UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

Korea Meteorological Administration

WORLD METEOROLOGICAL ORGANIZATION

Impact Based Forecasting and Early Warning System

Second KMA / WMO Workshop on Impact-based Forecasts in Asia

19-21 November 2018

Seoul, Republic of Korea

Presented by Yuki Mitsuka, Associate Economic Affairs Officer
Disaster Risk Reduction IDD, ESCAP

UNITED NATIONS
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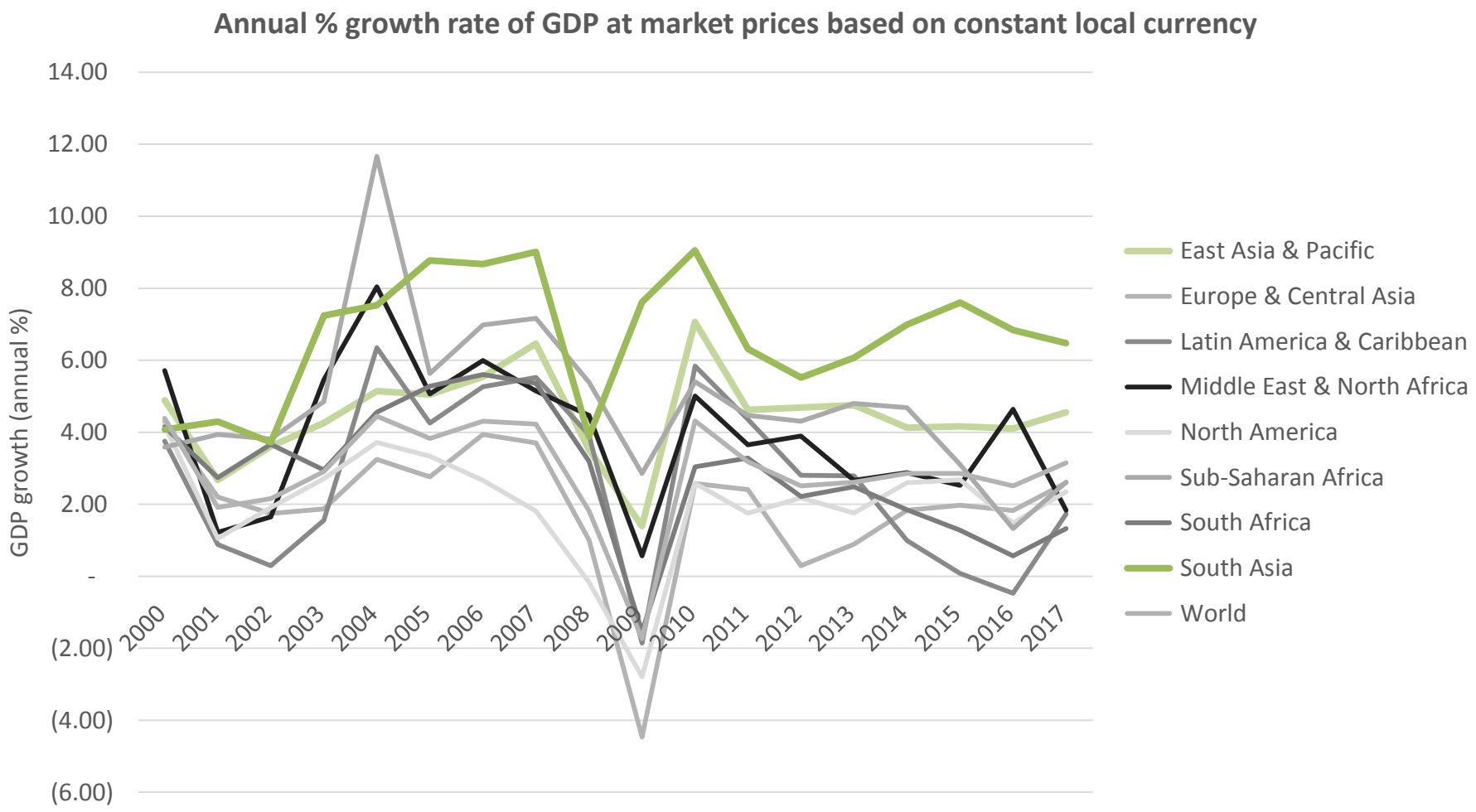
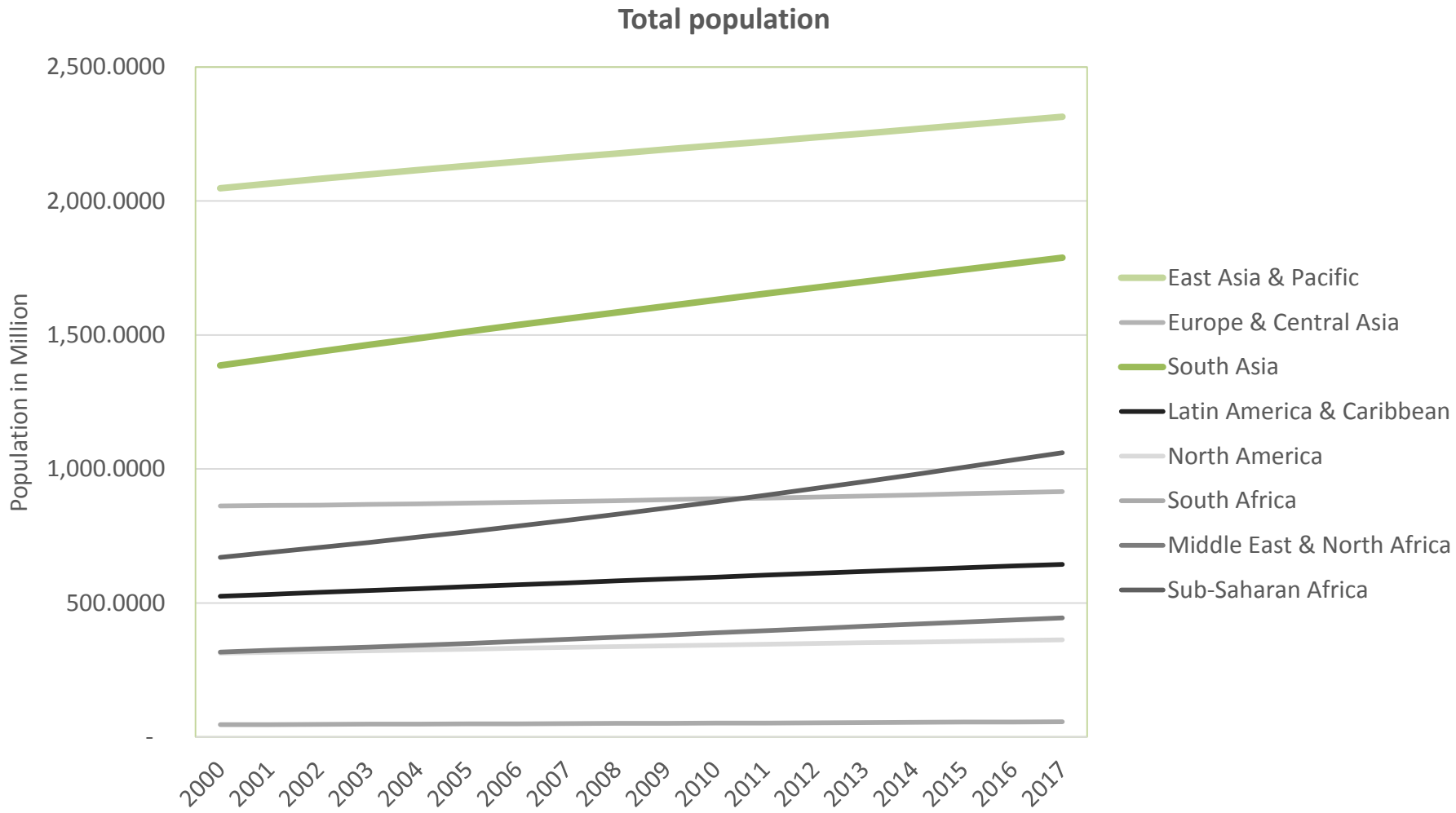
Asia and the Pacific as the Economic Champion of the 21st Century

Asia and the Pacific as the Champions in Economic Growth



Source: World Bank Data

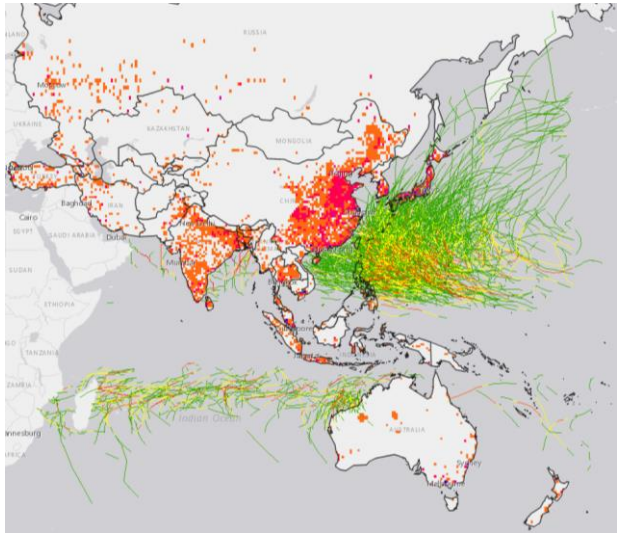
Highest Population Density in Asia and the Pacific



Source: World Bank Data

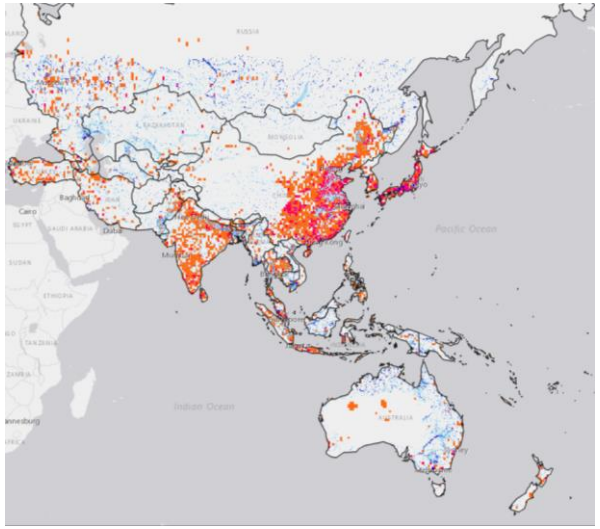
Asia and the Pacific as the most Disaster Prone Region in the World

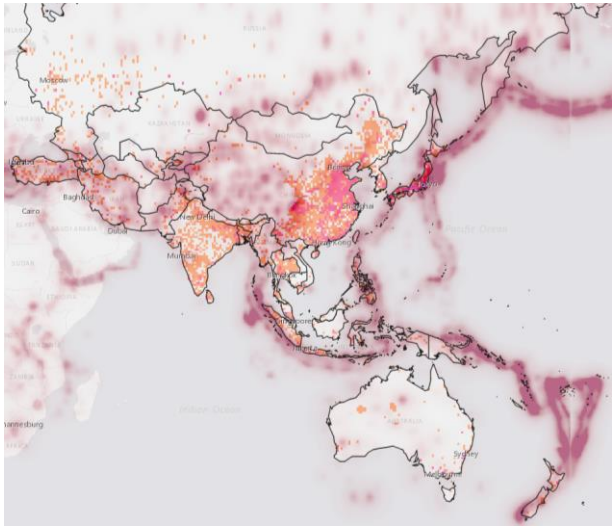
Economic Exposure to Disaster in Asia and the Pacific



