Capacity Enhancement for Sustainability - Status of Regional Collaborations On Disaster Mitigation

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Academia Sinica Grid Computing Centre (ASGC), Taiwan
On behalf of DMCC, UND and DMWG

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Disaster Risks Reduction Is Fundamental to Sustainability of the Humanity and Earth

- Common vision: sustainability of the humanity and the Earth
- Goal: Enhance capability of hazard risk analysis
- Challenges: limited knowledge is the primary barrier
  - Natural hazard is a complex system and many disastrous events are caused by compound hazards
  - Large natural variability and short of consistent observation data
  - Only limited knowledge on drivers and root causes of disaster events
  - Hardly to do experiments to understand the processes of a hazard on the similar scale
  - Not enough event cases for study
  - Difficult to transform knowledge into simulation facility and share

Data source: statistics of UNDRR (GAP Report 2019) from 2005 to 2017

Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)
Building Hazard Risk Analysis Capacity by Deeper Understanding Approach

- Deeper understanding approach: Quantify risks and Reduce (Vulnerability x Exposure x Hazards) by evolved knowledge of physical processes behind the disaster events, as well as by improved numerical simulations.
- Improving accuracy and efficiency of numerical simulations according to the knowledge of root cause and drivers of target hazards.
- Deeper qualitative understandings such as possible weather and disaster patterns are crucial to develop strategies against natural hazards.

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**Speeches**

- Prof. CY Lin, Prof. TR Wu (10:30am, 25 March)
- Prof. JN Liew (9am, 26 March)
- Prof. V Tanpipat (9:45am, 26 March) and partner reports

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**Diagram:**

1. **Case Study Selection**
   - Geology, Bathymetry and Event Background Information

2. **Observation Data**

3. **Physical mechanism Identification & Advancement of domain knowledge**

4. **Numerical Simulation & Modeling**
   - Accuracy & Efficiency Improvement
   - Better Predictive Capability

5. **Analysis Methodology and Computing Tech**

6. **Enhancement of Simulation Portal, Science Gateway and API**

7. **Applications (Output)**
   - Risk Analysis, Early Warning, Hazard Management, Coastal Area Planning and Protection, Education, etc.
Case Study by Deeper Understanding Approach
Realize Best Practices for Capacity Building

• 18 case studies of 6 types of hazards in 8 partner country had been Conducted
  • Tsunami, Typhoon & Storm surge, Dust transportation of biomass burning, Flood, Fire/Haze/Smoke monitoring, Lightning

• Values of Case Study commented by Prof. JN Liew (UKM, MY)
  • Case studies are important in meteorology
  • Assist in future field programs and numerical experiments design
  • Contribute to meta-analysis

• Deeper understanding approach:
  • Translate evolving scientific advancement into accurate numerical simulations
  • Understanding the trends of changes of hazard impacts
  • Develop risk analysis and mitigation capability
  • Buildup flexible/dynamic collaboration models of all parties
  • Integrate analysis pipeline and improve the distributed infrastructure

• More case studies of various types of hazards in different countries and more new partners as well as more engaged local user communities are happening

• More data/analysis methods/simulation engine/knowledge resulted from case studies will be shared
Collaborations Framework

- **e-Science for the Masses**: developing e-Science for hazard risk analysis with EGEE and EUAsiaGrid projects from 2008
  - APAN DMWG was approved and operational from 2014
  - DMCC was supported by EGI-Engage, EOSC-Hub and EGI-ACE from 2015
  - Environmental Computing Workshop in ISGC started from 2016
  - UND (deeper Understanding of Natural Disaster) funded by Asi@Connect during July 2018 - April 2021
  - Supporting Sentinel Asia disaster management cloud services together with NSPO and JAXA

- **Approaches**:
  - Case study oriented, deeper-understanding approach based, numerical simulation and ML enabled
  - DMCC/DMWG serves as a collaboration framework for Asia partners on disaster management and broader scope
  - Actively engages user communities, domain experts and e-Infrastructure/ICT/Application Support specialists working in concert
  - Case study could be reproduced online and all materials (data, tools, knowledge, etc) of a case study are open accessible

