PROCEEDINGS

India-Japan Workshop
on
Disaster Risk Reduction, 2018

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Prepared
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Disclaimer

This proceeding has been prepared for the Disaster Management Division, Ministry of Home Affairs, Government of India, by Dr Chandan Ghosh, Professor & Head, Dr Amir Ali Khan, Assistant Professor and Dr Ritu Raj, Research Associate, Resilient Infrastructure Division, NIDM, based on the two days India-Japan workshop on Disaster Risk Reduction-2018, involving all domain experts/stake holders from both India and Japan. The contents are mostly synthesized from the speeches, discussions, presentations made during the sessions.

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Way Forward

ABBREVIATIONS

AMCDRR	Asian Ministerial Conference for DRR
BARC	Bhabha Atomic Research Centre
BISAG	Bhaskaracharya Institute for Space Applications and Geo-informatics
BCP	Business Continuity Planning
CCS	Cabinet Committee on Security
CWC	Central water Commission
DDMA	District Disaster Management Authority
DRDO	Defence Research & Development Organisation
DRR	Disaster Risk Reduction
EEW	Earthquake Early Warning
EOC	Emergency Operation Centre
EWS	Early WarningSystem
GPS	Geographical Positioning System
HFT	Himalayan Frontal Thrust
HPC	High Power Committee
ICL	International Consortium on Landslides
ICT	Information Communication Technologies
IMD	India Meteorological Department
INCOIS	Indian National Centre for Ocean Information Services
IRC	Indian Road Congress
JBP	Japan Bosai Platform
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
MBT	Main Boundary Thrust
MHA	Ministry of Home Affairs
MoC	Memorandum of Cooperation
MoES	Ministry of Earth Sciences
NCMC	National Crisis Management Committee
NCS	National Centre for Seismology
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NGRI	National Geophysical Research Institute
NIDM	National Institute of Disaster Management
NILIM	National Institute for Land and Infrastructure Management
NIOT	National Institute of Oceanic Technology
NISA	National Industrial Security Academy
NSSP	National School Safety Program
PGA	Peak Ground Acceleration
RDSO	Research Designs & Standards Organisation
SDG	Sustainable Development Goals
SDMA	State Disaster Management Authority
SEZ	Special Economic Zone
SOI	Survey of India
SOP	Standard Operating Procedure
SPA	Scholl of Planning and Architecture
TERI	The Energy Research Institute
WIHG	Wadia Institute of Himalayan Geology

Executive Summary

The Ministry of Home Affairs, Government of India has organized first India-Japan Workshop on Disaster Risk Reduction on March19-20, 2018 at Vigyan Bhawan, New Delhi. The two-day workshop was organised as a follow-up of the Memorandum of Cooperation (MoC) signed between the two countries for cooperation in the field of disaster management. The MoC was signed during the visit of Prime Minister of Japan, Mr. Shinjo Abe to India in September, 2017. The workshop was expected to develop a specific bilateral action plan on areas of cooperation under the broad theme of disaster management / disaster risk reduction (DRR). The workshop deliberated on various themes encompassing disaster management policy framework, risk assessment, disaster resilient infrastructure, early warning system, preparedness by sub-national governments and approaches by private sectors from Japan and India.

The workshop had the following objectives:

- To facilitate knowledge exchange on good practices, lessons learned and latest technological advancements in the area of disaster risk management;
- To create an opportunity to gain an understanding of recent advancements in Japan in the area of earthquake detection, Tsunami damage assessment tools, retrofitting and earthquake early warning systems;
- To explore how Japan invests in making its infrastructure resilient to present and future disaster risks; and
- To make a forum for Japanese and Indian companies to share information on their disaster risk management practices in order to identify specific areas of cooperation for mutual help and learning thru' some pilot studies in India.

The workshop was attended by 48 delegates from Japan including experts from government, technical institutions& private sectors. From Indian side, about 65 delegates from the central government, state governments, National Disaster Management Authority, Indian Institute of Technology, National Institute of Disaster Management, National Centre for Seismology, INCOIS, National Remote Sensing Centre, Indian Metrological Department, National Geophysical Research Institute, TERI, BISAG, Wadia Institute of Himalayan Geology, Indian Institute of Human Settlement, SAARC Disaster Management Centre, National Institute of Urban Affairs, School of Planning & Architecture, Research and Information System for Development Countries, Infrastructure Companies, Private Sector and Non-Governmental Organizations had participated in the Workshop.

The opening ceremony was presided by Union Home Secretary Shri. Rajiv Gauba. Senior officers from MHA, NDMA and NDRF were also present during the inaugural session of the workshop.In his welcome address by Shri R K Jain, Member, NDMA, said, "We are living at a time when disaster risk reduction is not a choice but a need. In a globalized world, where origination of disaster risks has become increasingly non-local, mitigation also has to be a shared concern.Japan has been able to achieve remarkable level of earthquake safety in built environment mainly due to the way they disseminate risk to the communities and households. I think we have to learn a lot from them in this field. India, with its improved early warning capabilities, has successfully handled two major cyclones Phailin-2013 and Hudhud-2014 in the recent past, which is considered as one of the global best practices. However, there is need to improve last mile connectivity in real time". On behalf of Japan, Mr Mamoru Maekawa, Vice Minister, Cabinet Office and Mr Kenji Hiramatsu, Ambassador extended their welcome remarks for the successful organization of the 2 days workshop.

Dr. Rajiv Kumar, Vice-Chairman of NITI Aayog delivered the keynote address during the opening session. Dr. Rajiv Kumar underlined the synergy between the two ancient Asian civilizations of

India and Japan, both of which have frequently witnessed the fury of natural catastrophes and are investing proactively on mainstreaming risk reduction into development. He said that this workshop "marks the beginning of the formal implementation of the initiatives agreed under the MoC signed between the two countries on DRR in September 2017". While underlining the impact of the disaster on development, Dr. Rajiv Kumar stated that uncontrolled development without proper disaster risk assessment has increased the risk of losses from disasters. He added that climate change has further aggravated the disaster risk, therefore, DRR can no longer remain isolated from the overall strategy of sustainable development. Recalling commitments made in Sendai on DRR, in Paris on Climate Change and in New York on Sustainable Development Goals, Dr Rajiv Kumar emphasized the role of country leadership for implementing the commitments particularly in the field of DRR, as returns to investment are not easily visible.

The Workshop programme was divided into the six sessions on the various topics viz. DisasterManagement Policy Framework, RiskAssessment,Preparedness, Early Warning System, and Preparedness atsub-national level and Approaches byPrivate Sector. About 36 presentations(18 from India and 18 from Japan) were made by the experts. Copies ofthe presentationsare available at http://www.ndmindia.nic.in/india-japan-workshop-on-disaster-risk-reduction
Summary of presentations by each speaker are given with key-points. Some of the importations deliberations are:

- Ancient perspectives of India's State Policy, Military strategy and economic policy with excerpts from Kautilya's "Arthashastras" (2-3 Century BCE, in Sanscrit) were highlighted in the current context of DRR. Special mention was made about India Famine Code-1880.
- Ongoing and completed Seismic microzonation studies in many cities of India, Indigenous Tsunami warning system (INCOIS – established in 2007 for Indian Ocean RIM countries) and Earthquake Early warning system being developed in IIT-Roorkee, institutionalization of DM system as per DM act 2005 & Rule 2009 to all states and Union Territories of India are elaborated
- Seismogenesis of India with all details about its tectonic movement and generation of Himalaya vis-a-vis the sources of earthquakes in Indian subcontinent explained
- Earthquake scenario for Kolkata, systematic assessment of seismic hazard, vulnerability and risk in respect of proper assessment of Seismic Hazard were presented

- Sendai Framework (2015-30), Sustainable Development Goals (SDG) and Climate Change Strategies are integrated into Indian PM's 10 point Agenda (AMCDRR-2016)
- Special representation from Japan Bosai Platform (JBP – a consortium of 100+ private Companies formed after facing Great East Japan Earthquake-2011) with several forefront technologies, such as LiDAR mapping, Satellite Based DEM (Digital Elevation Modelling), Damage investigating tools, retrofitting, earthquake early warning, Siren & Public address system, real time Tsunami inundation & damage forecasting, earthquake sensor alarm system, disaster risk assessment tools, business continuity planning, extendable Tsunami protection wall, etc. were presented
- JBP proposes partnerships with Indian side in the form of
    - Made-in-Japan solutions to DRR related issues in India
    - collaborate, jointly formulate, and implement projects in India
    - joint development of DRR technologies for the global market
- India-Japan Cooperation in the areas of retrofitting, human resource development, international best practice exchange and pilot infrastructure development program to be undertaken

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Opening Session

Welcome address by Shri R. K. Jain, Member, NDMA

While welcoming to this two day India-Japan Workshop on Disaster Risk Reduction, which . emanates from a Memorandum of Cooperation, that was agreed and signed between Ministry of Home Affairs (MHA), Govt. of India (GoI)and the Cabinet Office of Government of Japan in September 2017, Shri R K Jain emphasized the need for cooperation and collaboration in the area of Disaster Risk Reduction (DRR) between India and Japan Government. Recognizing the challenges due to earthquake and Tsunami, Mr Jain said, Japan has not only emerged as the role model for risk reduction and risk management but has also provided global leadership in the area of disaster risk management. As a matter of fact, all the three World Congresses, that have been held so far, where the international community agreed to a framework on disaster risk reduction, have been held in Japan and hosted by the Govt. of Japan.In India's behalf Shri Jain mentioned that India due to its vast geography, agro-climatic variations, large population, concentration of assets and people in urban areas, is also one of the most risk prone nations of the world. Despite challenge of managing multiple risks, in a vast country which houses more than one sixth of the global population, India has also emerged as a nation which is taking a number of initiatives towards disaster risk reduction. He has further mentioned that the country needs to focus more on disaster resilient infrastructure (DRI). In India alone, an investment of US $ 1.5 trillion is anticipated in infrastructure in the coming ten to fifteen years. Considering the massive investments and complex nature of the problem, there is a need to establish a coalition for resilient infrastructure at the global level. India has taken a lead and recently conducted a two day conference in which more than 20 countries participated. Japan also participated in that conference. This workshop will also help to take a step towards that direction. Private sector is the largest creator of infrastructure. Housing sector is mainly private driven. Increasing role of private sector in power, transport, communication, and IT also

warrants that private sector imbibes disaster risk resilience. Hence, one of the highlights of the conference will be the session no. 6 on private sector participation, where speakers from both Japanese and Indian Private sectors shall deliberate on day 2.

2. Address by Mr Mamoru Maekawa, Hon'ble Vice Minister for Policy Coordination in the Cabinet Office, Japan,

The Hon'ble Vice minister for Policy Coordination in the Cabinet Office, Japan, Mr Mamoru Maekawa, thanked the Government of India for hosting this workshop, which is the first outcome of the Memorandum of Cooperation regarding Disaster Risk Reduction (DRR). He shared the Japanese experiences of DRR policies, including legal and planning framework, and discussed how Japan is preparing against mega-scale disasters, in collaboration with government, academia, private companies and citizens. He concluded that Japan and India could collaborate for the implementation of the Sendai Framework so as to contribute to Disaster Risk Reduction globally.