Cyclone

Flood

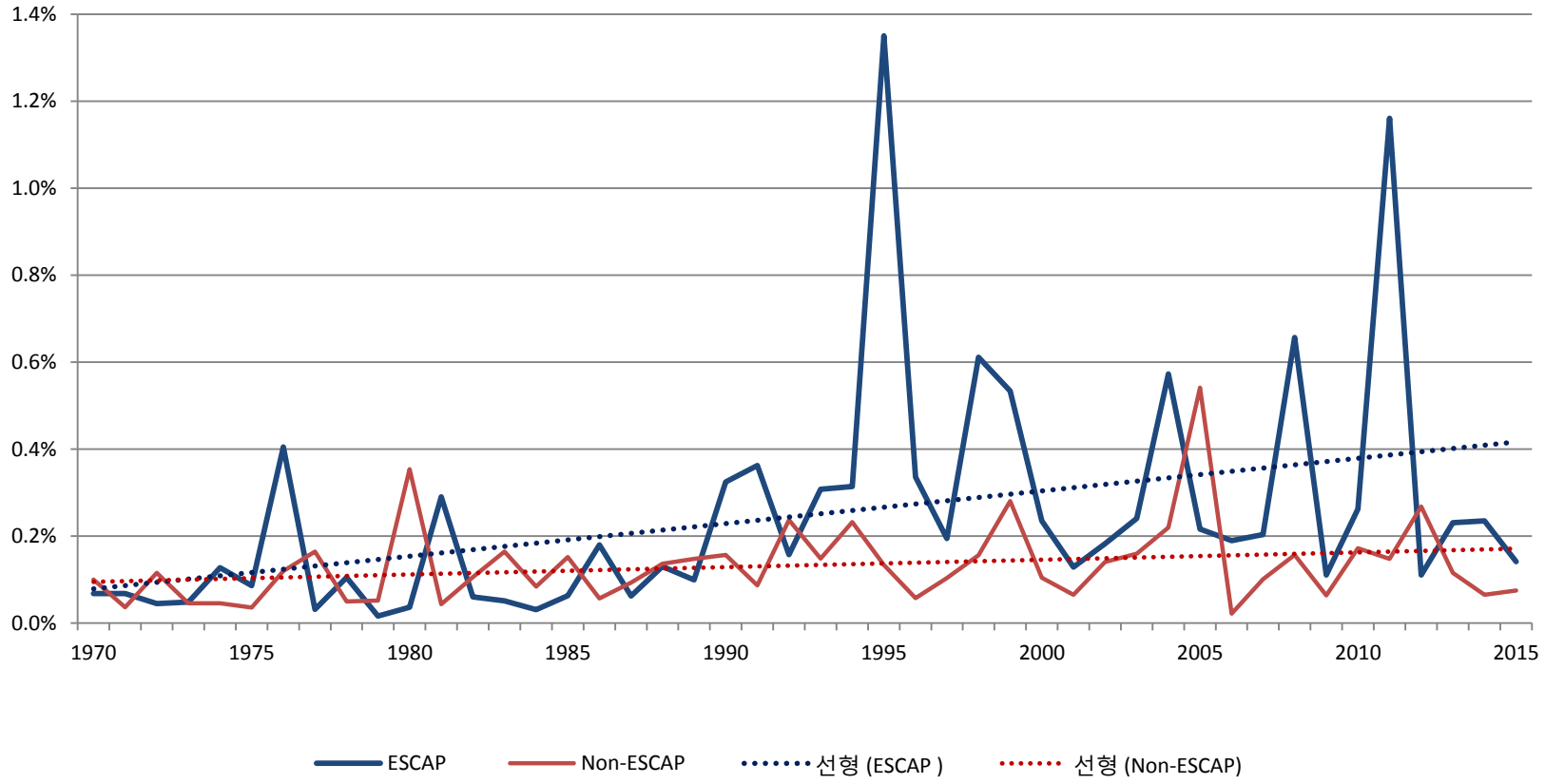




Earthquake

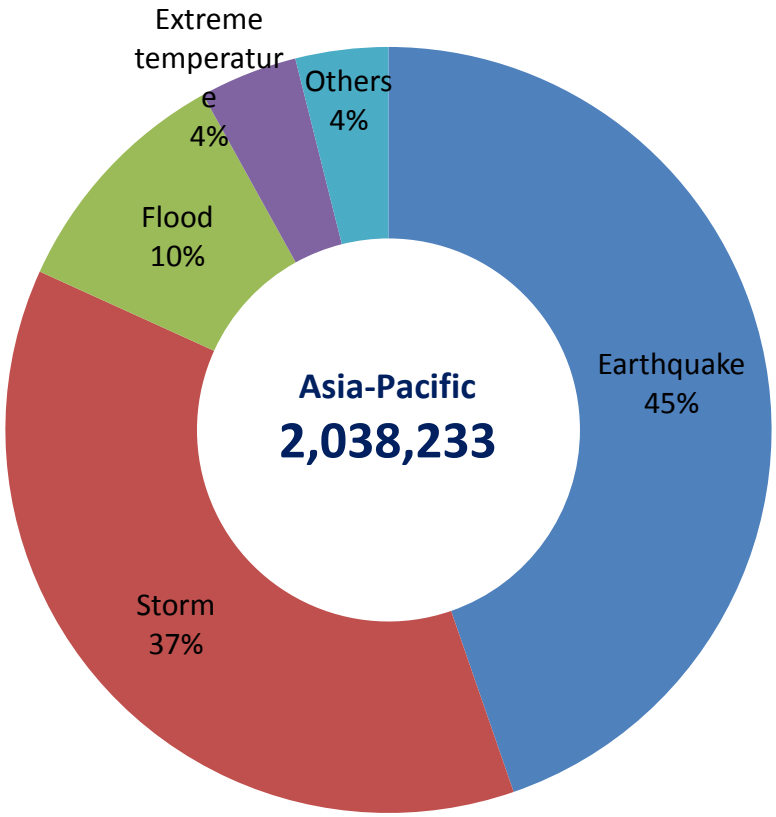
Disaster Risk is outpacing Disaster Resilience in Asia and the Pacific

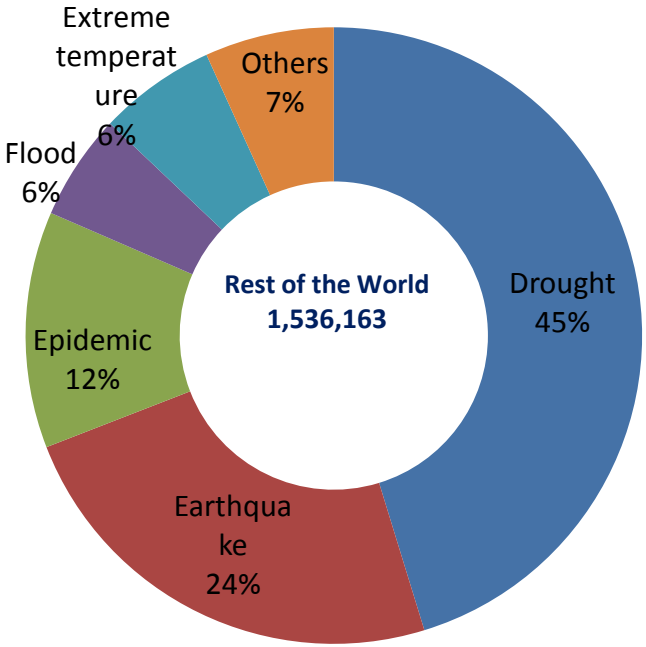
Economic damage from natural disasters, as percentage of GDP



Source: ESCAP based on damage data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://emdat.be/ (Accessed on 14 February 2017), and GDP data from ESCAP online statistical database. Available from http://www.unescap.org/stat/data

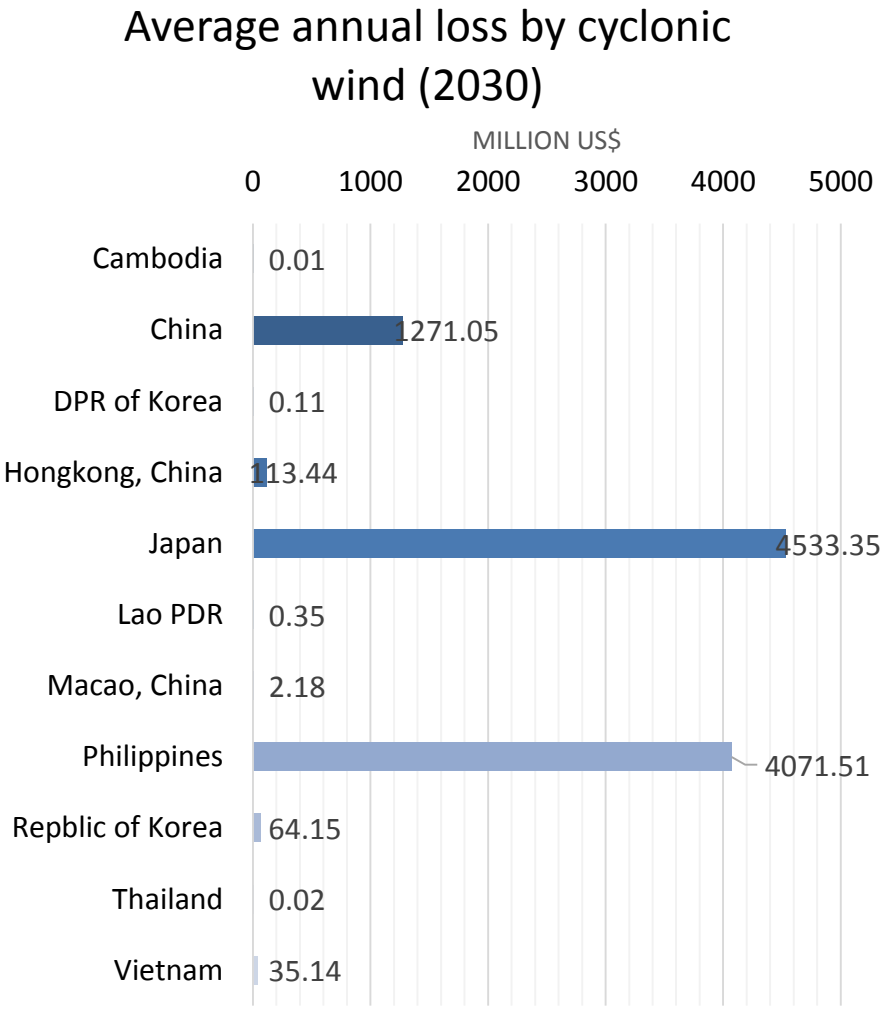
Asia and the Pacific most Affected Region in Fatalities from Natural Disasters since 1970

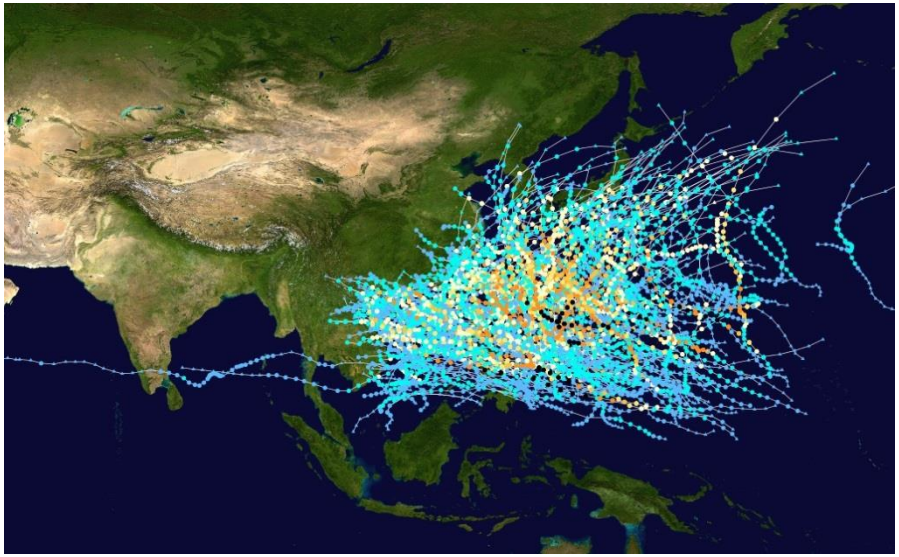




Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://emdat.be/ (Accessed on 14 February 2017)