- **Activities**:
  - 2 meetings/workshops a year in every APAN meeting
  - Joint workshop with Environmental Computing Group at ISGC (annual event usually held in Spring)
  - Event: meeting, training, workshop, masterclass (ID, SG and NZ)
  - 5 events, including 2 trainings (@MM, BD) and 1 Workshop were held in 2019 with support of Asi@Connect funding during 2018 - Jan. 2020
<table>
<thead>
<tr>
<th>Disaster Type</th>
<th>Target Event</th>
<th>Partners</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsunami (TW)</td>
<td>Indian Ocean Tsunami (2004)</td>
<td>ID, TW</td>
<td>Finished</td>
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<td></td>
<td>Tohoku Earthquake &amp; Tsunami (2011)</td>
<td>TW</td>
<td>Finished</td>
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<td></td>
<td>Sulawesi (2018)</td>
<td>ID, TH, TW</td>
<td>Finished (based on current data)</td>
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<td></td>
<td>Early Warning System of Indian Ocean</td>
<td>ID, TH, BD, TW</td>
<td>Ongoing</td>
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<tr>
<td>Typhoon &amp; Storm Surge (TW)</td>
<td>Haiyan (2013)</td>
<td>PH, TW</td>
<td>Finished</td>
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<tr>
<td></td>
<td>Soudelor (2015)</td>
<td>TW</td>
<td>Finished</td>
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<tr>
<td></td>
<td>Pabuk (2019)</td>
<td>TH, TW</td>
<td>Finished</td>
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<tr>
<td></td>
<td>Typhoon Usman (2018)</td>
<td>PH (ASTI and PAGASA)</td>
<td>Depends on status of data collection</td>
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<tr>
<td>Dust Transportation (Biomass Burning) (TW)</td>
<td>Tohoku Earthquake &amp; Tsunami (2011)</td>
<td>TW</td>
<td>Finished</td>
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<td>IndoChina (2018)</td>
<td>TH, ID, TW</td>
<td>Finished</td>
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<td>Flood (MY, TW)</td>
<td>Flash Flood Taipei, Taiwan (2015)</td>
<td>TW</td>
<td>Finished</td>
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<td></td>
<td>Sri Lanka (2016)</td>
<td>TW</td>
<td>Finished</td>
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<tr>
<td></td>
<td>Malaysia (2018)</td>
<td>MY</td>
<td>Finished</td>
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<tr>
<td></td>
<td>Myanmar</td>
<td>MM, MY</td>
<td>Depends on status of data collection</td>
</tr>
<tr>
<td></td>
<td>1) Northern Thailand (2017) caused by typhoon Son ca; 2) TH (Nov. 2018)</td>
<td>TH, TW</td>
<td>Starting from the one with better observation data first</td>
</tr>
<tr>
<td></td>
<td>Cases of TH in 2017, 2016 and 2007</td>
<td>TH, ID, TW</td>
<td>Emission data are required (e.g., PM2.5, PM10, CO/CO2, SO2, NOx, O Zone, etc.)</td>
</tr>
<tr>
<td>Simulation Portal, Platform &amp; Infrastructure (TW)</td>
<td>Development, Integration &amp; Improvement</td>
<td>TW, PH, MY, ...</td>
<td>COMCOT-Surge Portal ongoing</td>
</tr>
<tr>
<td>Lightning (TW)</td>
<td>Bangladesh</td>
<td>BD, TW</td>
<td>Depends on status of data collection</td>
</tr>
</tbody>
</table>
2013 Super Typhoon Haiyan (Yolanda)
Typhoon Life Cycle: November 3rd - 11th

Simulation of impacts from Storm surge caused by super typhoon by combining atmospheric model and oceanic model

maximum simulated storm tides at Leyte Gulf

Improved Vertical Wind Field Structure and Eyewall Contraction for Typhoon Haiyan
South East Asia haze 2015

NASA's Aqua satellite collected this natural-color image with the Moderate Resolution Imaging Spectroradiometer, MODIS, instrument on September 22, 2015.