3. Address by Mr. Kenji Hiramatsu, Ambassador of Japan to India

Narrating various challenges faced due to natural disasters the ambassador of Japan to India, Kenji Hiramatsu, expressed his gratitude to the people of India for sending the 46 memberteam of National Disaster Response Force (NDRF) to Japan, who extended their unstinting assistance in the aftermath of the Great East Japan earthquake in March 2011. He recalled Japan's help during 2001 Bhuj earthquake when Japan sent it'sself defence forces for relief and rescues operation. He also mentioned about the various cooperative projects related to Disaster Risk Reduction (DRR) which are currently ongoing between Japan and India; and emphasised the importance of people's awareness and precautionary measures for DRR.

4. Special Address, Dr P. K. Mishra, Additional Principal Secretary to the Prime Minister of India

In his special address, Additional Principal Secretary to the Prime Minister of India, Dr P. K. Mishra talked about the unparalleled contribution of Japan to global Disaster Risk Reduction (DRR). He appreciated their consistent global leadership in this area from the early days of the International Decade of Natural Disaster Reduction (IDNDR) to Yokohama Strategy, to Hyogo Framework to the current Sendai Framework. Dr Mishra lauded Japan's lead in technology and it's all of society approach in DRR. He stressed the need for imbibing the principles of Disaster Risk Management in all development sectors so as to prevent economic losses. While mortality risk are going down in many countries, India has to stress a lot in the proper utilization of science and technology to reduce such negative impact and for the cooperation between Japan and India is very crucial. India govt. is always looking forward to nurture such cooperation.

He recalled that in 2001, when Bhuj earthquake hit hard, he sought support from Japan. Finally he is always ready to keep up working together and maintain a sustained dialog between Japan and India.

5. Keynote Address, byDr. Rajiv Kumar, Vice Chairman, Niti Aayog

In his keynote speech, Dr Rajiv Kumar expressed that disasters put development at risk and at the same time, the development choices made by Individuals, Communities and Nations can generate new disaster risk. Although the natural hazards are frequently affecting communities on scales large and small, but civilization as a whole is more likely to survive a catastrophe today than ever before, which said is good news. But the disturbing news, as coined by Dr Rajiv Kumar is that while disasters have affected development, **uncontrolled development without adequate focus on protecting people and assets** from disasters has increased the risk of losses from disasters. The impact of natural disasters has been growing rapidly due to **global population growth, urbanization and increased socio-economic activity**; with a **tenfold increase** in losses from disasters since the 1970s. These numbers have yet to incorporate the real impact of climate change.

Dr Rajiv Kumar mentioned about proactive investment made by Japan in **developing advanced technology against earthquakes and tsunamis and designing buildings** to withstand the impact of waves, which have reduced disaster risk, minimizing material damage and loss of life. Moreover, communities in Japan are also prepared to quickly react to quakes and tsunamis due to a **highly-developed public education programme**. In Indian context, Dr Rajiv Kumar has mentioned about appreciable tackling of recent **cyclones** (Global Assessment Report 2015). On disaster management front, the **South Asia Satellite**, being operated by ISRO can provide secure hotlines among the participating nations, which will be useful for management of disasters like earthquakes, cyclones, floods and tsunamis. India has developed the **Indian Tsunami Early Warning System** and has established The **Indian National Centre for Ocean Information Services (INCOIS)** which gives round-the-clock alert and advisory services to Indian Ocean Rim Countries (IOR). **Therefore, from the two days workshop, he expects it would be very engaging indeed to exchange notes on each other's perspective on risk assessment, mitigation and management.** Lastly, he said "I would like to reinforce that both the countries must continue to **build partnerships** with stakeholders. This is crucial if we are to promote **risk informed investment** and to encourage business-driven innovation in all areas of disaster risk management. We must ensure that our **strategies** towards achieving the Sendai Targets are **inclusive**. We have to use the **potential of education** for reducing disaster risks. Because sensitizing children about disaster risks in their local areas helps build awareness and capacities not only for the children but an entire community leading to resilient communities in the long run".

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6. At the end of the opening ceremony, Mr. Sanjeev Kumar Jindal, Joint Secretary, Disaster Management, Ministry of Home Affairs, Govt. of India presented Vote of Thanks.

Session1: Disaster ManagementPolicy Framework

Disaster Management Policy Framework focusedupon existing policy framework existing in two countries including the historical background, existing institutional mechanism, national strategies, and National Plan for Nankai Trough Earthquake etc. The session was moderated by Shri R K Jain, Member NDMA. In his opening remarks, Shri Jain highlighted the need for robust disaster management (DM) policy and framework for handling the disasters. The presentations made during the session are as follows:

1. Dr. V. Thiruppugazh, Joint Secretary, NDMA

Dr. Thrupuggazhhighlighted that fact that India is highly prone to number of hazards like earthquakes, cyclones, floods, landslides, tsunami, industrial and CBRN disasters. Based on EM-DAT data, Dr. Thiruppugazh indicated that India is most disaster-affected country, which had second most number of mortality during 2005-2014. He highlighted that India have a robust DM mechanism existing from ancient times. Dr. Thiruppugazh provided a historical perspective by describing the management of disasters in 'Arthashatra', an ancient Indian document, where eight types of disasters have been described including fire and drought. In 'Arthashatra' much emphasis is given on community based disaster management (CBDM). During the British Period (18,19&20 century), large number of people in the tune of 60-80 million died due to famine, which led to development of 'Famine Code'1880. After independence many programmes like Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and watershed management programme were developed to counter the recurring droughts at national level.

Dr. Thrupuggazh stated that constitution of High PoweredCommittee (HPC)in 1999 was a turning point in the area of DM in India, which had provided direction to establishment of robust DM system at national level. Since then some of the landmark developments include shifting of DMdiscipline to MHA, 2002, DM Act - 2005, National Policy on DM - 2009. The DM Act highlighted establishment of NDMA and National Executive Committee at national level for providing directions to DM; similarly, State Disaster Management Authorities (SDMAs) and State Executive Committee (SEC) at state level and District Disaster Management Authorities (DDMAs) were established at district levels. For emergency management, National Disaster Response Force (NDRF) and State Disaster Response Forces (SDRFs) were established. For capacity buildings at national level NIDM was established. Many states have established State Institute Disaster Managements (SIDMs) and Administrative Training Institutes (ATIs) are providing assistance in imparting training and capacity building activities. Financing of disaster management is met through National Disaster Response and State Disaster Response Funds in addition to many flexi funds. Post disaster needs are met from the plan funds.

Dr. Thiruppugazh highlighted that Government of India is following a multi-hazard approach where emphasis is given to Community based Disaster Management (CBDM) for last mile connectivity, coordination at all levels and capacity building of all stakeholders to meet the challenge of disaster risk mitigation. NDMA has come out with a national plan on disaster management which is based on Sendai Framework for DRR (2015-30) and divides different targets into short, medium, and long –term goals. According to Dr. Thiruppugazh few of the challenges faced by the country including

mainstreaming DRR into development, financing of DRR at national level, risk transfer and insurance and community based DRR.

Salient points:

- Citing reference to "Arthashastra", development of 'Famine Code'1880, Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and watershed management programme were developed in India time to time
- India is highly prone to number of hazards like earthquakes, cyclones, floods, landslides, tsunami and CBRN and industrial disasters
- Mainstreaming of DRR into development, financing of DRR at national level, risk transfer and insurance and community based DRR are in progress in India
- Institutional mechanism of DM system in India explained

2. Disaster Management Policy Framework in Japan by Ms. Setsuko Saya, Director, International Cooperation Division, Disaster Management Bureau, Cabinet Office, Japan

Ms. Setsuko Saya in her presentation mentioned that Japan is highly prone to disasters like earthquake, tsunami, volcano eruption, typhoon, heavy rain, heavy snow and tornado etc. Japan is having a long history of facing devastating disasters. The important aspect of disaster management system in Japan is that after every disaster the Government has come out with a policy direction based on the lessons leant from particular event. The Basic Act on Disaster Management (1961) was one of the outcomes after the 1959 devastating typhoon Isewan, which claimed more than 5000 lives. The objective of the Basic Act is to protect people's lives and assets from disasters, and contribute to the societies' safety and well-being. The Act was revised after the Kobe earthquake, 1995 and after the Great East Japan Earthquake, 2011 to meet the challenge of response to such disasters.

Disaster Management in Japan is managed by the Cabinet Office and Ministry of Land, Infrastructure, Transport, and Tourism is the nodal agency. The Directorate of Disaster Management under the Cabinet Office had eight divisions where four divisions deal with preparedness, three with response and one division handles General Affairs related to disaster management at national level. Fire and Disaster Management Agency, National Police Agency, Japan Coast Guard and Ministry of Defence are the nodal agencies which play important role in managing disasters at national level in Japan. DM in Japan is based on three principles of preparedness, evacuation and acting for the worst case. For achieving the basic principles a lot of efforts are being made for Early Warning Systems (EWS) and capacity building to prepare all stakeholders to face a disaster. In case of a disaster efforts are focused towards quick response, resource management and recovery planning.

Basic Act on DM highlights the goals for DM policies covering DRR, division of responsibilities, science and technology, information to support people's lives, vulnerable people, and with a motto to "Build Back Better". The Act also highlights responsibilities of the national, prefectural, municipalities and designated organisations for public services and of citizens to be prepared for disasters and stock foods and the necessities of life, participate in DRR activates.

Japan has National Council for Disaster Management Chaired by the Prime Minister and consists of

Ministers, heads of public institutions and experts from science and technology. The roles of the National Council is to formulate and promote major disaster management policies, including deciding the Basic Plan for Disaster Management.

Japan has a Basic Plan for DM to achieve improved preparedness, response efficiency in case of emergency and to facilitate recovery and reconstruction processes. The Basic Plan was last updated in 2017 and approved by the National Council on Disaster Management under the Prime Minister.

At Prefecture (state) and municipality levels there are local disaster management councils and disaster management headquarters. Besides other activities, these entities prepare and implement Basic Plan in their respective authority areas. The community DRR Plans are prepared by citizens and submitted to the municipality to be included in the Municipality Basic Plan.

As far the financial support is concerned the respective executing agency/entity on implementations of laws has to bear the associating costs while the national government supports recovery from extreme events. Japan has developed a mechanism to bring out a White Paper on Disaster Management every year to report to the Parliament. The 2017 Version is the 55th edition since 1963 and it is available on the web by PDF version and is also available in book stores for general public.