Typhoons in Western North Pacific Ocean and South China Sea



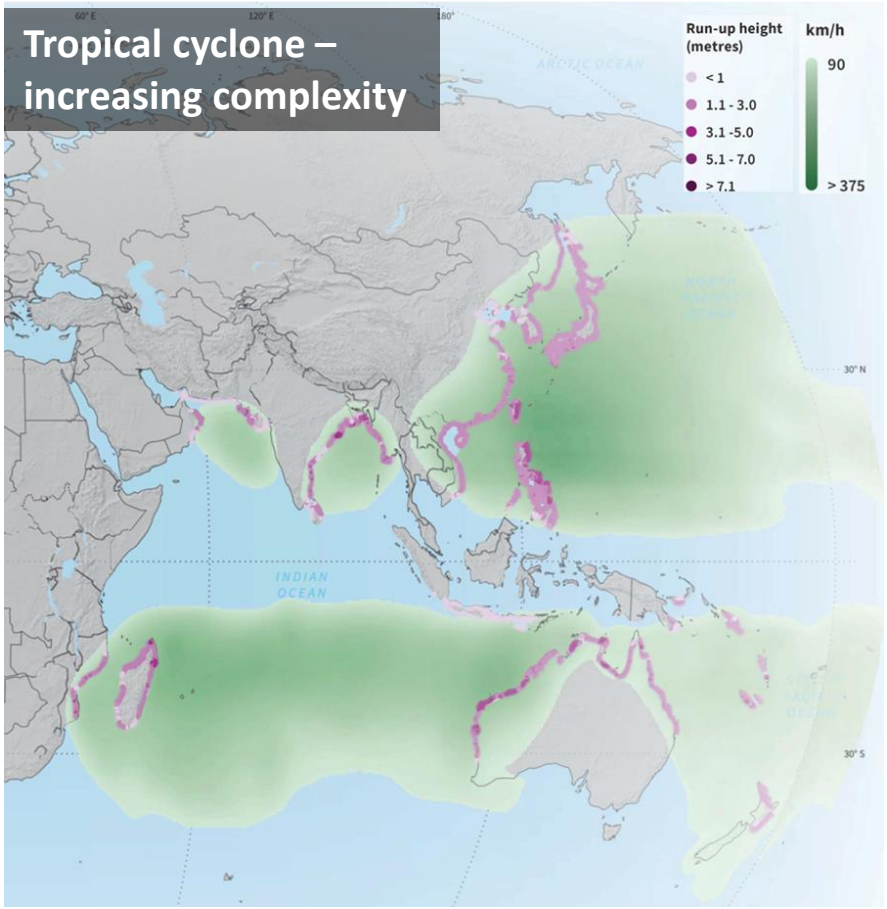


- 23 tropical cyclones in the Western North Pacific Ocean
- Long term average at 31 tropical cyclones per year
- However, 7 out of 23 are super typhoon intensity

Source: GAR 2015 – Data Platform

Shifting geography of typhoon risk

- Tropical cyclones will have
  - **Shorter return periods**
  - **Increasing storm surges**
  - **Increasing wind speeds**
- In the Pacific basin, the **track** of tropical cyclones may shift **eastward or northward**
- Three times increase in the **number of people and economic assets** exposed



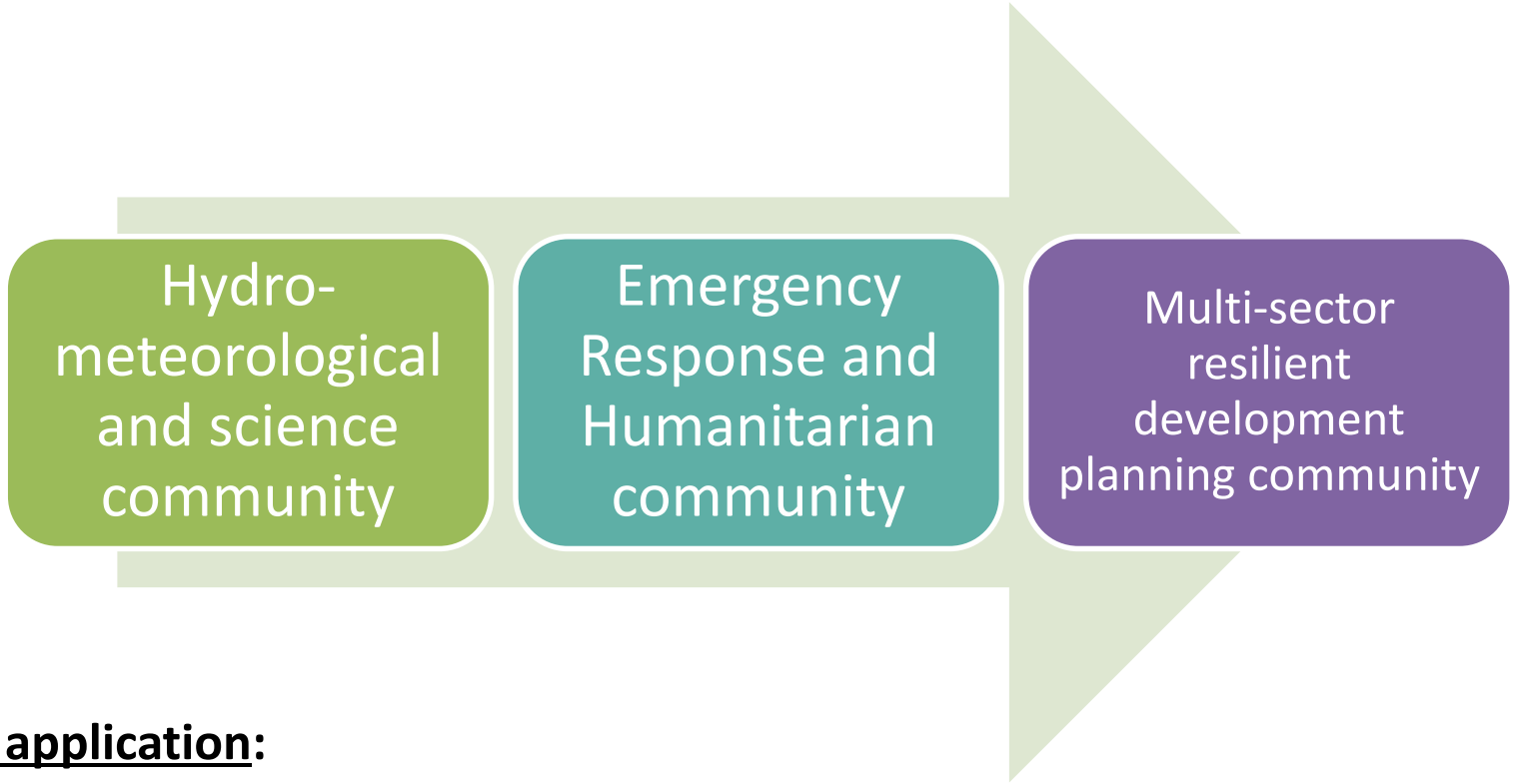
Source: GAR 2015 – Data Platform

Impact-Based Forecasting

Impact based Forecasting
- A Paradigm shift from 'early warning' to 'early action'

Purpose:

Connecting the dots: **Humanitarian to risk-informed development policy response**



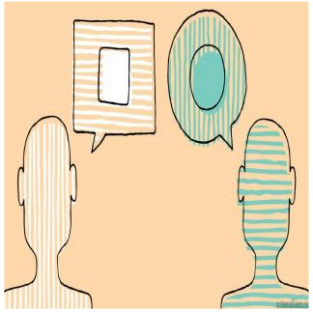
Killer application:

To target the community and assets at increasing risk in a specific location for short term interventions and long term policy responses.

Impact-based Forecasting Requires Joint Forces

Same goal approached differently

Interdisciplinary communication

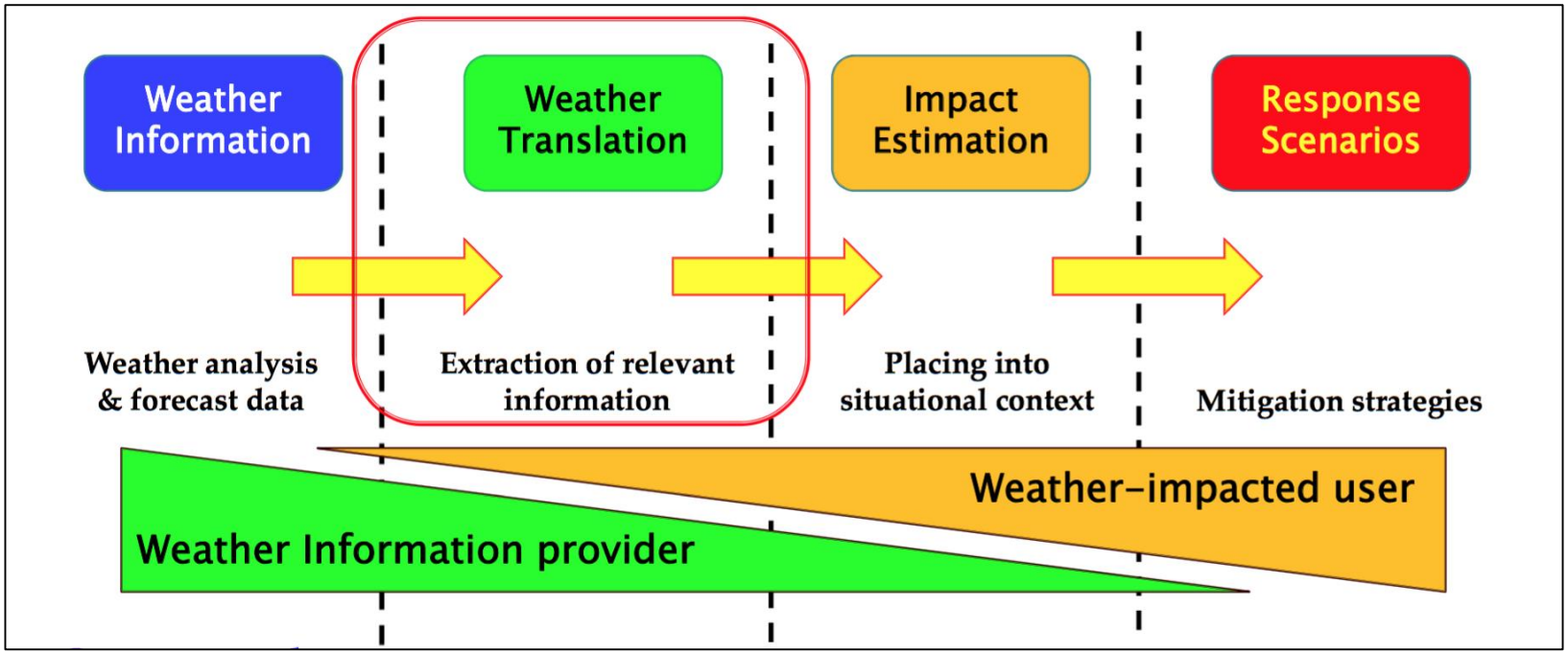


Joint forces across disciplines / sectors / institutions…

How Impact-based Forecasting Works

An illustration on how weather information can be translated to response actions

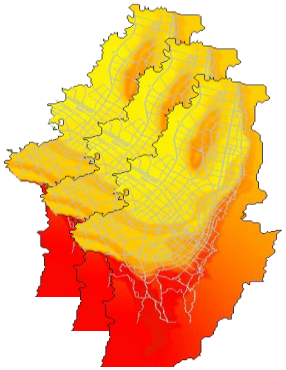
- Relevant information from weather information is extracted and placed into the situation context to produce impact estimations;
- With potential impact information available, response scenarios can be set-up



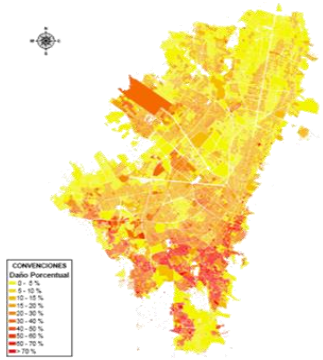
Source: Baode Chen and Xu Tang (2014) Translating weather forecasts into impact-relevant information

Key Essentials for Impact based Forecasting
Translating hazard information into impact scenarios

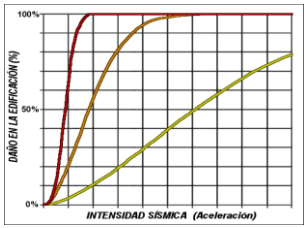
Hazard



Exposure



Vulnerability



Impact/Risk

Value at Risk

Statistical - census and survey data

GIS/Geospatial– Infrastructure, settlements, land use..

