bodies**
  to provide
  regional framework

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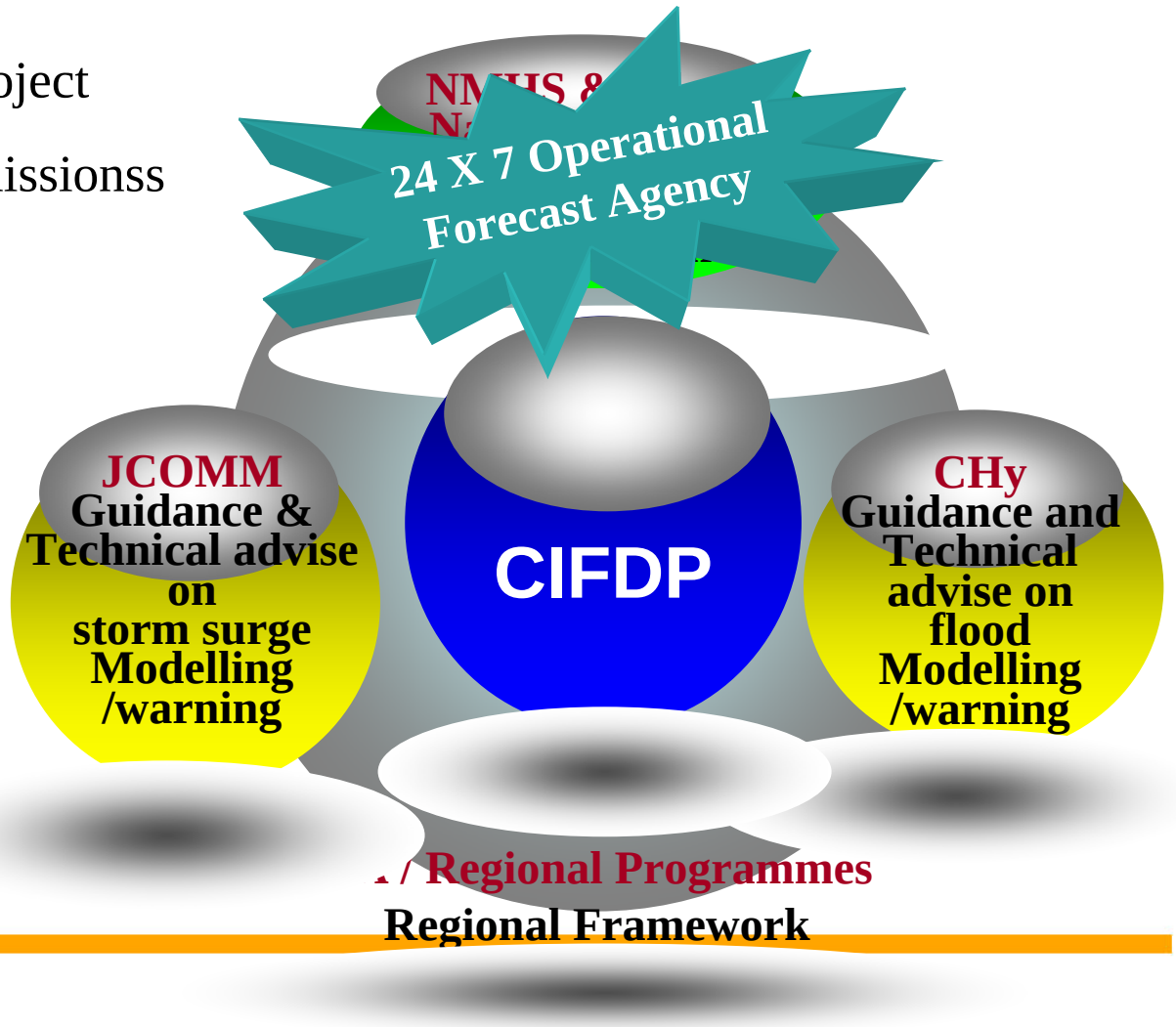
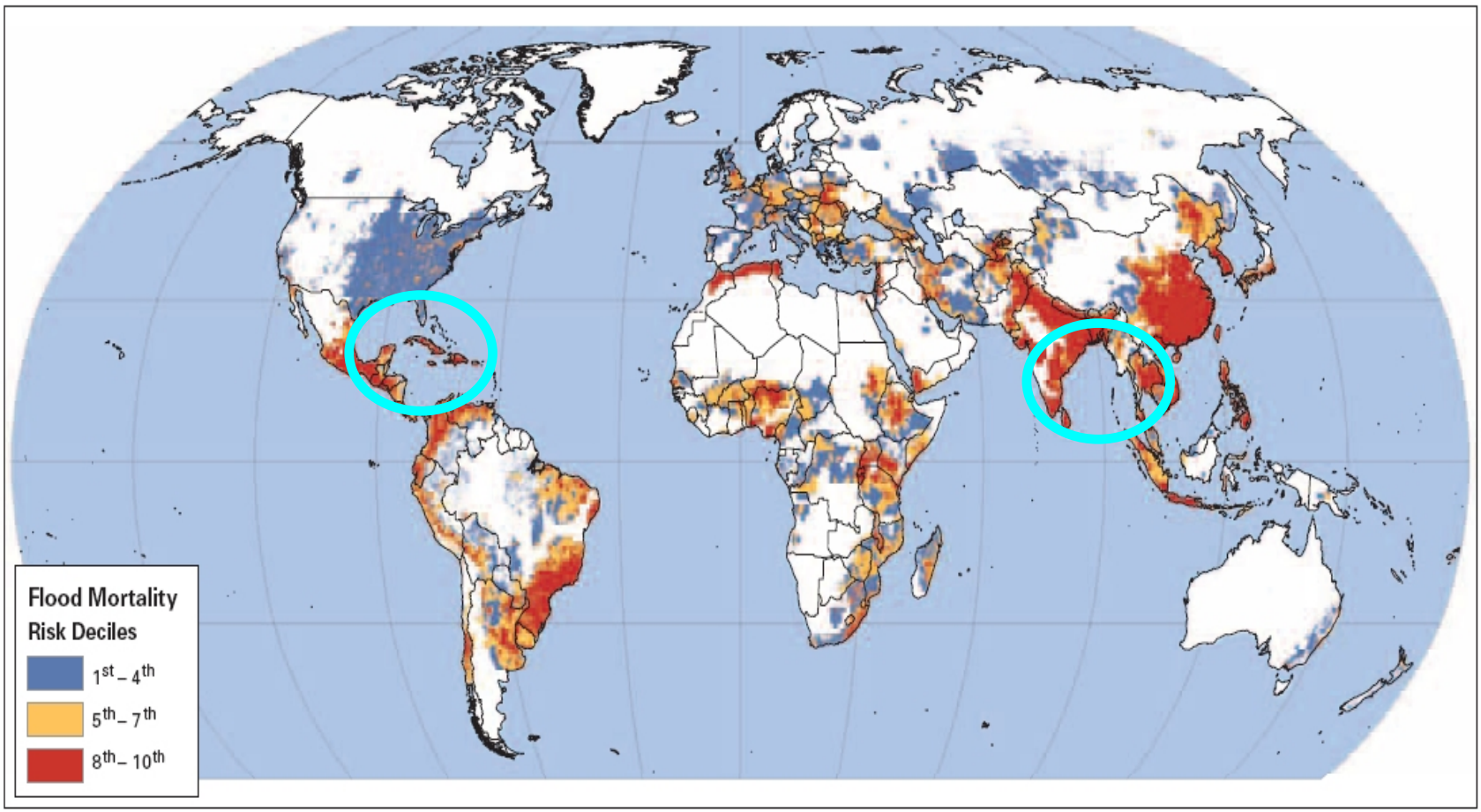