3. **Mr. Eiji Ohshima, Deputy Director, Research and Planning Division, Disaster Management Bureau, Cabinet Office, Japan**

Mr. EijiOhshima, focused on risk reduction policies against large scale earthquakes and tsunami in Japan. The entire Japan eastern coast can be divided into three distinctive zones like the Southern Sea, the Southeastern Sea and the Eastern Sea. These three zones may generate great earthquakes. According to Mr. EijiOshima, in the Southern Sea, the earthquakes of the Tokai, Tonankaiand Nankai, one earthquake or 2-3 earthquakes may occur in a row. The probability of occurrence in the Nankai Trough within 30 years of M8 to 9 class earthquake is about 70-80% which may result in huge damage to aged, primarily wooden urban areas and major cultural assets located in the area. In the Eastern Sea, the Trench-type earthquakes in the vicinity of the Japan and ChishimaTrench with a probability of (M 7.9 earthquake) occurring offshore of the Nemuro Peninsula within 30 years is about 60%. In the Southeastern Sea, the Tokyo Inland Earthquake（M7）has a probability of an M7 class earthquake occurring in the southern Kanto area within 30 years is about 70%. Similarly, The Great Kanto Earthquake in 1923, M8 Class, Trench-type Earthquakes has a probability of occurring within 30 years is about 0-5%.

The Nankai Trough has a history of large-scale earthquake occurring roughly every 100-150 years. However, there are records showing that there were two earthquakes (M8 and M7.9) in 1944 and 1946 in the Southern Sea, the Southeastern Sea. It is expected that these earthquakes will generate, as per estimation in 2014, seismic intensity of more than “6 lower” in area of about 71,000 km^2 and “6 higher” in the area of about 29,000 km^2 while the seismic intensity 7 will be felt in areas of about 4,000 km^2. The Nankai Trough Earthquake may generate Scale 7 tsunami in 127 municipalities and tsunami height more than 10m may go in 79 municipalities. The estimated damage by such earthquake may result in 323,000 people dead (in midnight, winterand 2.386

million buildings (evening, winterdamaged. The loss to infrastructure may include electricity loss in 27 million cases and communication network loss in 9.3 million cases. The impact on every day's life will be in terms of 9.5 million people evacuees and food shortage for 32 million meals in 3 days. The economic damage to assets will be in the tune of 1.49 trillion USD and damage on economic activities will be about 394 billion USD.

To reduce damage by Nankai trough earthquake, a master plan based on special measures law was established in 2014 which include estimating the worst case damage, the DM measures and the emergency measures. Such measures are being promoted steadily, contributing to reducing damage. The Master Plan has set damage reduction goals for next 10years and set specific goals for measures designed to achieve damage reduction goals.

Mr. EijiOhshima presented a very interesting analysis indicating that during the Great East Japan Earthquake in 2011 about 90% deaths were due to tsunami and during the Great Hanshin-Awaji Earthquake in 1995 about 80% deaths were due to collapse of buildings. Similarly; during the Great Kanto Earthquake in 1923 about 90% deaths were due to post earthquake fires. The importance of hard and soft measures for tsunami risk mitigation was explained by estimating fatalities caused by tsunami of the Nankai Trough earthquake. Importance of the public awareness for tsunami risk mitigation was highlighted with the help of an example. According to estimates, about 230,000 people are estimated to be killed by Tsunami if no intervention is made. However, by increasing the public awareness of tsunami and to promote early evacuation, the estimated number shifts to rightward and decrease to 93,000. Moreover, if effective hard measures take place, such as effective use of evacuation buildings, the number declines up to about 60,000.

Emergency Response activities in the event of a Nankai Trough Earthquake has been developed well in advance. Being aware of the importance of the first 72 hours when saving a human lives, set a timeline and target actions in each of the fields of emergency transport routes, rescue, medical services, goods, fuel in various fields. Similarly, dispatch support units by mobilizing resources nationwide, in particular, to support areas where the damage can be the most critical. Efforts are being made to revise the earthquake occurring probability in the long term assessment. Based on the available estimates basic procedure of "Information related to Nankai-trough earthquake" has also been developed.

Salient points:

- The probability of occurrence in the Nankai Trough within 30 years of M8 to 9 class earthquake is about 70-80%
- The Great Kanto Earthquake in 1923, M8 Class, Trench-type Earthquakes has a probability of occurring within 30 years is about 0-5%.
- During the Great East Japan Earthquake in 2011 about 90% deaths were due to tsunami and during the Great Hanshin-Awaji Earthquake in 1995 about 80% deaths were due to collapse of buildings and fire
- Emergency Response Activities in the event of a Nankai Trough Earthquake has been developed well in advance.

Moderator's final remark: Mr R K Jain, Member NDMA, highlighted about the Japan's effort towards mitigating earthquake induced disasters, initially taking into account of fire induced disaster and now, especially after 2011 earthquake-Tsunami, how it's preparing for the various technologies in Tsunami resistant infrastructure.

Special Session: Introductionof Japanese Private Companies

Moderator: Ms. SetsukoSaya, Director, International Cooperation Division, DisasterManagement Bureau, CabinetOffice, Japan

Ms Setsuko Saya had introduced Secretary General Mr Akhira Doi of Japan Bosai Platform, which was formed 3 yrs after great East Japan Earthquake Tsunami (2011). It's a Japanese association of about 100+ private companies, such as Asia Air Survey Co. Ltd (AAS), RESTEC (Remote Sensing Technology Centre of Japan), Gikken Ltd., Fujita Corporation, Hitachi Zosen Corporation, NEC Corporation, Challenge Co. Ltd., Kokusai Kogyo Co. Ltd, TOA Corporation. A brief presentation was made by each company during this special session. Detailed presentations were made by the companies during Session 6. The moderator, requested all Indian participants to interact with the Japanese Company personnel till detailed presentation are made next day.

Session2: Risk Assessment

The session was moderated by Ms. Setsuku Saya, Director, and Government of Japan. Defining the importance of risk assessment in the wake of any disaster, Ms Setsuko Saya, called the speaker one by one.

1. **Dr Vineet Gahalaut**gave a brief about the genesis of National Seismological Centre (NCS), established under Ministry of Earth Science (MoES), Govt. of India. Right now 116 seismic observatories are in place and 17 more organizations in the country are also maintaining such stations. All data are shared through ISGN network and accordingly all seismic informationis disseminated for the country with NCS as nodal agency. Some of the specific R&D related activities being taken up by the Centre are:
    - Crust and upper mantle structure of sections of Indian shield and Himalayan regions using receiver function techniques
    - Estimation of expected ground motions for critical areas from future scenario earthquakes using empirical Green's function technique
    - Carryout earthquake precursor observations and comprehensive analyses of the data sets to establish possible relationship with the earthquake occurrences.

One of the important work taken up by NCS is to have seismic microzonation map for 30 more cities and as on date 5 cities,Jabalpur, Guwahati, Delhi, Kolkata, Bangaluru, have been completed. He explained earthquake genesis of the Himalaya in terms of strain accumulation and severity at accelerated rate of northward movement of the Indian plate, with special mention about the central seismic gap that portending danger in near future.

Salient points:

- Detailed seismicity and seismotectonic studies of seismically active areas in the country
- Earthquake source characterization in distinct tectonic environments
- Seismic microzonation studies for Jabalpur, Dehradun, Kolkata, Guwahati, Sikkim, Delhi completed and for 29 more cities are in progress

2. Japanese Earthquake Researches for Seismic and Tsunami Disaster Resilience by Dr.Naoshi Hirata

Explaining a brief history of extensive earthquake (1965 to 1998) and Volcanic eruptionprediction (1974-2008) program during which the country faced 1995 Kobe earthquake,Dr. Hirata touched upon the national policy shift towards the integration of both earthquake and volcanic eruption program (1999-2013) with social study/observation, when Great East M9.1 earthquake took place. Japan government has embarked upon Earthquake and Volcano Hazards Observation and Research Program with social science perspectives (2014-2018). Giving details of recent earthquake impact, with special mention to Tohoku-Nankai (2011) and Kumamoto (2016) and aftershocks reported even for the Indian Ocean earthquake-Tsunami (2004), Dr Hirata has given grim scenario of Nankai region with probability human life loss over 0.3 million and damage of Japanese Yen 93 trillion.

Salient Points

- Basic Comprehensive Policy for the Promotion of Earthquake Observation, Measurement, Surveys and Research (first plan in 1998), which was revised in 2012 after Tohoku earthquake (2011) and active till 2019
- Basic Earthquake Survey and Observation Plan (1997)
- Probabilistic seismic hazard map for Japan a) to raise the public's awareness of earthquake disaster reduction, b) to take the earthquake disaster reduction measures more effectively and efficiently, c) to evaluate the risks of establishing important facilities and enterprises in a certain area.
- The 2016 Kumamoto Earthquake Sequence brought Seismic Intensity 7 in JMA scale at Mashiki town with an interval of 28 hrs.If the M7 event occur in Tokyo Metropolitan, a loss and damage is tremendous.
- The effect of the 2011 Tohoku-oki event is still continuing.
- The Nankai Trough earthquake is likely to occur and cause a very large loss and damages

In conclusion, Dr Hirata stated that the 2016 Kumamoto Earthquake Sequence brought Seismic Intensity of 7 as per JMA scale at Mashiki town with an interval of 28 hrs. The case of a M7 event in Tokyo Metropolitan areas, there will be a huge loss and damage. Despite of the fact that the effect of the 2011 Tohoku-oki event is still continuing the Nankai Trough Giant earthquake is likely to occur and cause a very large loss and damages with expected Tsunami wave height as high as 20m, for which measures taken so far are highly inadequate.

3. Earthquake Hazards and Vulnerability Studies of Dehradun city by Dr. D. Srinagesh, CSIR-NGRI, Hyderabad, India

Giving a brief account of the earthquake fatality of more than 35000 and building damages in India since 1988 Bihar-Nepal earthquake, seismo-tectonic studies of Dehradun city was presented by Dr D. Srinagesh. He explained dominant building typologies of Dehradun city from 2011 census data and mapping of subsurface structure along the active faults scenario of the past earthquake in region vis-à-vis with the Indian seismic-zonation maps. It's opined that at the current context vulnerability of buildings are quite alarming compared to Japan at a given intensity of shaking.