Cartographic, Geological, Hydro-meteorological ..
Geospatial Data – Vector and Raster

Source: Modified from Francis Ghesquiere, The Word Bank

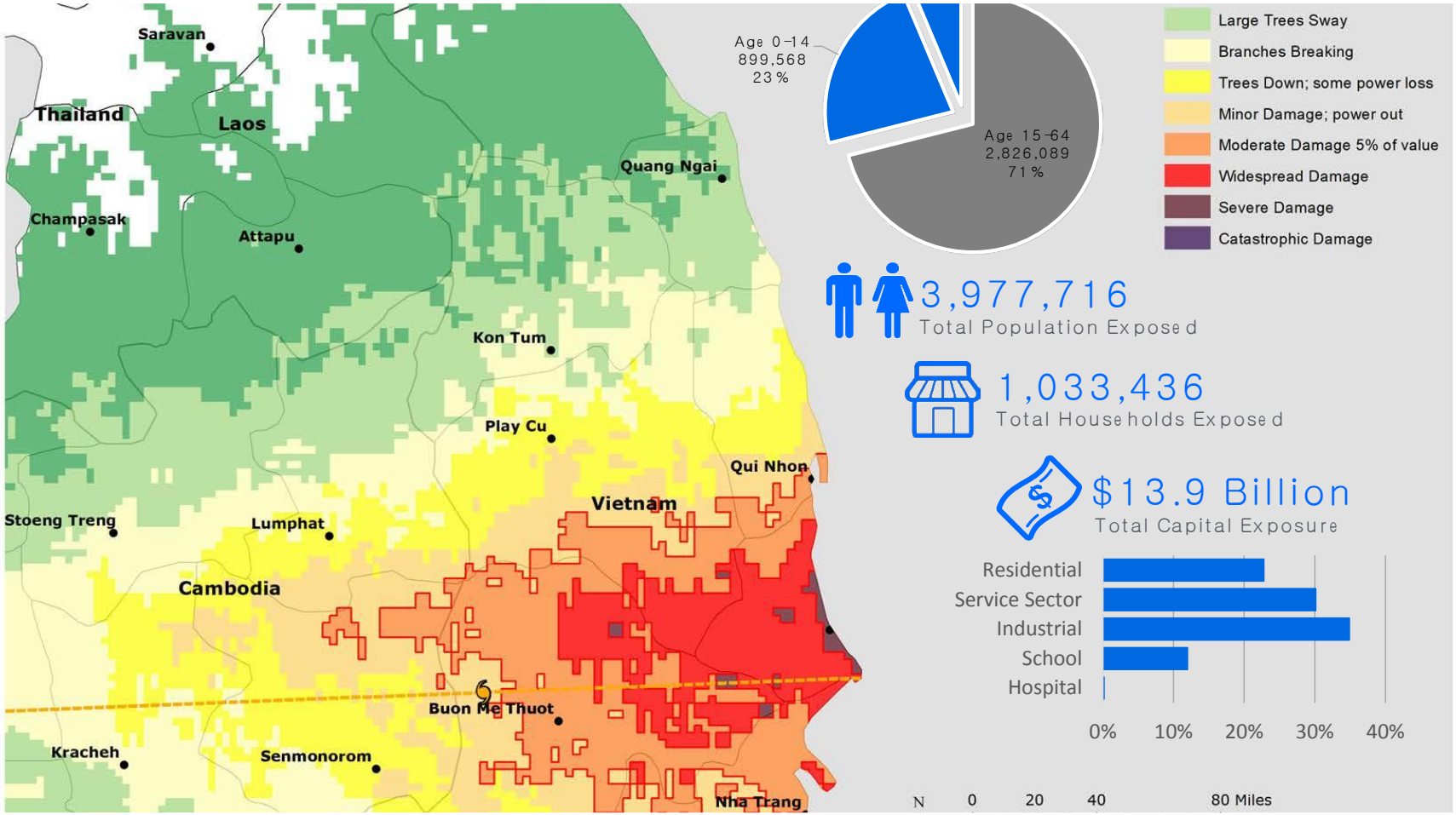
What is required for Impact-based Forecasting?

Greater emphasis on **societies and economies:** Impact-based forecasting shows how natural hazards interact with existing socio-economic conditions

Combine hazard forecasts with **data on risk of people in hazard-exposed** and affected marginal areas	Coordinated, **multi-disciplinary** effort among various government agencies	New investments in **data collection**	**Large-scale computing**: Satellite measurements, ground observation, crowd sourcing, cloud computing, census, and damage and loss databases…	**Regional cooperation** between technically advanced countries and those with low capacities

Examples of existing tools using Impact-based Forecasting

Existing analysis: Typhoon Damrey, Impact Forecasting
3 November 2017

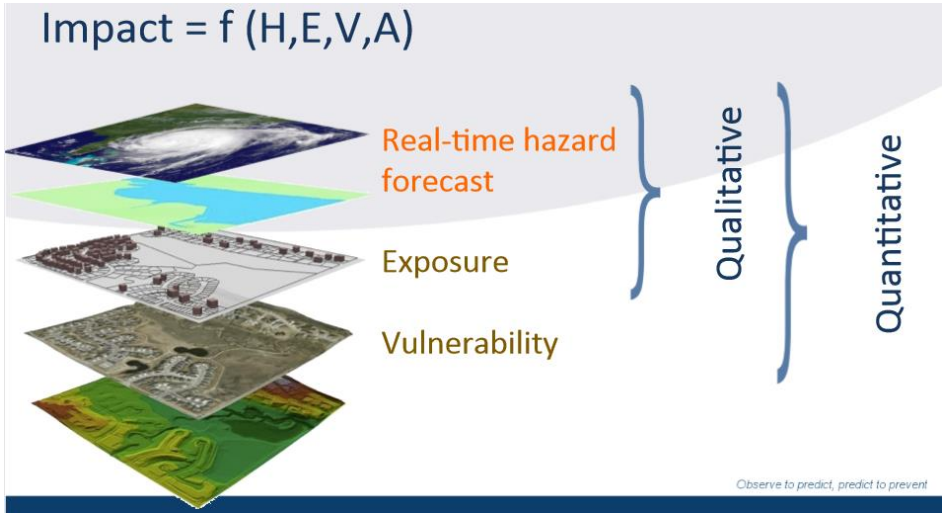


Source: Pacific Disaster Center

The Dewetra platform
Quantitative impact-based multi-model Early Warning System in a multi-hazard perspective

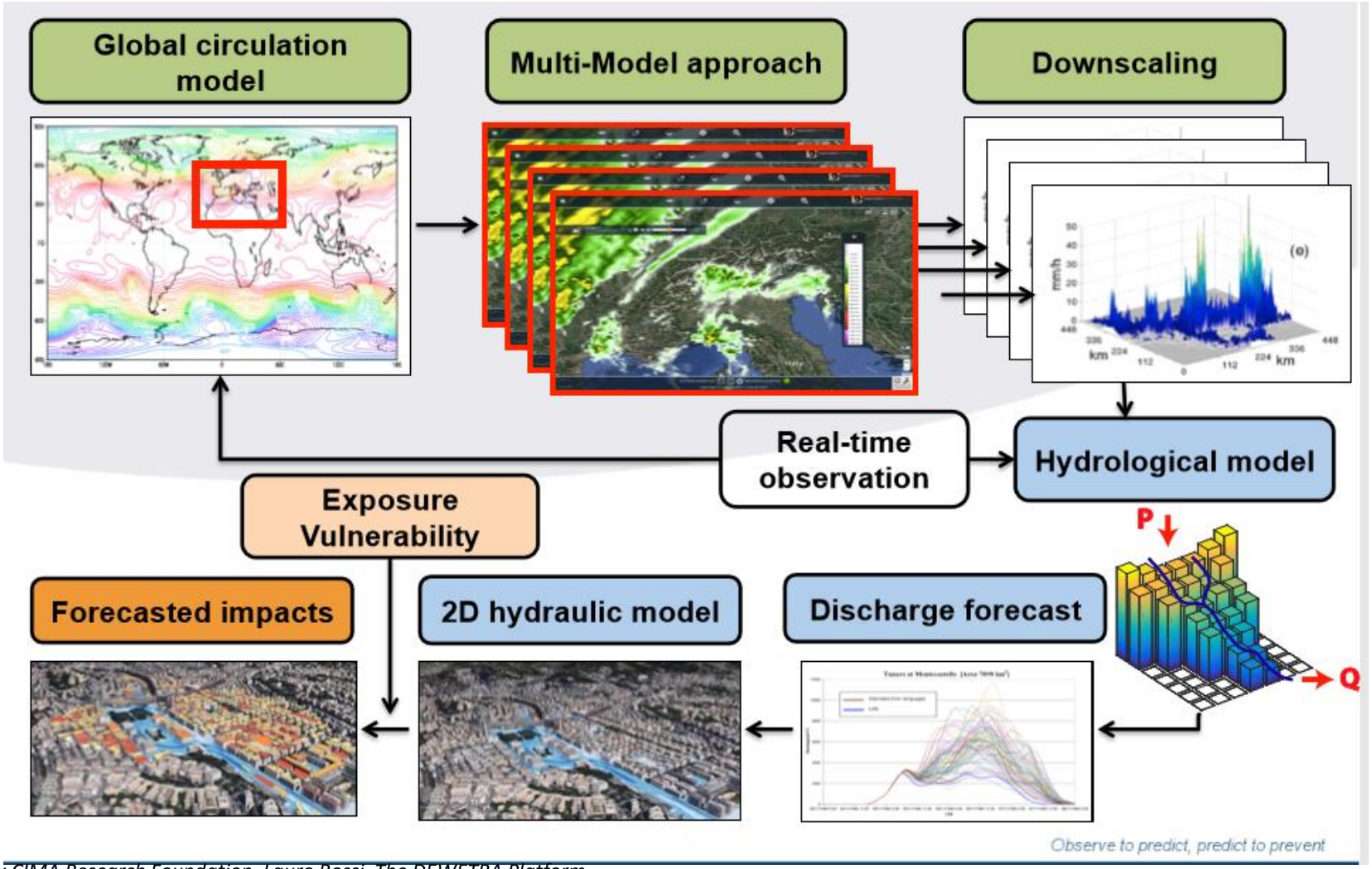
- The Dewetra platform is a **real-time impact scenario builder**, which enables the decision maker to take prevention actions based on impact forecast
- Dewetra is not a mere hazard forecasting tool, but also integrates information on vulnerability and exposure

Forecasters ⟷ **Decision makers**



Source: CIMA Research Foundation, Lauro Rossi, The DEWETRA Platform

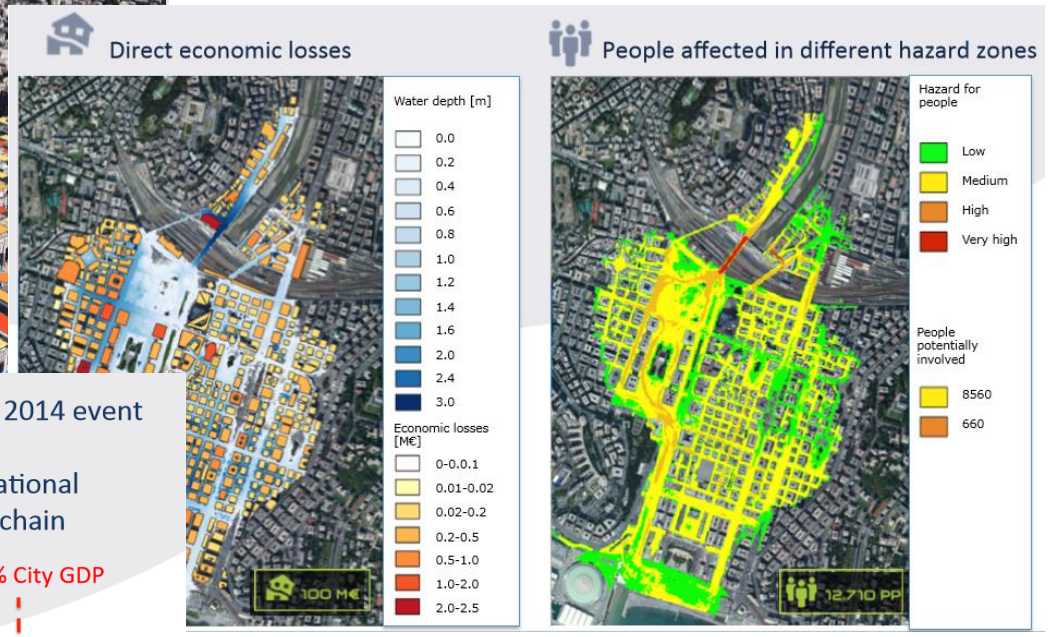
Impact-based Flood Forecasting Chain



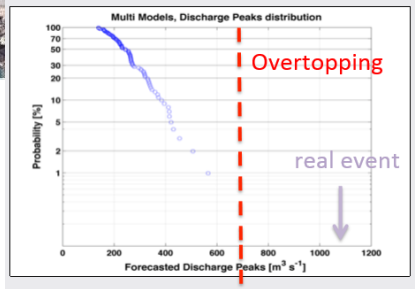
Source: CIMA Research Foundation, Lauro Rossi, The DEWETRA Platform