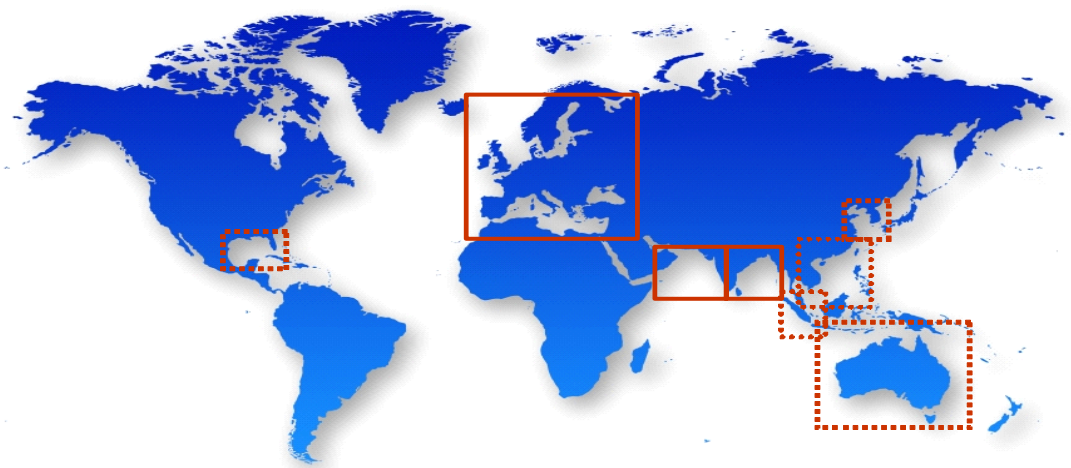
CIFDP: Project Implementation

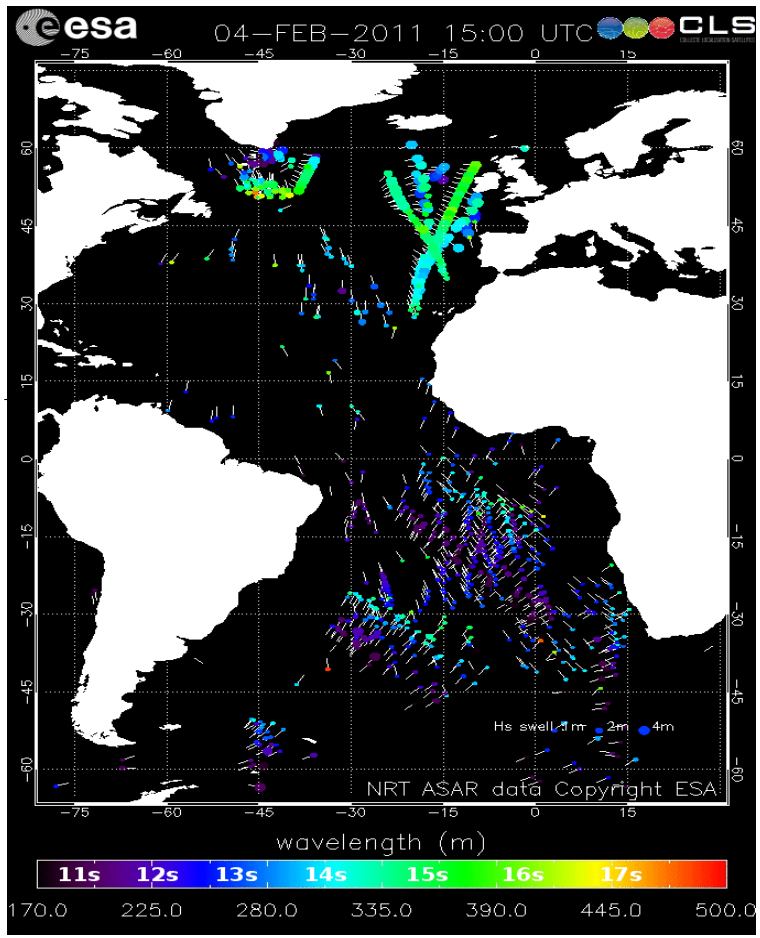
http://www.jcomm.info/CIFDP



ESA R&D Project: *eSurge*

- ESA Data User Element project for 2011-2013 (€1 Million)
- Objective:
  - To increase the use of the advanced capabilities of **satellite data for Storm Surge applications.**
  - To contribute through Earth Observation to an integrated approach (Total Water Level Envelope: **TWLE**)