Salient points:

- Earthquake fatality in India is about 1000/yr
- Detail seismic Microzonation of Dehradun city, India presented in technical cooperation with IIIT-Hyderabad
- Vulnerability profile of Dehradun city explained in terms of buildings and 2011 census data
- Collapse and damage to buildings would be Unreasonably high in IndiaCompared to any other country for similar level of ground shaking
- Urgent need to Understand housing risk in IndiaMinimize future losses of life and property

4. Earthquake Occurrence as an Extreme Event as conceptualized from Genesis to Prognosis implicating Hazard, Vulnerability and Risk in the Indian and Japanese Peninsula by Dr. S. K. Nath, Professor, IIT-Kharagpur

Dr. S.K. Nath described the seismogenesis of India with all details about its tectonic movement and generation of Himalaya vis-a-vis the sources of earthquakes in Indian subcontinent. Giving a brief about the Indian government initiative in the seismic microzonation studies, recently taken up by Ministry of Earth Science (MoES) for 30 cities, in which, according to Prof. Nath,activities related to ambient noise survey, Multi-Channel Analysis of Surface Waves (MASW) survey, in-situ geotechnical testing, in-situ seismic measurements etc. were carried out and after analysis of data sets different maps viz., Peak Ground Acceleration (PGA), spectral accelerations for different periods, liquefaction potential, predominant frequency, amplification factor, average shear wave velocity at 30 meters depth, geology & geomorphology and projected Hazard Scenarios at GIS platform etc. have now been made available for 5 cities in India. While sharing the his team-effort in the microzonation studies of Kolkata City, it was noted that unplanned urbanization defying building codes are continuously increasing the earthquake vulnerability of Kolkata placed at the border of Seismic Zone III and IV. Therefore, systematic assessment of seismic hazard, vulnerability and risk need to be done in respect of (a) Proper assessment of Seismic Hazard (b) Implementation of safe building construction codes, and (c) adopting appropriate land-use planning. Taking into account of building typology, height, shapes for 11 buildings along with population density as per 2011 census data, Prof. Nath found that risk is reallyhigh in

the case of Kolkata.In the last part of his presentation Prof. Nath took up an earthquake scenario exercise for Kolkata. The projected economic and life loss at various time of the day and night are being obtained and further work on relating risk insurance on the forecast and prediction of the damage scenario.

Salient points:

- Seismogenesis of India with all details about its tectonic movement and generation of Himalaya vis-a-vis the sources of earthquakes in Indian subcontinent explained
- Based on the detail studyand earthquake scenario for Kolkata, systematic assessment of seismic hazard, vulnerability and risk need to be done in respect of Proper assessment of Seismic Hazard
- Implementation of safe building construction codes, and adopting appropriate land-use planning.
- Microzonation studies by MoES, Govt. of India, for 30 cities are in progress.

5. **Challenges & Options for Risk & Vulnerability Assessment & DRR by Mr. G.K. Bhat, Chairperson, TARU, India**

Sharing his long experience in the risk mapping exercises across the country Mr. G. K. Bhat, explained that urbanization and expansion of built environment areadding to vulnerability challenges. The country has been seriously affected by earthquake& Tsunami, cyclones, urban floods, heat waves. Informal constructionsin the periurban areas have been amplifying the risk. Large proportion of buildings stock is informally built poses challenge to enforcing town planning & building regulations and large proportion of old building stock, were not built to withstand hazards.While giving a scenario of building constructions in the entire country along with the population density, there is an alarming sign being projected. Moreover, addition and alterations in buildings are so much complex that it is so difficult to get the specific details and there is no search specific ways to know the building response during earthquake. Taking a case for an Indian city, Surat in the State of Gujarat, where built-up facility is changing every now and then; impact of Climate Change adds more complexity than viable way-out in pinpointing vulnerability profile. He explained various other challenges in hazard, vulnerability and risk profiling for the country and following as wayforward:

Salient points:

- Develop **anticipatory culture** to predict changing risk profiles
- Mainstream multi-hazard risk and vulnerability assessment, Mitigation action across scales and sectors and Context specific, risk informed construction practices
- Develop and continuously upgrade **end-to-end early warning systems**
- Creating **no-development zones** in high risk areas (esp. floodplains, landslide, coastal high risk zones)
- Develop and facilitate "**Technical Support Agencies**" to build safer & monitor adherence to safe building practices, especially in urban areas
- **Vulnerability reduction** across scales through multi-stakeholder engagement

- **Develop and Enforce regulations**
- **Finance retrofitting/replacement activities**, especially focussed on poor
- Integrate insurance to enable **risk transfer** and to facilitate adherence to building guidelines

At the end of the session, moderator Ms Setsuko Saya sought few questions from the participant's side but no one responded. So she closed the session with thanks to the organizer.

Session 3:Disaster Resilient Infrastructure

Mr. Kamal Kishore, Member, NDMA and moderator of the session stated that we are living in a region where past is no longer a good guide for future safety and with the change in climate we are witnessing lot of things and lot of uncertain things are happening around. It is really hard to develop the structure for long duration as we are to look into the structure thatcan serve multiple generation. In context of both developing and developed countries, the risk is multifold and the amount investment to be made is enormous. This is an issue which concerns not only country like India but also to Japan because, a lot of their infrastructure also need to be replaced with new technology.

1. **Development and Management of Disaster-Proof-Infrastructures to make Disaster-Resilient-City by Mr. Masaki Takemura, Japan**

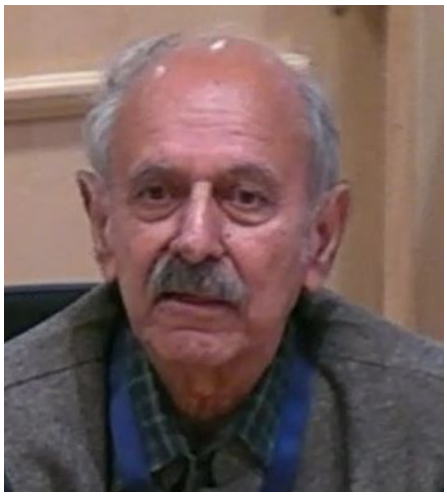
Giving details of several earthquake induced damages in Japan, Mr. Masaki Takemura, showed that river levees in wide range from Tohoku to Kanto area were damaged heavily due to Great East Japan Earthquake (2011). Some of them were serious to lose capability to protect against water. The cause of the large-scale damage to River Levees was liquefaction. He highlighted several mitigation measures along with case studies for few rivers in Japan. He has also given crucial role played by the Members of TEC-FORCE officials from each Regional Development Bureau, who gathered from whole country according to the scale of disaster.The special investigation and technical supports are provided by the members from MLIT, Local Transportation Bureaus, the National Institute for Land and Infrastructure Management(NILIM), the Meteorological Bureau, the Geographical Survey Institute.Finally, Mr. Takemura showed how to use GPS log (GARMIN, Smart phone) and wearable camera for site investigation.

Salient points:

- Use drones to investigate damage situation and to support rescue and search for missing persons.
- Understand the scale of disaster remotely from out of restricted area by measuring distance and height using laser measuring instruments.

- Understand the situation of damage, combining laser profiler (LP) data and photographic 3 dimensional models.

2. Bridge Construction : Reducing Disaster Risk by Prof. Mahesh Tandon



Giving background history since 1908 at Italy about earthquake induced effects on bridge pier foundationsProf. Mahesh Tandon described salient design aspect that continually adapted in Japan and simultaneously how codal provisions are refined from the experiences gained time to time till recently in India that led to a publication by RDSO, IRC-6 and IS 1893-2014, Part 3 for Bridges and Retaining walls. He showed several milestones in the earthquake resistant design and enriched understanding in the liquefaction after Nigata (1964) earthquake in Japan. Special mentioning were made about the incorporation of post-elastic behavior and ductility in design after the year 1981.The effect of hard top layer underlain by liquefiable layer on bridge foundation has been mentioned by him and giving several pictorial proofs of lateral spreading induced failure both in Japan and India. Japan Road Development Authority in 1996 brought a significant change in codal provision. Then regarding Indian context, he showed some of the rare signatures of those earthquake effects in India during 1897 to 1950.In 1950, the Assam-Arunachal border earthquake changed the course of Brahmaputra River. In *Lakhimpur* area of Assam several signature of liquefaction and sand boiling noted but remained unexplained till Japanese scientists came forward to explain Nigata (1964) earthquake induced failures.

Salient points:

- Historical background in the development of Bridge foundation design codes and several upgradation, stemmed from Japanese experience that took place as every earthquake gave new lessons to the geotechnical professions.
- Understanding of Liquefaction since Nigata (1964) earthquake in Japan.
- Several foot prints of earthquake induced ground failures that took place in India during four mega (M>8) earthquake took place in the Himalaya respectively I 1897, 1905, 1934 and 1950.
- Upgradation of Japanese codes vis-à-vis in India with latest one as IS 1893 2014, part 3.

3. Prior Investment on Disaster Risk Reduction by Mr.Takema Sakamoto, JICA

Mr.Takema Sakamoto gave a brief about the JICA activities across the South East Asia. It's an important bilateral donor agency acting as bridge between Japan and emerging countries, and provides assistance in forms of loan, grant and technical cooperation so that the emerging countries can strengthen their capabilities in DRR.It helps in the implementation works together with concerned Ministries/department of the respective countries. He mentioned about successful implementation of several DRR projects in Nepal following Nepal earthquake (2015), Philippines (cyclone -2009), Thailand (flood-2011),

Vietnam, Sri Lanka, Bangladesh (building collapse- 2013) and some of which are still going on. JICA's role in India and ongoing projects in the state of Uttarakhand with Forest Department and Cooperation in railway freight corridors, bullet train were also mentioned by Mr. Sakamoto.Some of the JICA projects in India are given in https://libportal.jica.go.jp/fmi/xsl/library/Data/PlanInOperation-e/EastSouthAsia/054_India-e.pdf

Salient Points:

- Willing to contribute DRR principles in all project in India
- Stressed for strong bond among policy makers, experts and implementing agencies
- Exchange of bilateral information on capacity building, expertise, policy making
- ODA loan/assistance in more project in India
- Assisting in the post disaster damage survey and loss assessment

4. Policy planning for urban infrastructure by Ms.Alpa Seth

In the light of development, growth and disaster safety being experienced and giving background of policy makers and disconnect at operation level, Ms.Alpa Seth presented the Srinagar (2014) flood situation. Taking the case of Sabarmati Riverfront development project, Ahmadabad, she explained that:

- Parameters to be considered in design of riverfront developments
- Design return period flood level to be considered for maximum credible high flood level
- Max reduction in cross section area of the river
- Whether New construction to be allowed on reclaimed land- and if so how much?

In her presentation salient issues were discussed, e.g. policy standards, enabling mechanism, protocol, enforcement mechanism. More so about the role of new authorities being created, such as SEZ, Smart City, slum rehabilitation board, to name a few in the country. She has shown the impact of disasters in Japan and India in terms of deaths and damage, which are more or less similar.

Salient points:

- Fatalities in flood and cyclone are less in India compared to earthquake related deaths in Japan.
- Decadal death rate due to flood is more or less same in India.
- More emphasis on policy implementations and protocols.
- Problem of over occupation of lakes and wetland due to uncontrolled urbanisation in Srinagar city, India.
- Appealing to NDMA, India for developing guidelines for robust but flexible to unknown and uncertain risks rather than "fixed, optimal engineering approach" .
- Avoid being locked in financing large-scale investments that might prove obsolete with change in future risks.