Implementation in Genoa Urban Area

Qualitative



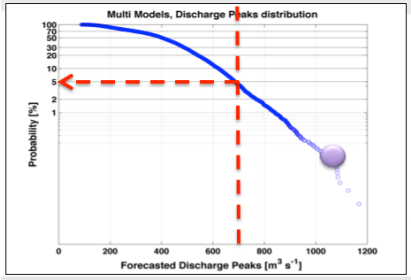
Quantitative

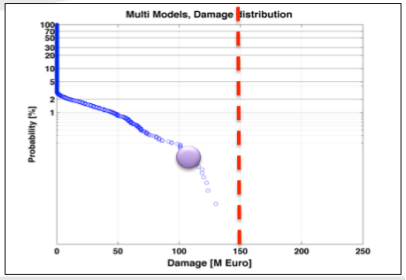


Genoa, 9 October 2014 event

present operational forecasting chain

0.6% City GDP



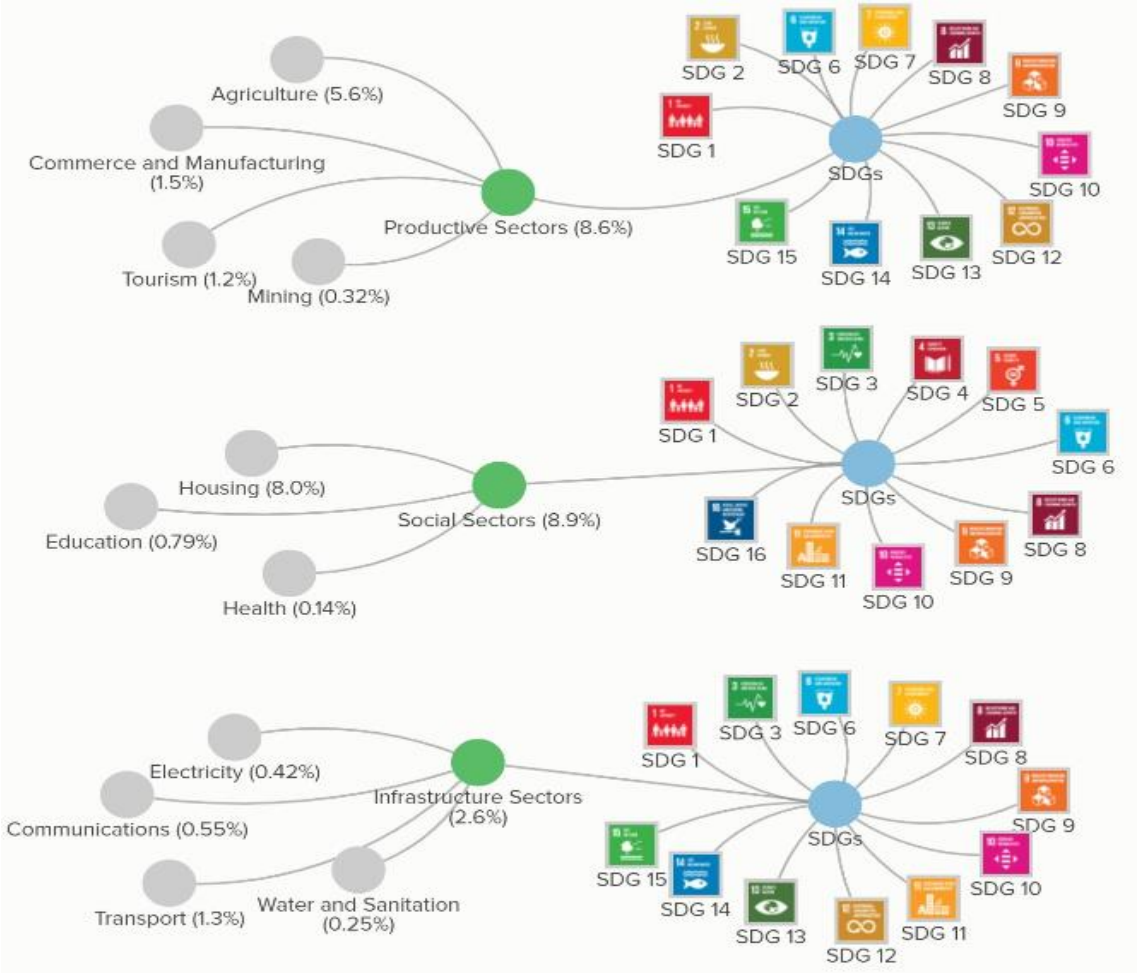


Source: CIMA Research Foundation, Lauro Rossi, The DEWETRA Platform

Impact on Sustainable Development Goals

Source: Ocean Accounting for Disaster Resilience in the Pacific SIDS, ESCAP

The impact of Cyclone Winston (Fiji, 2016) on various sectors and SDGs relevant to oceans

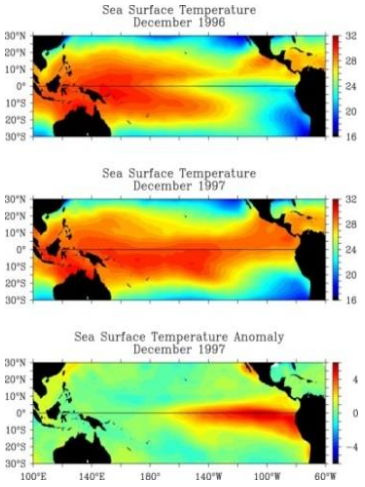


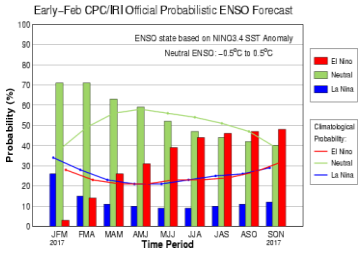
Source: Ocean Accounting for Disaster Resilience in the Pacific SIDS, ESCAP

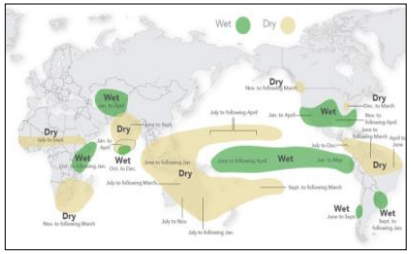
A case study for slow-onset disaster – 2015/2016 El Nino

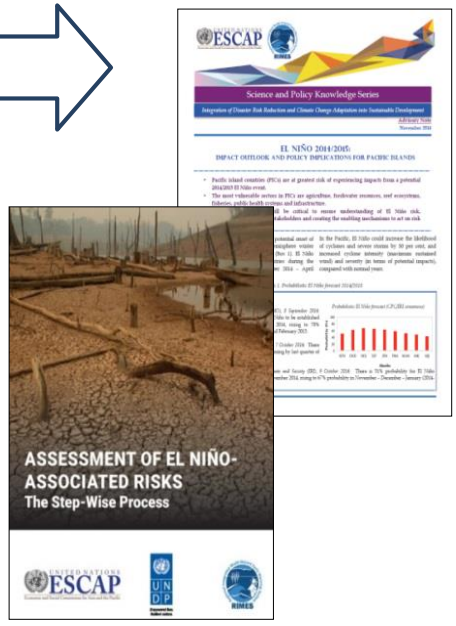
Challenges of Impact based forecasts:
Real time scenarios

Trigger → Probabilistic Forecast → Risk Scenarios → Impact Outlook







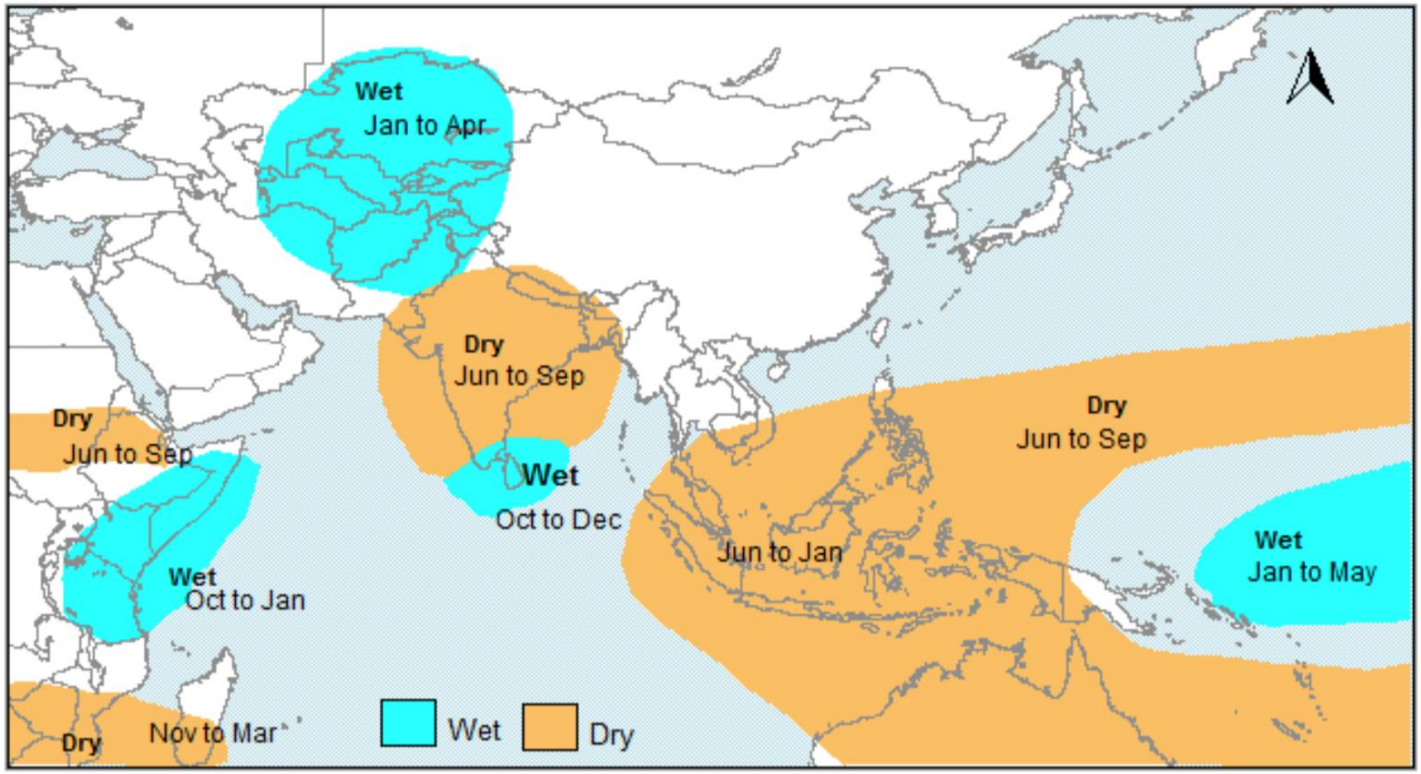


El Niño events can lead to significant impact in the region

In Asia-Pacific, El Niño is associated with irregular rainfall and extreme weather:

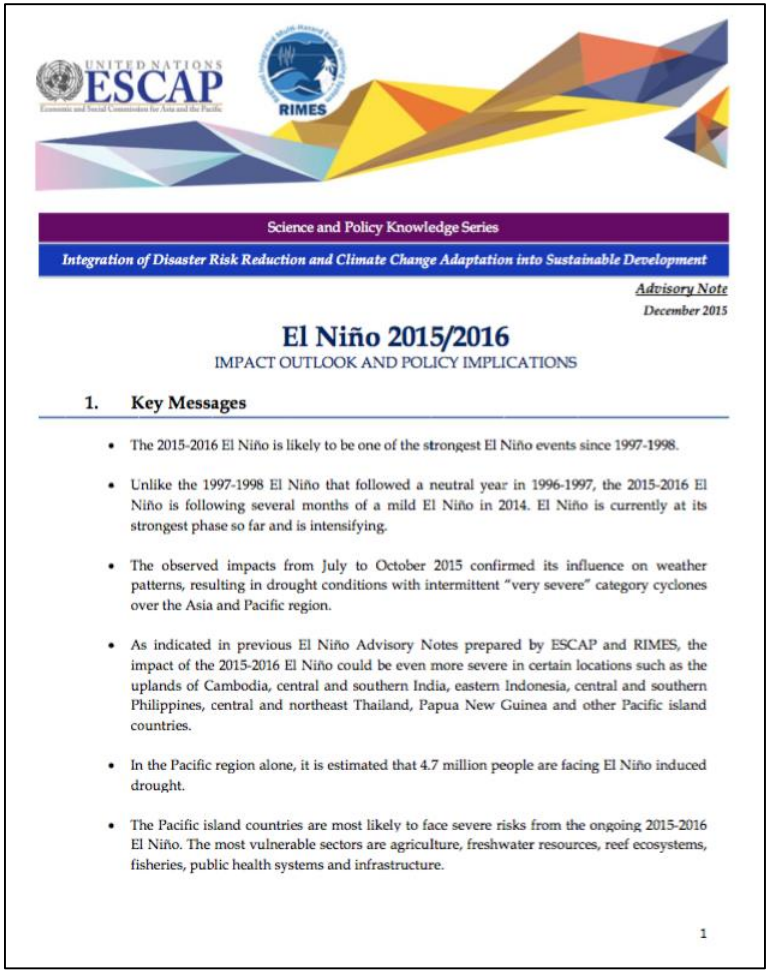
- In El Niño years, countries affected tend to experience decreases in wet season rainfall
- El Niño also leads to rises in sea levels and more intense tropical cyclones

El Niño historical impacts on rainfall, tropical cyclone frequency, and sea level



El Niño have significant impacts on industries

- **Agriculture**
  - Drought conditions can cause failures of staple food crops and force people to rely on bush crops or aid.
- **Fisheries**
  - El Niño can has led to changes in marine habitat and this can lead to falls in productivity.
- **Infrastructure**
  - More intense cyclones and sea level rise can lead to damage to vulnerable infrastructure
- **Public Health**
  - Warmer climate facilitates virus growth and mosquito-borne diseases, most notably dengue and malaria
- **Ecosystems**
  - Increased sea surface temperatures threatens coral colonies and local people's livelihoods



UNITED NATIONS ESCAP
RIMES

Science and Policy Knowledge Series

Integration of Disaster Risk Reduction and Climate Change Adaptation into Sustainable Development

Advisory Note
December 2015

El Niño 2015/2016
IMPACT OUTLOOK AND POLICY IMPLICATIONS

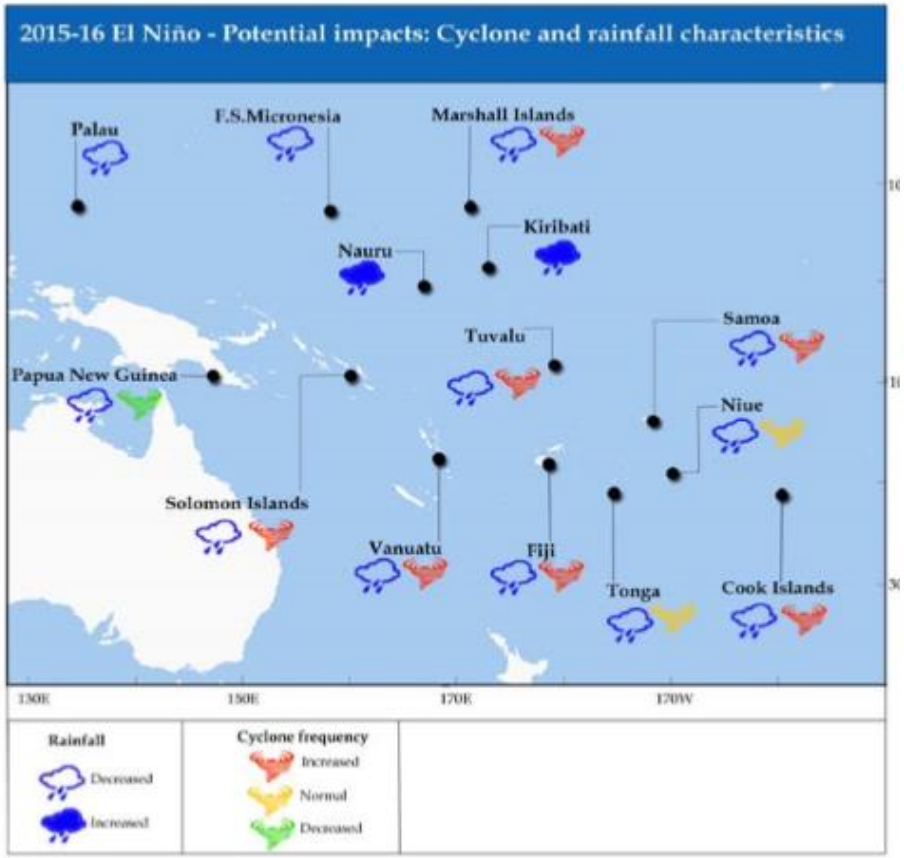
1. Key Messages

- The 2015-2016 El Niño is likely to be one of the strongest El Niño events since 1997-1998.
- Unlike the 1997-1998 El Niño that followed a neutral year in 1996-1997, the 2015-2016 El Niño is following several months of a mild El Niño in 2014. El Niño is currently at its strongest phase so far and is intensifying.
- The observed impacts from July to October 2015 confirmed its influence on weather patterns, resulting in drought conditions with intermittent "very severe" category cyclones over the Asia and Pacific region.
- As indicated in previous El Niño Advisory Notes prepared by ESCAP and RIMES, the impact of the 2015-2016 El Niño could be even more severe in certain locations such as the uplands of Cambodia, central and southern India, eastern Indonesia, central and southern Philippines, central and northeast Thailand, Papua New Guinea and other Pacific island countries.
- In the Pacific region alone, it is estimated that 4.7 million people are facing El Niño induced drought.
- The Pacific island countries are most likely to face severe risks from the ongoing 2015-2016 El Niño. The most vulnerable sectors are agriculture, freshwater resources, reef ecosystems, fisheries, public health systems and infrastructure.

1

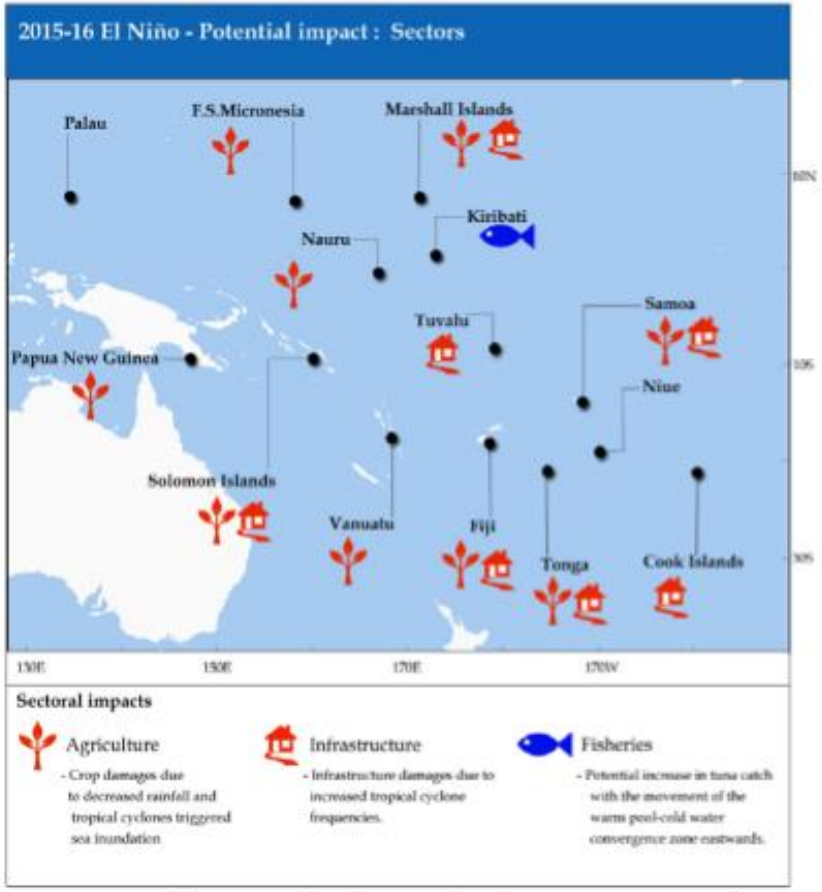
2015-16 El Nino Potential Impacts

Cyclone and Rainfall Characteristics



Source: Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, 2015.

Sector-wise impacts



Source: Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, 2015.

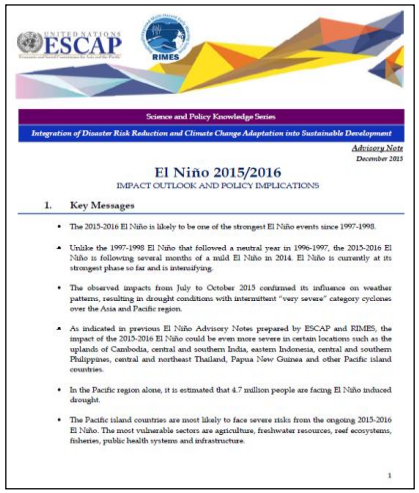
ESCAP's Approach on Slow-Onset Disasters using Impact Based-Forecasting

- **Slow-onset disasters**, having longer lead time to respond, are information and knowledge intensive
- The mitigation strategies therefore need to be driven by **scientific knowledge of the risk**

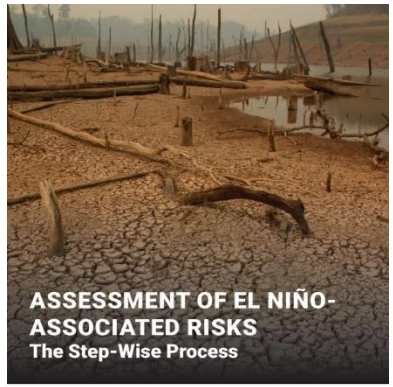
- ESCAP, jointly with RIMES and UNDP, develops a series of **knowledge products** and context-specific **capacity development training** to countries at risk of slow-onset disasters
- The response to **2015/2016 El Nino** started with a **regional Impact Outlook** on the country-specific impact scenarios and a **operational guidebook** on the assessment of El Nino associated risks to support the risk mitigation strategies and fills in the gaps between science and the policies.