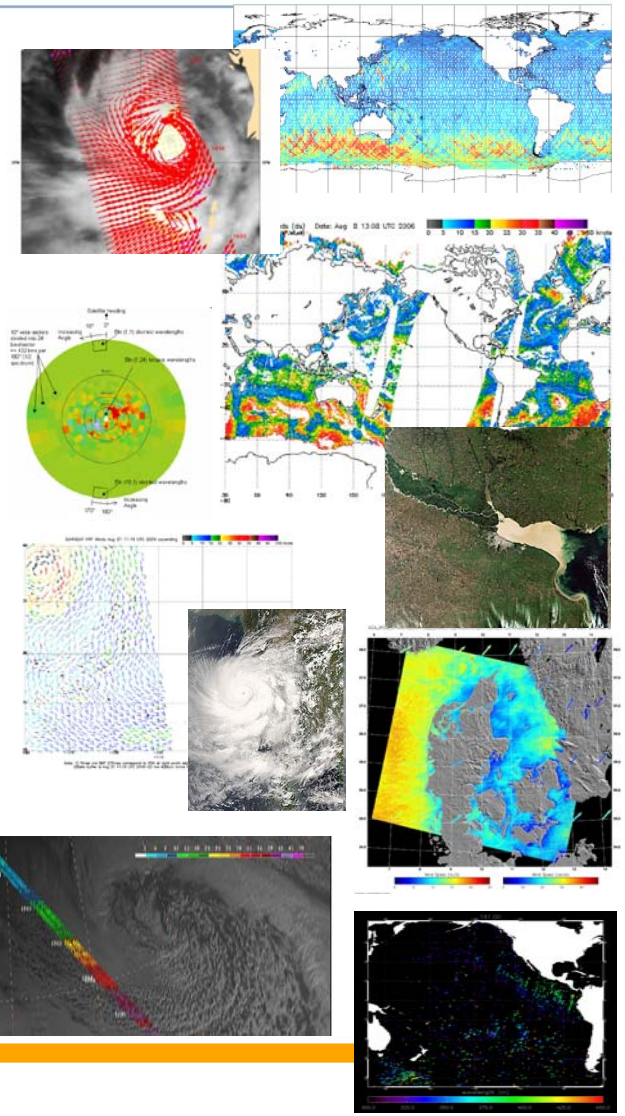


ESA R&D Project: *eSurge*

- Develop, demonstrate and validate advanced techniques for retrieving **high-resolution information on TWLE, wind speed, and waves in the coastal zone**.
- Develop and provide **validated coastal altimetry products** user defined Areas of Interest (AOI)
- Develop an open-access database (called the ***eSurge* Event Analysis and Repository Service (SEARS)**
  - Provide **access to general EO** data products, NWP, NOP and other socio-economic data that characterise storm surge events in AOI.
  - historical and contemporary storm **Surge EVent (SEV) case studies**
- Provide a demonstration **NRT service of EO data products and *eSurge* services** in support of operational and experimental storm surge forecasting and warning services.
- **Demonstrate the impact of EO data** on storm surge applications (re-analysis data assimilation, validation experiments for historical and contemporary storm surge events)
- Provide dedicated **training activities** to encourage and assist the storm surge community to fully exploit the potential of satellite data for storm surge applications

eSurge Input Data Examples

- Altimeter (ERS, ENVISAT, GEOSAT, TOPEX, JASON, CryoSAT)
- Passive Microwave (SSM/I, AMSRE, TMI, WindSat)
- Scatterometer (ERS, QuickScat, ASCAT, NSCAT, OceanSat-2)
- SAR (ERS, ENVISAT, RADARSAT, COSMO SkyMed, TerraSAR-X, RISAT…)
- Optical data (MERIS, AATSR, AVHRR, SeaWiFs Oceansat OCM-2…)
- NWP and NOP model outputs
- Storm Surge model output and forcing
- Flood maps
- In situ measurements