5. **Vulnerable Critical Infrastructure- water infrastructure by Prof. Kapil Gupta**

Describing critical infrastructures that includes communications, emergency services, energy, dams, finance, food, public services, industry, health, transport, gas, information technology, commercial

facilities, chemical and nuclear sectors and water Prof. Gupta took example of Latur dam - reservoir induced seismicity and extreme drought that needed water supply through rail water tankers. Significant investments are required to protect the water infrastructure:

- Investments in water and sewerage infrastructure
- Improvements in operation and maintenance
- Investments in flood protection works
- Protection of urban holding ponds and natural water courses
- Excessive groundwater withdrawal and contamination

Salient points:

- Water being a human necessity, provision of water supplies and restoration of water supplies should be accorded priority during disasters
- Water sector should embed disaster risk management into their core activities
- Water sector should network and cooperate with each other for effective disaster risk management
- The role of international cooperation is extremely desirable for sustainable disaster risk management
- Existing codes and manuals of practice need to be updated regularly to include latest developments in technology and knowledge

6. **Development of Infrastructure by Prof. CVR Murty, Director, IIT-Jodhpur**

Prof. Murty gave following suggestions:

- Education: International Masters Degree Program 1 for each Sector :Hosted in India with faculties hired from all over the globe
- Standards: International Best Practices Exchange Program; 1 for each Sector ::Hosted in India ::
- Professional services: System for Licensing of Engineers in India 1 for each Sector ::International Best Practices
- Techno-legal regime: System for Peer Review of New Infrastructure in India
- Retrofit: International Critical Infrastructure Assessment & Retrofit Program
- Human resource: International Skilled Worker Development Program
- International Continuing Education Program for Engineers
- Pilot Infrastructure Development Program
- Formal effort needed for securing Infrastructure
- Policies and Implementation Program to affect substantive change
- Indo–Japan Cooperation can champion this cause in many countries, including through Pilots Projects in India

Moderator's final remarks: Mr. Kamal Kishore gave an excellent coverage of the salient points after each presentation and at the last there was no questions asked by audience.

(Photos: Delegates visited Humayun Tomb, New Delhi)

Session 4: Early Warning System

This session was focused upon Early Warning Systemsagainst earthquakes, communication of early warning to citizens and response of the national government following the early warning. The session was moderated by Ms. Setsuko Saya, Director, International Cooperation Division, Disaster Management Bureau, Cabinet Office, Japan. In her opening remarks, Ms. Setsuko Saya highlighted the need and importance of earthquake early warning system. Brief details of the five presentations made during the session are as following:

1. Preparing Earthquake Early Warning (EEW) in Japan byDr. Masumi Yamada, Assistant Professor, Disaster Prevention Research Institute, University of Kyoto

Dr. Masumi Yamada in presentation on "Preparing Earthquake Early Warning (EEW) in Japan" started with Tohoku Earthquake- 2011, where location and magnitude of the earthquake weredetermined and early warning was issued within 27 seconds. Within three minutes observation,seismic intensity was reported and Tsunami Warning was issued within 3.5minutes. She further explained the concept of EEW with the help of an algorithm where receipt of P-Wave, source estimation is done of an earthquake and EEW is issued before the arrival of S-wave. Based on the EEW for Tohoku earthquake 27 bullet trains were stopped without derailments; however, the bullet trains infrastructure had some damages in terms of damage to cable column, damage to cables, damage to column, and damage to rail tracks.

Dr. Masumi Yamada further explained that for effective EEW there are pre-requisite which include good infrastructure, information technology and good knowledge of seismology. She quoted example of availability of seismic stations in India and Japan where India has a network of 82 observatories, spread over the entire length and breadth of the country while Japan maintains a network of about three thousand observatories covering entire country. After receipt of source information of the earthquake, EEW is shared by the Japan Meteorology Agency with the community using television, radio, cell phones and other available means for this purpose with expected level of shaking. At the same time information was sent to bullet trains and factories and other such services, which stop functioning on receipt of EEW. Highlighting the importance of good knowledge of seismology, she explained that for estimating the level of shaking is based on three steps. In the first step location of an earthquake is estimated with arrival times of P-waves. In the second step magnitude and displacement are estimated using standard equations. In third step shaking intensity is estimated using Magnitude and displacement.

Dr. Yamada in her presentation discussed an example of possible scenario for EEW in case of Bhuj earthquake. There are three seismic stations located at Bhuj, Bhavnagar and Jaisalmer in that area. The expected arrival time of P-wave at these three stations are 10 seconds, 40 seconds and 60 seconds respectively. In comparison, the EEW was issued within 27 seconds after the occurrence of Tohoku earthquake. In the end she highlighted the importance of dense network of seismic stations

which can help in early detection of P waves, which will help in making useful calculations for effective early warnings.

In the last part of her presentation, Dr. Yamada highlighted the facts and figures about the number of EEW issued in Japan and issuance of false warning. In one of the examples quoted by her an EEW was issued for an earthquake of Magnitude of 7.8 while in reality the earthquake was only 2.3 magnitude. All such warnings were issued due to the problems associated due to noise and occurrence of simultaneous earthquake, which were observed by the seismic strains at the same time leading to issuance of false EEW. As far the public perception about the false warning only 3% people got upset while 28% of people were not upset, but concerned, another 40 % people have no choice while rest of the people surveyed were unconcerned or disinterested. In the end she concluded that for an effective EEW system required public education in addition to good infrastructure, information technology and good knowledge of seismology. She further highlighted that there are challenges for EEW which include underestimation of intensity and poor identification of hypocenter. The system is working on improving the EEW to make it work more accurately in coming days.

Salient Points:

- Demonstrated Earthquake early warning (EEW) for great East Japan (2011) earthquake. Early Warning was issued within 27 seconds. Within three minutes Observed Seismic Intensity was reported and Tsunami Warning was issued within 3.5minutes.
- Effective EEW there are pre-requisite which include good infrastructure, information technology and good knowledge of seismology
- Highlighted the importance of dense network of seismic stations which can help in early detection of P waves, that will help in making useful calculations for effective early warnings
- One of the few challenges for EEW, include underestimation of intensity and poor identification of hypocenter

2. National Early Warning System for Tsunami and Storm Surges by Dr.Patanjali Kumar, Scientist, INCOIS

Dr. Patanjali Kumar in presentation on “National Early Warning System for Tsunami and Storm Surges” started with tsunami on December 26, 2004 generated by magnitude 9.1 earthquake. The tsunami resulted in 238,000 causalities, including 51,500 missing. In India alone, 16,389 causalities including 5,640 missing people were reported. The few of the reasons for huge loss include limited risk assessments, limited seismic and sea level data, ignorance of natural signs, no ‘Tsunami Early Warning System’, and limited community awareness etc. He further explained that there are two potential Tsunamigenic Zones exist in the vicinity of India which include Andaman-Sumatra subduction Zone and Makran

Subduction Zone. Both of these Zones have recorded history of generating tsunamis which had impacted the India Coasts.

While discussing about the Indian Tsunami Early Warning System, Dr. Kumar discussed about the risk assessment, detection, warning, dissemination, awareness and response. For assessing tsunami risk historic earthquake data base is used in addition to paleo tsunami studies and studies related to tsunami Travel Times. For detection of tsunami existing observation networks like seismic network, BPR network and tide gauge network are used. For communications VSAT, GPRS and INMARSAT are used. For tsunami warning generation warning centre uses information related to bathymetry, tsunami modelling, topography and costal vulnerability. For tsunami warnings, Decision Support System (DSS) along with standard operating procedures (SOP) along with ICT infrastructure are used. For improving response to tsunami warning, regular communication tests, tsunami drills, trainings and distribution of publicity material are used. In addition regular programmes on capacity building and research on paleo-tsunami studies, tsunami modelling and GNSS Data use are done. In the tsunami early warning system the participating institutions include IMD, NIOT, ICMAM, SOI, NRSC, INCOIS, MHA, NDMA, coastal states, academia.

Tsunami Early Warning Centre works 24 x 7, which collects heterogeneous real-time data from a variety of Sensors for issuing the tsunami early warning. The data is collected from real-time Seismic Monitoring Network of 27 broadband seismic stations and seismic data from International stations (GEOFON / IRIS), Indian Tsunami Buoys Network (comprised of real-time network of 7 Tsunami Buoy Systems) and Indian Tide gauge Network (comprised of - INCOIS installed 31 tide gauge station along Indian coast line and Islands) and Receiving 14 tide gauges data from NIOT.

The Indian Tsunami Early Warning Centre (ITEWC) services for an event commence whenever an earthquake is recorded with $M \geq 6.5$ within the Indian Ocean and $M \geq 8.0$ outside of the Indian Ocean. ITEWC identifies four threat levels corresponding to different public responses as per NDMA guidelines. Similarly, ITEWC issues regional tsunami warning.

The ITEWC issues Tsunami warning which is disseminated to International Level (All 23 Indian ocean rim countries), National Level (MHA, NDMA, Ministry of Earth Sciences, NDRF Head quarters, IMD & CWC), all coastal states, all coastal district level and responsible Institutional network at national level including NDRF, NDMA including media and public The warning re issued using Fax, Email, SMS, Web resources and GTS. In addition, INCOIS implemented a fail-safe satellite-based communication system "VSAT aided Emergency Communication System (VECS)" at 7 Emergency Operation Centres (EOCs) of A&N.

Dr.Patanjali Kumar highlighted that for tsunami preparedness and response, communications tests, SOP workshops, tabletop exercises and mock drills are conducted regularly. In addition, INCOIS has worked out coastal inundation mapping, coastal multi-hazard vulnerability assessment, 3D GIS mapping for coastal disaster management, risk assessment at building level, evacuation routes and evacuation plans.

In the end of the presentation, Dr. Patanjali Kumar had highlighted the challenges faced in tsunami early warning which include under-estimation of magnitude of the earthquake and tsunami wave heights. According to Dr. Kumar, INCOIS is working to overcome few of such challenges by using Strong Motion data for Magnitude calculation, GPS data for Displacement estimation, Sirens connected via VSAT or VHF or wireless technology and Community awareness and preparedness.

In addition, INCOIS is working for Storm Surge Advisory in collaboration with IMD for the cyclonic storms.

Salient Points

- Reasons for Tsunami (2004) impact in the Indian Ocean Rim countries were due to: no Tsunami Early Warning System, limited risk assessments, limited seismic & sea level data, Ignorance of natural signs, ,limited/No community awareness, limited response planning, absence of coordinated international effort.
- For a tsunami to hit Indian coast, it is necessary that a Tsunamigenic earthquake occurs and its magnitude should be larger than M 7. Possible locations of such events are shown.
- Indian Tsunami Buoys Network and Tide gauge network, Tsunami warning decision support systemexplained.
- The Indian Tsunami Early Warning Centre (ITEWC) services for an event commence whenever an earthquake is recorded with $M \geq 6.5$ within the Indian Ocean and $M \geq 8.0$ outside of the Indian Ocean.
- Uniquely designed SOP for generation of timely and accurate tsunami bulletins to handle both near-source and far-source coastal regions.
- Full scale mock Tsunami Drill to evaluate and improve the effectiveness of SOPs of TWC and DMOs, in responding to a potentially destructive tsunami.
- On October 12, 2011 UNESCO handed over the responsibility of Indian Ocean tsunami advisories to the Tsunami Service Providers India, Australia and Indonesia.
- INCOIS Storm Surge Advisory was provided in collaboration with IMD for the Cyclone Hudhud (2014), Hudhud (Oct, 2014), Nilofar (Oct,2014), Ashobaa(Jun,2015), Roanu (May, 2016), Kyant (Oct, 2016), Nada (Nov, 2016), Vardah (Dec, 2016), Maarutha (Apr, 2017).