2018 Sulawesi earthquake and tsunami
M 7.5 - 78km N of Palu, Indonesia
2018/09/28 UTC10:03

Ground movement: A Strike-Slip Fault
“Tracking surface features in satellite imagery, we see up to 7 metres of displacement in opposite directions across the sharp fault surface break.”

Simulation of summer thunderstorm
Composited atmospheric conditions (78 cases)
Summary on Flood Case (4-5 Nov. 2017) in Malaysia

- Conducted by Prof. JN Liew, UKM, MY
- More test cases are needed to understand various extreme rainfall producing mechanism at different part of Malaysia
- Northern part of Peninsular Malaysia and Sabah has experienced increase in interannual variability. In certain area, the interannual variability has doubled.
- Accurate forecast of different time-scales is expected to become more crucial for disaster mitigation purpose.
- Questions of interest which require further analysis:
  - How is the quality of the simulations affected by model resolutions and moisture schemes?
  - How is the local topography influence the rainfall intensity?
  - Where does the system obtain its moisture from?
  - How does the Typhoon Damrey affected the events?
Welcome

iCOMCOT - Tsunami wave propagation simulation portal based on COMCOT model.
iCOMCOT is developed by the collaborations of Tsunami Science Research Laboratory of National Central University and ASGC

https://icomcot.twgrid.org
Climate-Resilient Agriculture for Disaster Risk Reduction (CRADR)

Asi@Connect funded project (Dec. 2020 - April 2021)

Collaborations of partners from AgWG, DMWG and Data Sharing

- **Objectives**
  - To exchange the evaluation of meteorological parameters impact on agricultural production for climate-resilience agriculture
  - To expand the use of STI for climate-smart agriculture by transferring technologies
  - To create resilience and build the capacity of participating countries in relation to meteorological impacts on agricultural production
  - To improve food security, livelihood and disaster resilience at local level

- **Expected Outcomes**
  - Good practices and lesson learn from the pilot study site
  - The improvement of optimization productive by STI at the study site
  - Information and disaster short-term impacts analysis
  - Sharing of technologies for climate change forecast towards climate-resilient agriculture and smart farmers
  - Improve climate change impacts awareness and resilience in agriculture aiming food security

**Case study target:**
Phrae Province (Northern Thailand)

**Speeches of Prof. Adinarayana**
(13:00, 24 March)
Utilization of Earth Observation Information

• Collaborations and Data Source: information sharing and application support/development
  • Himawari Satellite Mirror Sites (JP, TH, PH, TW)
  • Sentinel Asia: ISRO (India), the JAXA (Japan), the GISTDA (Thailand), the KARI (Korea), NARL (Taiwan), CRISP (Singapore)
    • Linking with UN-SPIDER and UNOOSA (International Charter)

• Satellite Data Applications: in addition to real-time observation/monitoring of weather, dust, etc.
  • Forest/wild fire/haze/maze/smoke detection and monitoring
  • Satellite Derived Bathymetry for tsunami inundation simulation
  • Aerosol Optical Depth (AOD) data
  • Assessment of damage and casualty
  • Lightning observation
  • Typhoon tracks and characteristics
  • Better analysis of satellite images of Earth: automate the processes of satellite image analysis

• Intelligent and Efficient Data Transmission
Moving Towards Open Science (1)

- Disaster Mitigation Competence Centre has been part of EGI-Engage and EOSC-Hub from 2015
- EGI-ACE: Jan 2021 - June 2023
- Reusability, Reproducibility and FAIR open data
- Supporting platform over EOSC-interoperable infrastructure is provisioned: Distributed cloud; HPC/HTC; ML-based big data analytics; web portal; Data analysis pipeline management; Data repository

Implement the Compute Platform of the European Open Science Cloud and contribute to the EOSC Data Commons by delivering integrated computing, platforms, data spaces and tools as an integrated solution that is aligned with major European cloud federation projects and HPC initiatives.