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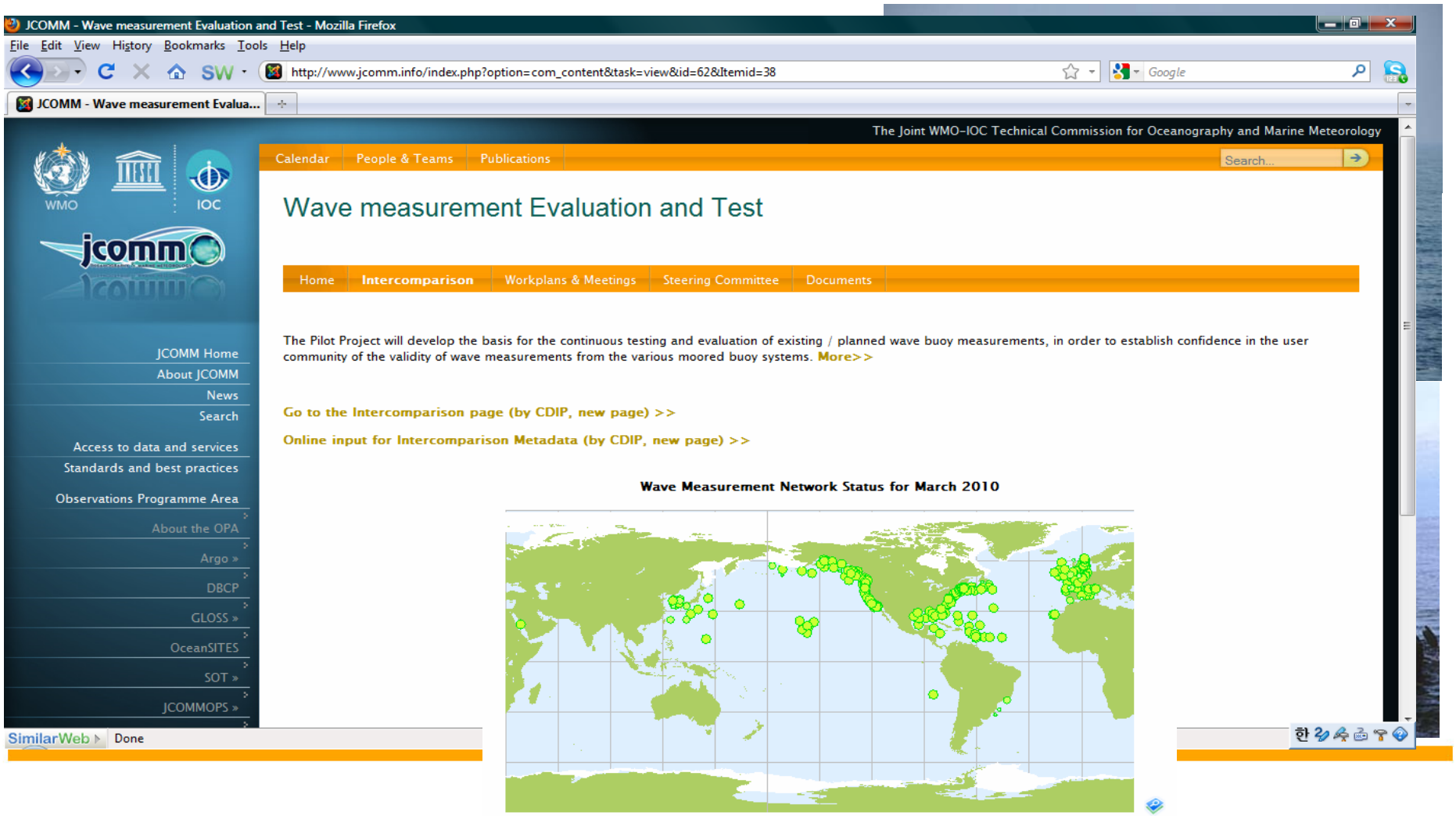
THANK YOU

Wave Observations: making sense of what we measure…

http://www.jcomm.info/WET



WMO DRR Survey (2006)

- 70% need amendments or restructuring of national policies and legislation
- 65% National Met/Hydrological Services (NMHSs) need strengthening or full modernization of infrastructure
- 80% NMHS need technical and management training
- 80% of NMHS need strengthening or building multi-sectoral institutional partnerships, coordination and service delivery (QMS and SOPs)