3. Operation by the Government after a Large-scale Disaster -Example from the Kumamoto Earthquake 2016 by Ms. Setsuko Saya, Director, International Cooperation, Disaster Management Bureau Cabinet Office, Government of Japan

Ms. Setsuko Saya, in the presentation gave an account of the Kumamoto Earthquake 2016. The Kumamoto Earthquake 2016 had a foreshock of M 6.5 Earthquake on April 14, 2016 before the main shock of M7.3 Earthquake on April 16, 2016. There were 249 deaths and 2,790 injured (as of 16 October 2017). More than 200,000 housings were damaged and destroyed. While briefing about the emergency management operation after the earthquakes, Ms.Saya indicated that Japan has a robust disaster management system at all levels. Starting with national level, the Headquarter for DM is located at Tokyo (Cabinet Office), which is headed by the Minister of State for DM including the heads of bureaus in line ministries and agencies as members. After the Kimamoto earthquake first meeting for supervising emergency management operation took place within 44 minutes under the chairmanship of the Prime Minister. The local level headquarter for DM was at the Kumamoto Prefecture under the Governor while the field headquarter for DM was established in Kumamoto was under State Minister of Cabinet Office for DM. Describing the different operation for management of disasters, Ms.Saya mentioned that during the emergency operations peak in the number of evacuees was 183,842 on 17 April while the peak in the food supply reached

610,000 meals on 20 April 2016. Overall total food supply support in the push mode operation 2.63 million meals were delivered to affected areas by "the push mode", which provided foods supply by the national government, prior to request from Kumamoto Prefecture. As far the support by government officials is concerned, 1,000 persons a day (April 26 – May 20, 2016) were dispatched from nationwide local governments, based on the support agreements. Overall approximately 960,000 persons were dispatched from the national government and nationwide local governments in composition of Ministry of Defence -approximately 814,200 persons, from Police - 27,936 persons, fire fighters - approximately 113,746 persons and Other Ministries - 8,388 persons.

It was highlighted that support agreements were concluded before the earthquake by the prefecture and city governments in Kumamoto. Overall 40 agreements were concluded before the earthquake which included 29 agreements with other Local Governments and private companies, 6 agreements with private companies and 5 agreements with other Local Governments.

Japan has a tremendous support system in terms of cooperation with volunteers and NPOs. The examples were quoted from East Japan Great Earthquake (2011) where 5.5 million persons volunteered. During Kumamoto earthquake (2016) – 120,000 persons and 300 NPOs provided their services while during Northern Kyushu Heavy Rain (2017) 40,000 persons 130 NPOs were engaged. The activities supported by these volunteers include removing mud out from houses and parking lots, removing and transporting driftwoods, arranging "toilet cars", consulting environment improvement at evacuation centres and supporting management of volunteer centres.

While concluding her presentation Ms.Saya highlighted key lessons learnt from the Kumamoto Earthquake 2016 which include need for enhance support for the affected municipalities, Improve living environment of affected people, Secure temporary housings and support recovery of livelihood, Facilitate logistics to transport goods, effective use of ICT, promote "self-help" and "mutual support "and increase preparedness for the large scale disasters. All such lessons were integrated into the Basic Plan for Disaster Management to improve the operation for the future.

Salient points:

- Enhance support for the affected municipalities
  - ○Capacity building of mayors and senior officials through training
  - ○Dispatch support staff who knows the area and disaster
- Improve living environment of affected people
  - ○Proper usage of the list of people who need special support during evacuation
  - ○Share information with experts for the management of evacuation centers
- Secure temporary housings and support recovery of livelihood
  - ○Improve systems to assess damage level of housings.
  - ○Use systems to support issuing the certificate of being affected by disasters.
- Facilitate logistics to transport goods
  - ○Develop systems to share information on logistics and needs
  - ○Share info on privately owned facilities which could be used as logistics hubs
- Use ICT
- Promote "self-help" and "mutual support"

4. Earthquake Early warning by Prof. M. L. Sharma, IIT Roorkee

Prof. M. L. Sharma during the presentation "Earthquake Early Warning" started with a description seismic hazard, vulnerability and risk. He mentioned that seismic hazard can be calculated through deterministic, statistical and probabilistic approaches while the vulnerability may be multi-dimensional as physical, social, economic, environmental, institutional and human factors. Vulnerability is dynamic, which changes over time. At the same time it is also scale dependent, which can be expressed at different scales from human to household to community to country resolution. Seismic risk can be in terms of loss of life and economic loss.

Prof. Sharma further described in detail about the Pilot Project on Regional Earthquake Early Warning (EEW) for Northern India. This project is funded by MOES for North India and it is being implemented by the IITR. Under the project IIT Roorkee has deployed 84 stations streaming data in real time in 2015; 26 stations installed at blocks/*tehsils*/districts networked using SWAN Uttarakhand and 58 stations were installed inside BSNL towers and are connected using VPNoBB. Algorithms were tested for real time. Simulation for performance of the software successfully completed using previously recorded data of Taiwan of similar instruments installed in similar conditions. IITR hostels have been used to test and demonstrate functioning of the EEW system. The current status of the project is that it has been taken over by Uttarakhand State Government; all sensors are working successfully. Under the new setup it has been agreed to maintain existing 84 sensor network and to deploy another set of 100 new sensors; the new network/set-up has to be expanded towards Dharchula area; to develop algorithms to issue warning to society; to installation of sirens at District Headquarters and installation of sirens at SEOC, Dehradun and Haldwani.

Prof. Sharma highlighted the need for made in India EEW system. According to him, there is an urgent need to instrument about 5 million km2 covering 16 north and northeastern Indian states covering 24 clusters. Overall 5000 sensors need to be deployed in the area. IITR can develop all necessary equipment like sensors, application software and dissemination Apps for the stakeholders like MHA – NDMA, foreign manufacturer, DOT, private partners (Institutional and commercial).

Salient Points:

- Development of EEW dissemination system in context of India;
- development of shake map/intensity map using EEW;
- Hardware development for disseminating earthquake early warning using various medium such as Internet, Radio Waves etc.;
- Development of location based warning system which incorporates local site effects and attenuation;
- Development of a dedicated GIS for maintenance of EEW warning system;

- Development of an algorithm which can be used for various purposes in On-Site Early Warning System (Hybrid);
- Development of smart phone apps which can transmit a warning message without any network (peer to peer); and
- Preparation of an IT based Application for identification of victims of disaster.

5. Active Tectonics of Himalayan Faults/Thrusts System in Northern India on the basis of recent and Paleo Earthquake Studies by Dr. Sushil Kumar, Scientist & Head, Geo-physics Department, Wadia Institute of Himalayan Geology

Dr. Sushil Kumar during the presentation on 'Active Tectonics of Himalayan Faults/Thrusts System in Northern India on the basis of recent and Paleo Earthquake Studies' started with a description about the Indian scenario where Himalaya is rising as a consequence of the collision of Indian Plate with Asian Plate. To observe the movement of faults in the north-western Hiamlaya region, WIHG is running Seismic Networks comprised of seismograph stations, GPS stations, Magnetotelluric (MT) stations and long-period Magnetotelluric (LMT) stations. According to Dr. Kumar, the Himalayan arc has been ruptured during the great earthquakes of 1897, 1905, 1934 and 1950 and the observed GPS convergence rates vary between -3 to -20 mm/yr (plus, minus 2 mm/yr) while the convergence rate for the Tibetan plateau is about -9 mm/yr (plus, minus 2 mm/yr) indicating that high movement of India Plate. Dr. Kumar further described about the space distribution and histogram of the local seismic activity in the NW Himalaya.

Dr. Sushil Kumar highlighted that WIHG is collecting multi-parametric geophysical data since 2007 for earthquake precursory research at their observatory located at Ghuttu, Uttarakhand. Various parameters observed include BBS and Accelerograph, GPS and strain meter, magnetic observations, EM Emission in ULF Band, ground water, radon monitoring, super conducting gravimeter and resistivity measurements. It can be concluded that Himalayan frontal zone is the active deformation zone that lies between the MBT and the HFT. Deformation and thrusts have migrated to the south. HFT zone show quaternary-Holocene deformation.Active tectonics of Himalayan frontal zone lies in the frontal active zone between the MBT and HFT, there active frontal anticlines like Mohand and Janauri anticline and the HFT. Accordingly distribution of piedmont fans on both N & S slope; and the faults and drainage pattern in the valley are noticeable.These active faults, out of sequence Bhauwalafault. HFT demarcate a physiographic tectonic break between the frontal Himalaya and Ganga alluvial plain.

The cross-section across Dehradun structures along Dehradun andMohand based on seismic profiling clearly showing a HFT dipping NE. In the front is Mohand anticline of Dehradun in both. At the same time sshortening and slip rates have been estimated on the HFT using uplifted stretch terraced. The shortening ratio is 14±2 mm/yr.

According to Dr. Kumar six trench siteshave been extended on the Himalayan front along the HFT for paleo-seismological study. The data obtained from six trenches have been analysed to constrain the timing of earthquake event. Based on this paleo-earthquake dating 1500 AD has been found.

This earthquake shows evidence of surface ruptured fault extending some 250 km along strike. Similarly, rapture zones of historical earthquakes have been identified in the Himalayan front along withestimation of slip rates for the earthquakes of 1505, 1555, 1803, 1833, 1905, 1934, 1950, 2005. Maximum slip rate observed was 40-50mm/yr.

Salient Points:

- Segment between HFT and southern extent of Micro-seismicity zone is locked as per GPS measurement;
- Micro seismicity zone represents elastic strain is accumulating there;
- Evidence suggests that surface rupture earthquakes in the HFT zone;
- Inferences that large to great earthquakes take place in locked segment. The rupture produced by the earthquake propagated to south and recorded on the HFT as recorded in the trenches; and
- Future next large to great earthquakes may take place in this locked zone.

Session5: Preparedness/ Response at Sub National level

Focus of this session was on earthquake risk preparedness. During this session two major questions addressed include (i) how do sub-national governments prepare for and respond to earthquakes?; and (ii) how do local communities develop their resilience by planning in advance.

The session was moderated by Lt. Gen (Retd.) N. C. Marwah, Member, NDMA. In his opening remarks **Lt. Gen (Retd.) N. C. Marwah**, Member, NDMA highlighted the need for robust earthquake disaster preparedness for handling the impending earthquake disaster. During the session following six presentations were made by:

1. **Brig. Ajay Gangwar, Adviser (Ops), NDMA** in his presentation on **"**Preparation and Response by Sub national Governments" discussed the importance of sharing responsibilities amongst different divisions of governments and various agencies; coordination within and across sectors and with stakeholders at all levels; and present institutional mechanism at national and state levels in the country. Brig. Ajay Gangwar highlighted that India has a very elaborate institutional mechanism including Cabinet Committee on Security (CCS), National Crisis Management Committee (NCMC) and National Executive Committee. Overall responsibility of DM lies with Ministry of Home Affairs while sector specific disasters are dealt by the concerned Ministries. India has some specialised agencies like NDMA, NIDM and NDRF working at national level. Similarly, all states have SDMA and few states have SDRFs as well. Every state has an equally elaborate DM system that also includes DDMAs.