Speeches of Prof. Gergely Sipos (14:15, 26 March)
Moving Towards Open Science (2)

- In collaboration with APAN Open and Sharing Data WG
- Partnership with European Open Science Cloud (thru EGI-ACE project)
- Approaches
  - All related data are openly available at the time of publication
  - For outreach and education, simplified data sets are available
  - Release full data sets and analysis tools of a case study with the level of detail which are useful for algorithm, performance and scientific studies
  - Support reproduction, reuse, repurpose of all materials from case studies
  - Based on FAIR (Findability, Accessibility, Interoperability, and Reusability) principles
  - Implemented over EOSC interoperable cloud infrastructure - regional infrastructure by federating resources of ASGC and partners
Future Works

- More case studies are happening in next few years
  - Several case studies of different hazard types had been conducted by the simulation portals
- Capacity building for dealing with more complex multi-hazard scenarios
- Topographical structure might be changed after a disaster. Related data has to be updated accordingly in time. Such changes should be also recorded in the open application framework.
- Extending to agriculture applications leading by TH, JP and IN.
- Extending to space-based resource federation and applications
- Systematically, efficiency, AAI, advanced data analysis, GPU/Container/Jupyter over cloud are also our focus
- APAN and ISGC are primary collaboration framework of all partners and also for extension of this collaboration
## Draft Agenda for the UND Workshop in Thailand (19 – 20 April 2021)

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda</th>
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<tbody>
<tr>
<td><strong>Day 1 (19 April 2021)</strong></td>
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<tr>
<td>10:00 – 10:10</td>
<td>Opening by HII</td>
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<tr>
<td>10:10 – 11:00</td>
<td>Deeper Understanding for Disaster Mitigation By Simon Lin, ASGC, TW</td>
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<tr>
<td>11:00 – 11:40</td>
<td>Plenary Talk by HII <em>(Early Warning System)</em></td>
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<tr>
<td>11:40 – 12:00</td>
<td>UND, DMCC+ and Regional Collaborations on Disaster Mitigation</td>
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<tr>
<td>12:00 – 13:00</td>
<td>Lunch</td>
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<tr>
<td>13:00 – 16:00</td>
<td>Case study presentation (30 mins) + discussion (30 mins)</td>
</tr>
<tr>
<td>13:00 – 14:00</td>
<td>• Drought <em>(Development of Operational Drought Monitoring using Drought index in Thailand by Ms. Ticha Lolupiman, HII)</em></td>
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<tr>
<td>14:00 – 15:00</td>
<td>• Tsunami Case study</td>
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<tr>
<td>15:00 – 16:00</td>
<td>• Storm Surge Case Study</td>
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<tr>
<td><strong>Day 2 (20 April 2021)</strong></td>
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<tr>
<td>10:00 – 12:00</td>
<td>Case study presentation (30 mins) + discussion (30 mins) (cont.)</td>
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<tr>
<td>10:00 – 11:00</td>
<td>• Flooding Case study</td>
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<tr>
<td>11:00 – 12:00</td>
<td>• Fire/Haze/Smoke Monitoring Case study by Dr. Veerachai</td>
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<tr>
<td>12:00 – 13:00</td>
<td>Lunch</td>
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<tr>
<td>13:00 – 14:00</td>
<td>Summary of the UND by ASGC</td>
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<tr>
<td>14:00 – 15:00</td>
<td>Discussion</td>
</tr>
<tr>
<td>15:00 – 15:30</td>
<td>Closing remarks by ASGC</td>
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</tbody>
</table>
Acknowledgement

• Special Thanks to Great Supports From EGI, Asi@Connect, NSPO/NARL, Sentinel Asia and Academia Sinica
• Also Appreciate all Contributions From Partners - BD, ID, IN, JP, MM, MY, NZ, PH, TH, TW, VN and CZ, DE