Asia-Pacific Impact Outlook

Pacific Impact Scenarios



Risk mitigation strategies



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UNDP
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Work in Progress – ESCAP Tool to Support Impact Based Forecasting:

Asia-Pacific Disaster Risk Atlas

ESCAP | APDIM
Asian and Pacific Centre for the Development of Disaster Information Management

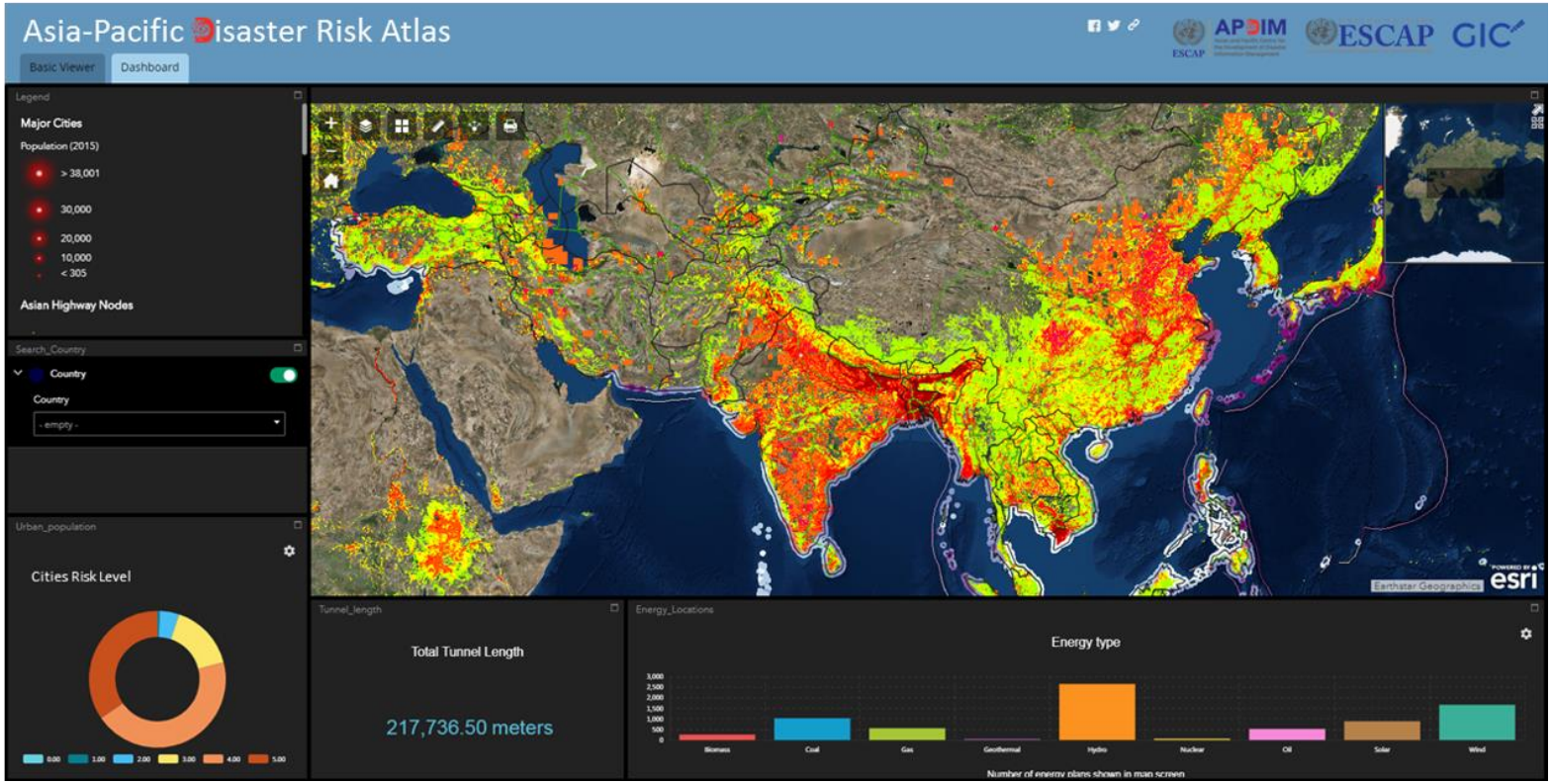
The Asian and Pacific Centre for the Development of Disaster Information Management (APDIM)

Based on ESCAP Resolutions 67/4 and 71/11, the Asian and Pacific Centre for the Development of Disaster Information Management (APDIM) was established in Tehran, Islamic Republic of Iran as a regional institution of the Commission, which contributes to the ESCAP programme of work in the area of information and communications technology and disaster risk reduction.

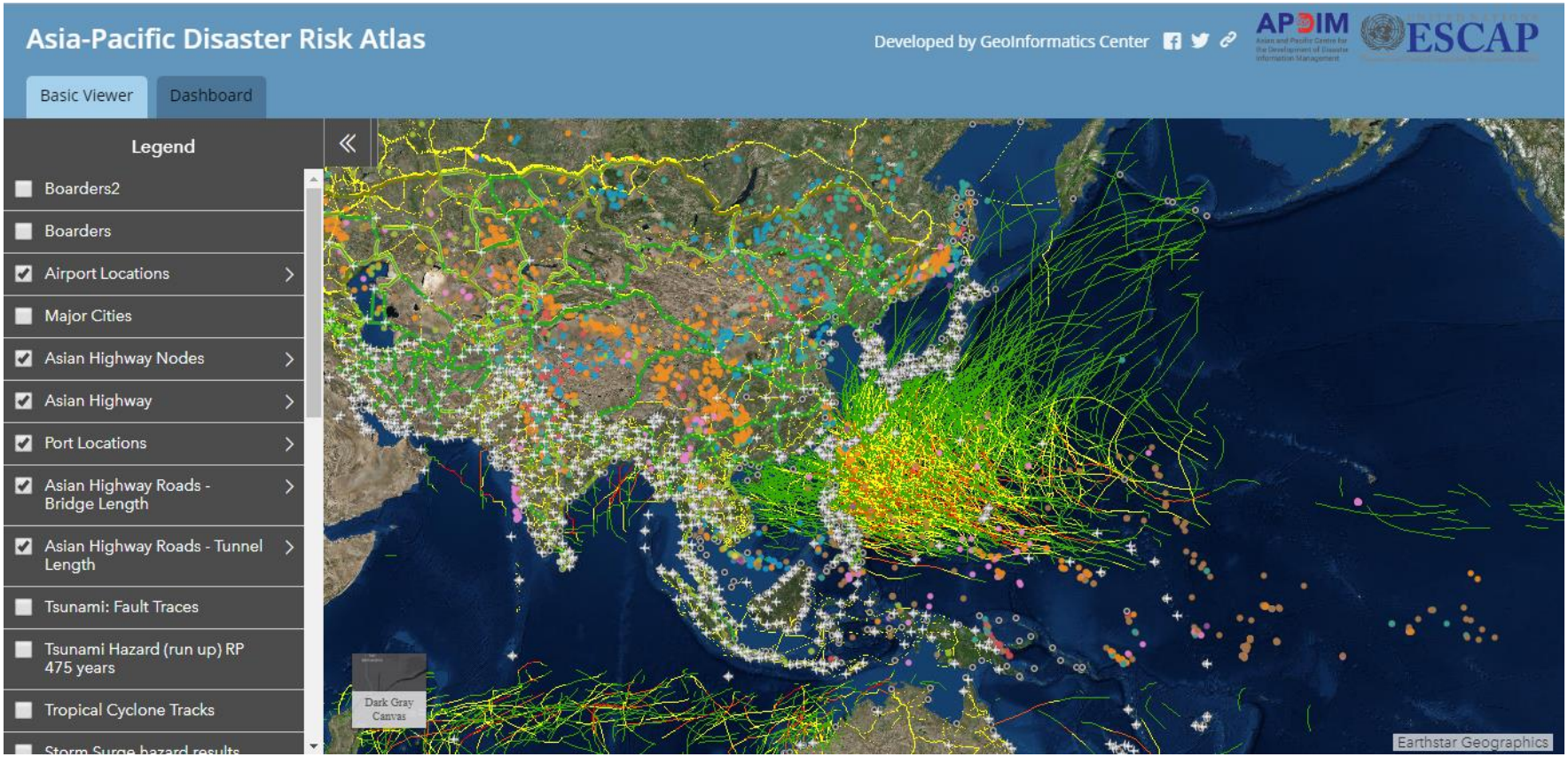
Information and knowledge management	Capacity development	Regional information services for cross-border disasters
Regional repository of databases, information and knowledge	Regional capacity development hub for exchange of expertise, experiences and knowledge	Specialized services (geospatial & statistical) for cross-border disasters
Regional hub of new tools, techniques and standards for information management	To provide demand driven and customized training services to address the information and knowledge gaps	Regional information (maps & databases) for cross-border disasters

Asia-Pacific Disaster Risk Atlas

- APDIM will soon release the Asia Pacific Disaster Risk Atlas (the Atlas)
- The Atlas is an online tool containing geospatial datasets relating to natural hazards and exposure of energy, telecommunications, and transport infrastructure
- Users can view layers on a base map to determine how exposure varies throughout the region
- Basic analysis of the selected data is available through the dashboard

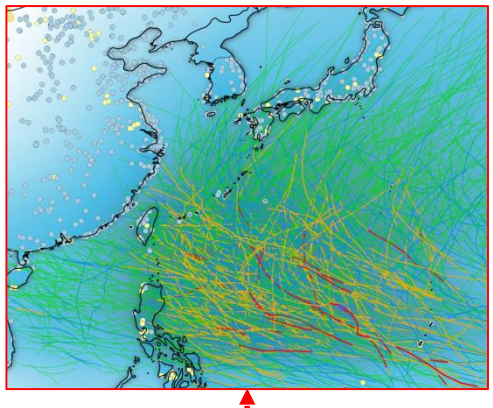


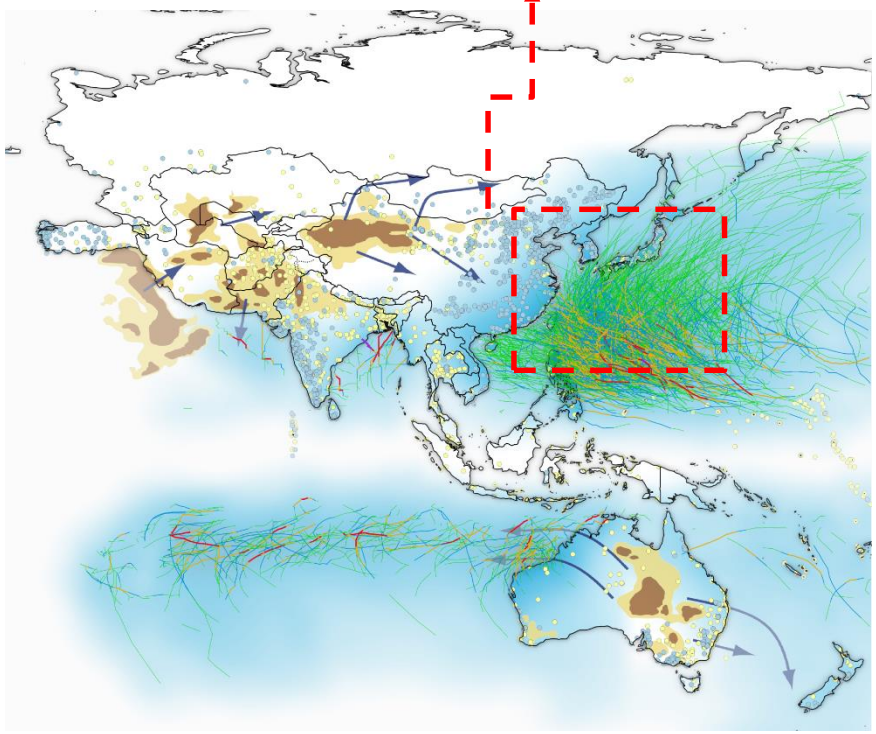
Preview of the Atlas website



Energy Infrastructure Exposure

- Map of cyclone tracks, solar and wind power plants
- Cyclone track data from GAR Atlas https://www.unisdr.org/files/53086_garatlaslr2.pdf
- Power plant data from Asia Pacific Energy Portal, ESCAP https://asiapacificenergy.org/