Brig. Gangwar highlighted four priorities for actions, which are as follows:

A) Under the category on understanding risk four types of activities are being carried out at national level which include

- Earthquake monitoring services to share information widely;
- Scientific Seismic Zonation to ensure implementation; monitoring and awareness creation;
- Seismic micro-zonation to carry out end-user needs assessment;

- Hazard Risk Vulnerability Assessment is being done as part of preparing and periodic revision of DM Plans.

B) Under the category on strengthening governance three types of activities are being taken care as following:

- Overall disaster governance include preparation and implementation of DM plans and ensuring the functioning of agencies with DM tasks;
- Organizing the immediate response and assistance from central agencies; and
- Adapting the norms/ regulations as per State's requirement, enforcement and monitoring

C) Investment in DRR can be grouped in two major groups as:

- Structural Measures which include strengthening and seismic retrofitting of buildings in all government departments, public buildings and schools; hazard resistant construction through collaboration with technical agencies and implementation; and social housing schemes to ensure that earthquakes resistant features are incorporated in planning and execution of these schemes.
- Non-structural Measures include regulations, model codes and safety audit of lifeline structures and buildings by adopting suitable byelaws and ensuring strict compliance; licensing and certification of professionals through appropriate legal framework and institutional mechanism; and public private partnerships in disaster management facilities.

D) Enhancing Disaster Preparedness measures include training DM workers and volunteers, curriculum development for different academic courses, awareness generation among the masses, conducting mock drills/exercises, empowering women, marginalized and persons with disabilities and encouraging community-based disaster management.

2. **Mr. Daisuke, Sugawara, Acting Manager, Housing Policies Section, Urban Planning Bureau, Sendai City, Japan**

Mr. Daisuke Sugawara started his presentation with a brief introduction about the Sendai City, which was severely impacted by the tsunami generated due to the Great East Japan Earthquake. Sendai is a city located in the centre of the Northeast area of Japan, and has more than a million people. The east area of Sendai is facing the Pacific Ocean. There were two kinds of serious damages due to direct impact of the Great East Japan Earthquake and the impact of the tsunami, generated by the earthquake, which was confined to eastern parts of the city. After the Great East Japan Earthquake, Sendai city reviewed the DM plan, taking the existing damage assumption and the propositions given from the Earthquake into account. The Sendai city prepared various countermeasures before disaster occur, which included countermeasures against various damage assumptions, such as accidents at nuclear plants, which were not included before the Great East Japan Earthquake. Also the City prepared the disaster prevention plan against the most serious damages which include preparation of the DM plan in anticipation of the worst case, considering

possible damages estimated by the national and Prefecture governments, and the results of disaster simulation implemented by municipality of Sendai. To build back better Sendai prepared for and responded to future earthquakes by:

☐ Helping people to understand disaster risk information - in order to provide information on what is disaster and how to escape, giving lessons learned from the Great Earthquake, Sendai developed a Tsunami Evacuation Guide, and distributed it to all households. This Tsunami Evacuation Guide is available in English, Chinese, Hangul and Japanese.

☐ Making place and residential area safe by three defences as Coastal Levee, Elevated Road, and another elevated road named Sendai-Tobu road. Residents lived in the coastal area relocated to the inland residential areas where rice fields are developed. Trees were planted and reuse the vacant places after the relocation. In addition Evacuation space (park), evacuation staircases and evacuation towers have been constructed to protect the community from tsunami.

☐ Reinforcing existing buildings (public and private) - public buildings including schools, housings and social public utilities (transportation, water supply, gas) have been retrofitted 100% after the earthquake. In addition additional strength has been provided to special buildings like City hall, Hospitals, Fire stations, Elementary schools, Ward offices and Social housings in comparison to existing building code requirements.

☐ Improving disaster-resistance for new structure buildings - About 90% of 560,000 houses in the city have been constructed or reinforced to be anti-earthquake after the Great East Japan Earthquake. The percentage of anti-earthquake buildings has been improved to be 91%, in the section of private buildings that are large and specific use, such as hospitals, private schools, theatres, and hotels. The city has a new hospital developed by municipality of Sendai. It has eleven stories above ground and one below. The building is designed as a seismic isolated building, as it is required to be a hub hospital in a time of disaster.

3. Disaster preparedness in the state of Bihar -some initiatives by BSDMA/Government of Bihar by Dr.Vyas Ji

Giving outline about state specific disasters such as Lightning, Heat Wave, ExcessRainfall, Unseasonal and Heavy Rain, Boat Tragedies, Drowning (rivers, ponds and ditches), Human Induced Group Accidents such as Road Accidents, Airplane Accidents, Rail Accidents, and Gas Leakage, etc.Mr Vyas Ji, discussed **the following:**

- Policies: Bihar State DMt Policy (2007), Bihar State Action Plan on Climate Change (2015), DRR Roadmap for 2015-2030 (2016)
- Plans: State DM Plan (2013), District DM Plans in all the 38 districts
- SOPs/ directives: Flood Management, Fire prevention, Drought Management, Drinking Water Crisis, Fire safety in Hospitals and Protocol for Treatment of AES
- Financial Management: State Disaster Response Fund and State Disaster Mitigation Fund
- DRR Roadmap is aligned with three global agreements signed in 2015 i.e. Sendai Framework (SFDRR), the SDGs and Paris Climate Agreement.

4. Community Disaster Management Plan System by Mr. Toyokazu Tamura

Giving brief about community based DM plan in Japan, the Basic Act on DM was amended to establish the Community DM Plan system which defines a DM activities at the community level in consideration of local circumstances. Citizens of the community may develop a plan taking into account of geographic and social characteristics of the community. Moreover, citizens may propose their Community DM Plan to be integrated as a part of a Local DM Plan for a municipality.A Community DM Plan may cover various kinds of disaster preparedness and management activities, which were elaborated during his presentation.

5. Disaster Risk Reduction Sikkim by Prof. V.K. Sharma, Vice Chairman, SDMA, Sikkim, India

Giving comprehensive background of the DM structure of Sikkim that specially came into force following Sikkim (2011) earthquake, Prof. V.K. Sharma sequentially described status in terms of the followings:

- State DM Act
- State Plan for DM
- District DM Plans for all four districts
- Panchayat level DM Plans (in preparation)
- Departmental Plans
- Mainstreaming DRR in every sector

Citing how Central Government supported various efforts taken at the state level, some of which are:

- NDMA supported School Safety Programme
- State launched state-wide school safety programme
- Disaster Education&Awareness
- Earthquake safety Day- 18 September
- DRR in teacher's training programme
- Books and material translated in local language- Nepali

6. Role of National Disaster response force to Earthquakes by Mr.Ravi JosephLokku, Inspector General, NDRF

Explaining the institutional structure of DM system in India, Mr. Ravi Joseph Lokku defined the roles of central government and state government, which are as follows:.

- National Level – NDRF, Defence Force, CAPFs & other Central Agencies as & when required (Level-III disasters)
- State Level – SDRF & other State Agencies (Level-II disasters)
- District Level – Civil Admn., Local Police, Civil Defence, Fire & Emergency Services, Home Guards etc. (also Local Community, NGOs, Voluntary Agencies) (Level-I disasters)

NDRF battalions are located at twelve different locations in the country based on the vulnerability

profile to cut down the response time for their deployment. NDRF with its swift and highly skilled rescue operations has emerged as most visible and vibrant force of the NDMA. NDRF personnel are invariably trained in courses like Flood Rescue, Collapsed Structure Search and Rescue, Medical First Responders, Rope Rescue, Nuclear, Biological and Chemical Emergencies; Dignified Disposal of Dead Bodies etc. NDRF personnel are trained in prestigious institutes like NISA, DRDO, BARC, CME, Army, Navy and Air Force as well in foreign countries like US, Singapore, China, Finland, Korea, Switzerland etc.

Session 6: Approaches by Private Sector

Opening remarks by Moderator Prof. Ravi Sinha, IIT-Bombay, India

In his opening remarks, Prof. Ravi Sinha has noted how so many Japanese Companies have come forward to help local and central govt. to reach to affected community with all possible technological measures addressed duly to various goals and targets defined in Sendai Framework (2015-30). Giving importance to private sector participation, he noted that few Indian companies are taking part voluntarily in relief and response measures. Therefore, it is felt that in this session an avenue is created to bring Japanese experience into the fore vis-à-vis learning for Indian sides.

Introductory remarks byMr. Akhira Doi,Secretary General, Japan Bosai Platform

At first, from Japanese side, Mr.Akhira Doi, Secretary General, Japan Bosai Platform (JBP), introduced altogether about 9 companies acclaiming various DRR technologies nurtured in Japan and now being applied across the globe. It's expressed that the main impetus for the formation of such platform came from the Great East Japan Earthquake (March 11. 2011). JBP is an association of Japanese private companies, established in 2014 headquartered at Tokyo, in which more than 100 member companies from diverse industries/expertise are engaged in saving lives and assets before disasters strike hard. It's operated by membership funds with services catering to engineering consultancies, construction, architectural, ICT, manufacturers of DRR equipment, GIS and remote sensing companies, etc.

Besides arranging technology seminars in Japan and for the visiting teams, JBP provides free online database, assist local and central governments agencies in finding cutting edge technologies developed by Japanese companies. The "Solution Map" so derived serves as "one stop shopping mall" in areas of DRR.

JBP consider partnerships with Indian side in the following manner:

- JBP proposes Made-in-Japan solutions to DRR related issues in India
- collaborate, jointly formulate, and implement projects in India
- joint development of DRR technologies for the global market

It is highlighted that DRR technologies in Japan has brought several dimensions by combining flexible facilities with advanced information at the planning (preparedness), prevention and emergency response stages. Some of conditions for successful cooperation mentioned by Mr.Akhira Doi are:

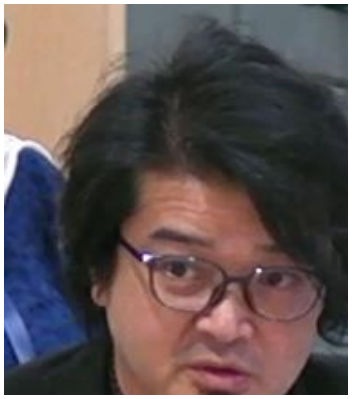
1. Japanese Government and Companies are already set through JBP with a long-term commitment in serving the DRR goals.
2. Expects from India to have a long-term commitment from planning stages through to implementation and beyond
3. Expects India-Japan work on a partnership mode, where domain experts from both countries shall collaborate in solving the DRR issues

While elaborating about partnership mode, Mr. Doi stressed for the functional collaboration among private and public sectors in India. A joint task force needs to be established for the effective coordination, technology transfer through DRR project formulation, sharing experience and accumulated data. For more details about JBP (www.bosai-jp.org).