Wind

Solar

Cyclonic wind RT 100 years

Tropical cyclone tracks

1

2

3

4

5

Transport Infrastructure Exposure

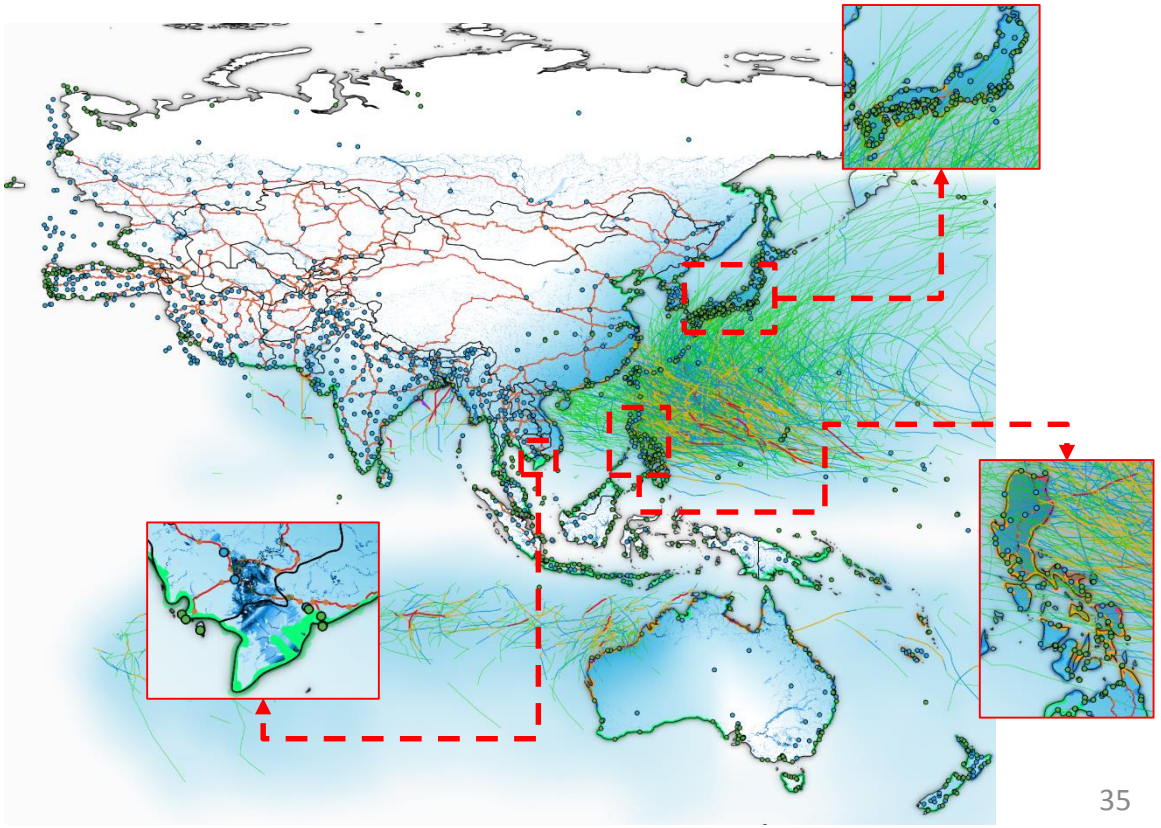
- Map of cyclone tracks and Asian highway roads, ports and airports
- ESCAP Network Analysis of Asian Highway roads https://www.unescap.org/our-work/transport/asian-highway/database
- ARC GIS World Port Index https://www.arcgis.com/home/item.html?id=1aeb61a734f04a55a33e5589931ad760#overview
- Global Airport Database http://www.partow.net/miscellaneous/airportdatabase/

Asian highway node

Asian highway roads

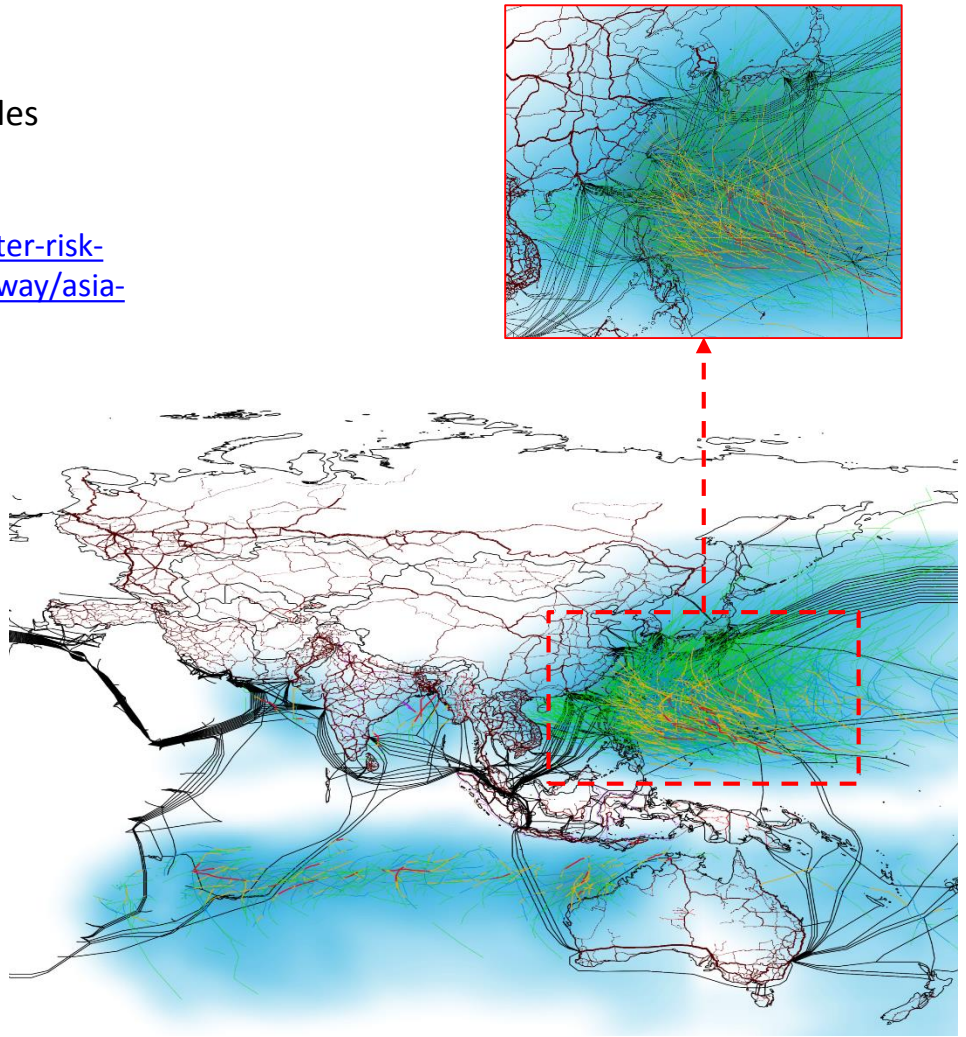
Port

Airport



ICT Infrastructure Exposure

- Map of cyclone tracks and fibre optic cables
- Data from ESCAP and ITU (International Telecommunication Union) https://www.unescap.org/our-work/ict-disaster-risk-reduction/asia-pacific-information-superhighway/asia-pacific-information-superhighway-maps



Many Investment Decisions have Long-Term Consequences and Face Deep Uncertainty

- Infrastructure shapes development for decades or centuries, a duration that often extends beyond the lifetime of infrastructure because the economic system reorganizes itself around them.
- The possibility of rather radical changes in the environmental conditions under which infrastructure performs cannot be ruled out and its design needs to take climate change possibility into account.
- Sectors which decisions should already take into account climate change are:

Sector (examples)	Time Scale	Exposure
Water infrastructure (e.g. dams, reservoirs)	30-200 years	+++
Land-use planning (e.g. flood plain, coastal areas)	> 100 years	+++
Coastal and flood defenses (e.g. dikes, sea walls)	> 50 years	+++
Building and housing (e.g. insulation, windows)	30-150 years	++
Transportation infrastructure (e.g. port. Bridges)	30-200 years	+
Urbanism (e.g. urban density, parks)	> 100 years	+
Energy production (e.g. nuclear plant cooling system)	20-70 years	+

Example for Hydropower Infrastructure Investment Decision-Making under Deep Uncertainty

Example case: Decision-making under deep uncertainty of an investment of USD 100 million for a hydropower infrastructure investment

Guiding question 1: What does the **current situation** looks like?

Guiding question 2: What does the **projection of the future situation** looks like?

Guiding question 3: What is the **current location of infrastructure**?

Guiding question 4: What should be done that hydropower investment **ensures climate resilience**?

- Investment should consider difference of exposure to climate change in the present and future
- Prioritization of investment areas based on the current and future exposure data
- Consideration of timing, location and allocation of investment in the target area due to deep uncertainty requiring continuous monitoring of the deep uncertainty evolution
- Trade off between maintenance of existing hydropower plants or whether to invest in new hydropower plant in a location less prone to hazard exposure

Understanding the decision making process helps to understand what data is required & in communicating which data can be provided

Examples of Applying "Decision-Making Under Deep Uncertainty"

- **Lima's** water supply master plan and identification of necessary investments
- **Nepal's** prioritization of hydropower investments in the Koshi Basin
- **Peru's** prioritization of investments to reduce road networks vulnerable to natural disasters
- **Sri Lanka's** prevention of urban wetlands in Colombo in varying conditions in the housing market and climate change
- Investment decision making in **Mexico** and **Lima's** water sector, **Mozambique**'s rural roads, **Tanzania's** transport sector

How does the Atlas Feed into the Application of "Decision-Making Under Deep Uncertainties"?

Application of "Decision-Making Under Deep Uncertainties":	The use of the Atlas:
The use of downscaling techniques improves the ability to reproduce the current climate environment	The Atlas captures regional, sub-regional and even local **data on the current climate**
Downscaling makes it possible to represent the future climate on a more relevant and detailed level for policymakers	The Atlas contains **projection of climate patterns** on the regional, subregional and local level
Analysis under deep uncertainties typically utilizes specialized local knowledge through stakeholder involvement to build a cloud of possible vulnerabilities. Uncertainty reduces with local expertise creation and R&D	The Atlas helps to identify **hotspots** and the need for local expertise centers and R&D
Models need to be combined with expert judgment due to limited skill in predicting climate probabilities	The Atlas provides an idea where information is lacking and where export knowledge is needed to **close data gaps**
Deep uncertainties are reduced through incorporation of new information while the decision-making process	• The Atlas helps **supports "information creation"** plans by visualizing where data and information is most needed • The Atlas is dynamic and can incorporate new data and information. This allows visualization of the latest available data

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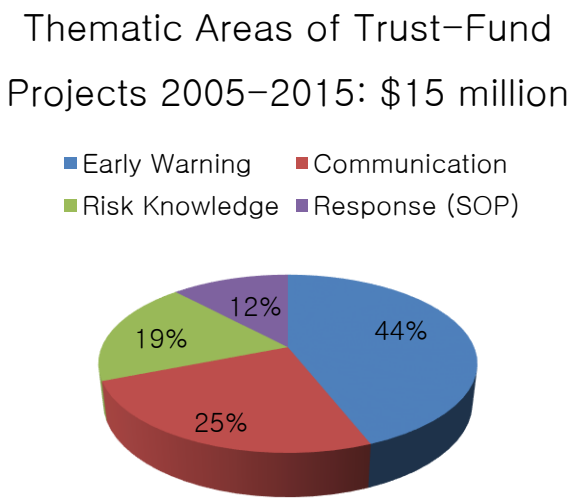
ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness

Regional Cooperation for Multi-hazard Early Warning System



ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness

Key benefits

- Put in place a regional architecture of multi-hazard early warning to support low capacity, high risk countries through establishment of the Regional Integrated Multi-hazard Early Warning System (RIMES)
- Contributed to the Indian Ocean Tsunami Warning and Mitigation System in partnership with UNESCO-IOC, Australia, India and Indonesia
- Built institutional capacity of more than 20 member States
- Partners include -

ISDR OCHA UNDP UNESCO UNEP WMO

Main achievements

Established Seismic and Sea Level Stations in the Asia-Pacific region

- Built seismic and sea level stations producing real-time seismic data
- Integrated remote broadband seismic stations in Myanmar
- Contributed the establishment of the Indian Ocean Tsunami Warning and Mitigation System

(Lubang Tsunami Early Warning Station)

Built capacities at all levels, from decision makers to end users

- Established the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)
- Established and institutionalised multi-stakeholder multi-hazard EWS national Monsoon Forums
- Raised awareness and conducted drills on tsunami and costal hazards in Pakistan

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ESCAP Publication: Asia-Pacific Disaster Report (APDR)

- APDR is a **biennial publication** of the ICT and Disaster Risk Reduction Division ESCAP
- The reports aim to deepen understanding of **disaster risks and their implications** on sustainable development in the Asia-Pacific region
- The reports offer **innovative policy options and tools** to meet the challenges that the region faces from natural hazards
- Aimed at **policymakers, practitioners, experts, academia, business, international agencies and non-governmental organizations** working or interested in these issues in the Asia-Pacific region