1. One-Stop service Point for Disaster Risk Assessment-Dr Kazuo Kawamura

Giving a brief Company Profile, Dr Kazuo Kawamura, Air Asia Survey Co. Ltd. (AAS), gave many applications of Geospatial Technology for disaster risk assessment. AAS has expertise on terrain visualization, which was pictorially shown, how Red Relief Image Mapping (RRIM) gives clarity in the 3D terrain visualization that traditional methods are not capable of elsewhere. Application of RRIM in Slope mapping, earthquake induced landslides etc. was explained. Modality of partnership with India through joint ventures with companies in India and ODA/PPPs were mentioned. AAS also offered disaster database development jointly with India. In conclusion, Dr Kawamura, noted that India is susceptible to various geo-hazards and partnership with AAS can help in making enriched geospatial data set. For details (www.ajiko.co.jp/en/)

2. Earthquake Damage Assessment Using AW3D (Satellite Based DEM) - Mr. Akira Mukaida



On behalf of Remote Sensing Technology Centre of Japan, Mr. Akira Mukaida, gave a service assurance for using satellite data from JXSA, Japan. The main operational areas are given in Fig. 1. Some case studies on earthquake induced damage assessment, landslides, flood, and building damage distribution were explained. AW3D has been used in 73 countries for more than 400 projects, some of which are accorded thru' JICA, International Consortium on Landslides (ICL) and Tohoku-Gakuin University. Case studies include a) preparation of hazard map for long term reconstruction plan after Nepal (2015) earthquake, b) Landslide risk assessment technology and education in Vietnam and c) Early response to Tsunami in Japan (2011). In order to safeguard global targets and SDGs, AW3D ensures automated data processing, disseminate/archiving information to all levels, so that cities and human settlements are resilient enough (www.restech.or.jp/en) .

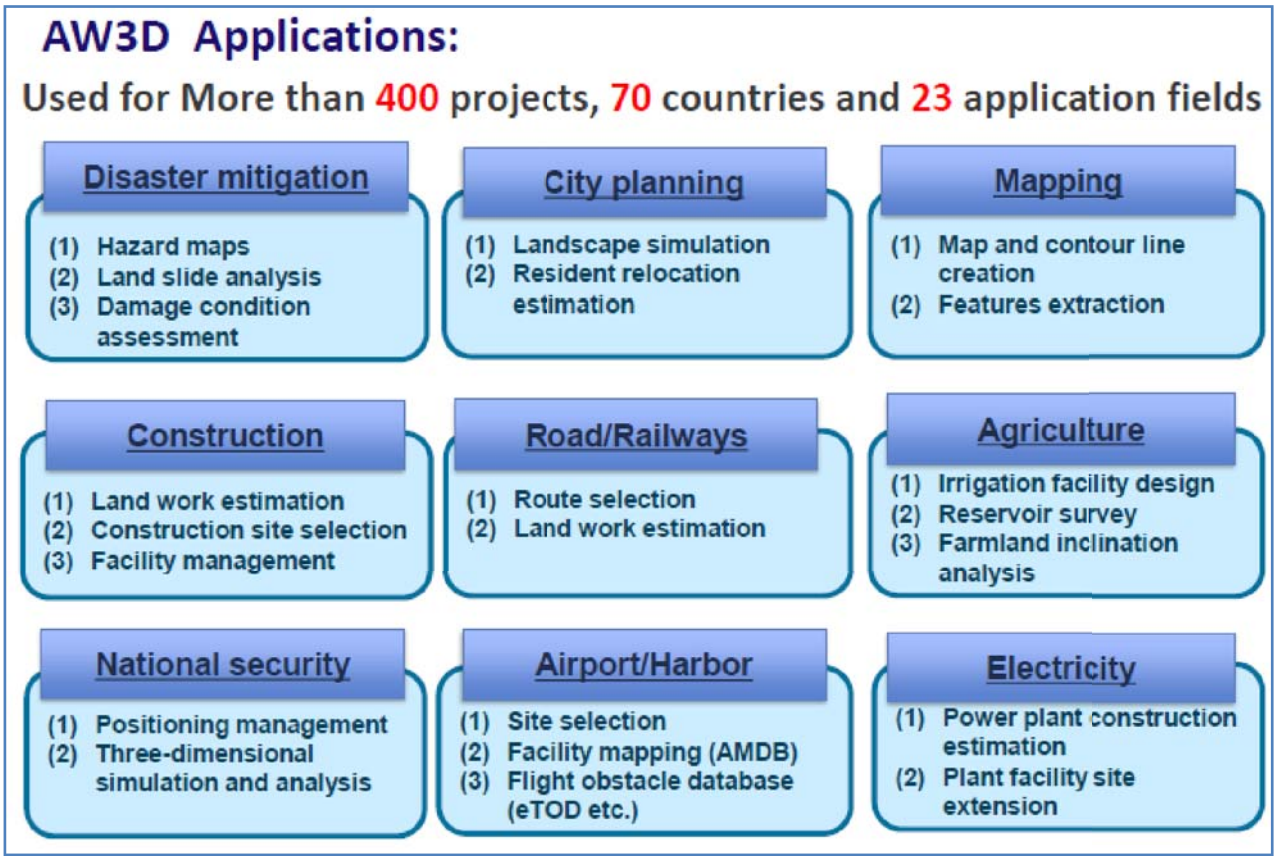


Fig. 1: Application domain of AW3D

A proposal for the DRR between India and Japan is given as below:

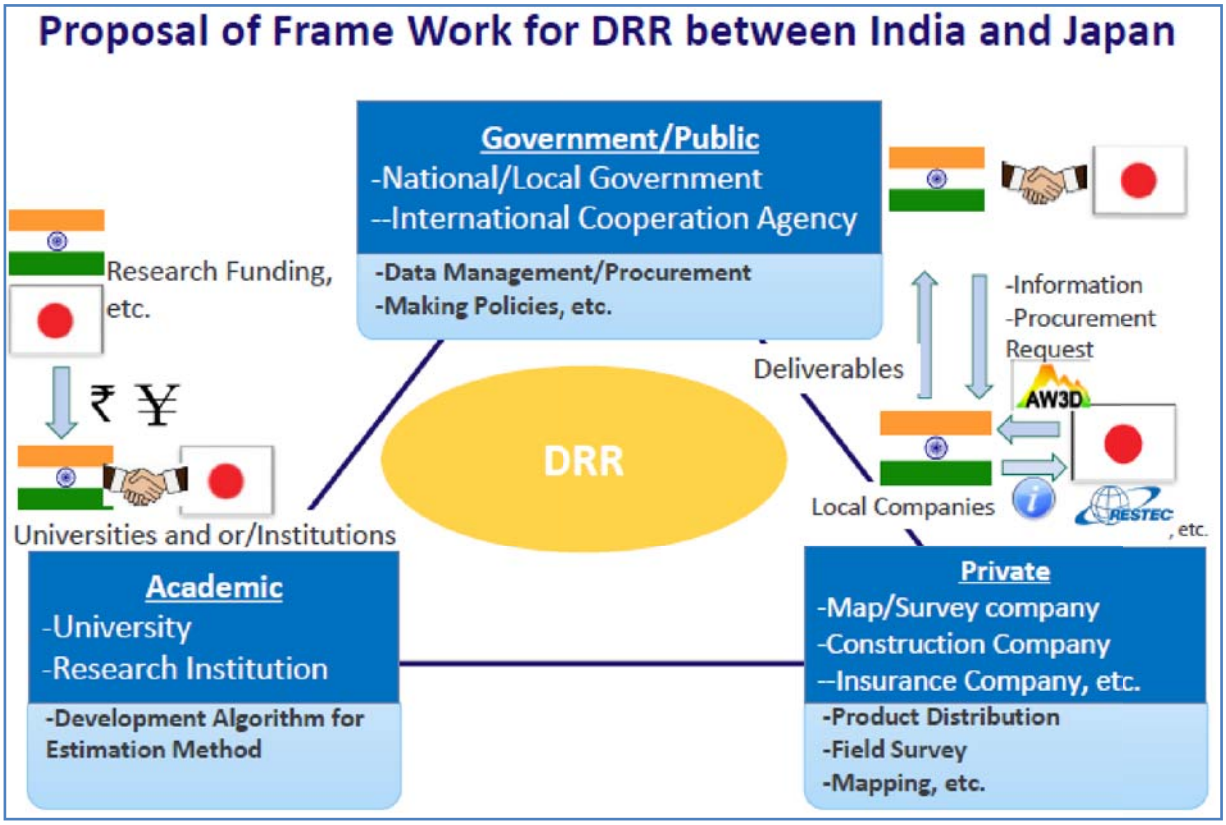


Fig. 2:A proposed framework for India and Japan in the domain of DRR

3. Implant Structure for Disaster Risk Reduction by Mr.HisanoriYaegashi

Mr.HisanoriYaegashi, GIKKEN Ltd., gave few examples of damaged coastal structure during Great East Japan earthquake of 2011. The company deals with a. Development of environment friendly construction solutions, b. Manufacturing and sales of construction machinery and c. Development of high-skilled undergroundfacilities in congested space. Based on the harsh experience that faced by Japan, his company developed Implant structure for attenuating the wave effect, which are otherwise not effective for conventional retaining walls. Many examples of Implant structures were given with visual effect/animation that highlight about the positional and relative advantage even in very constricted urban ambiance. The company has spread its expertise across 36 countries, including a bridge project Bangladesh and working or several projects where minimum disturbance to functional operations such as traffic, hospitals, emergency operation centre are ensured (www.giken.com/en/).

4. Building Hardware Contributing to Hospital BCP – Case Study of a Japanese Private Hospital–Mr.Masataka Ota

Giving brief introduction of the Fujita Corporation (Estd. 1910), spreading over 13 regions across the world, including one at Chennai,Mr. Masataka Ota explained the concept of Business Continuity Planning (BCP) specially for Hospitals that includes high end retrofitting, Base isolation, response control measures so that public facilities and hospitals can remain operational even after the earthquake. The company has built the institute of Child Hospital in Chennai (2016),Yamaha Motor India (2017), Renault Nissan Automobile India (2012) MunjlalKiriru India (2017) in which latest Japanese technologies are deployed. Several case studies in BCP specifically for accomplishing an effective control over demand and supply chain of hospitals during earthquake

were explained during presentation. The balance between soft and hardware that includes medicine, life lines, medical staff and facilities/equipments have been defined while examining BCP from emergency stage to restoring normal functioning. While taking cue from the Sendai Framework (2015-30), Mr. MasatakaOta gave several measures in reducing the mortality rate, economic loss and infrastructure damage mainly caused by earthquake. In order to enable BCP Fig. 3 presents few real lifeexamples (www.fujita.com/)

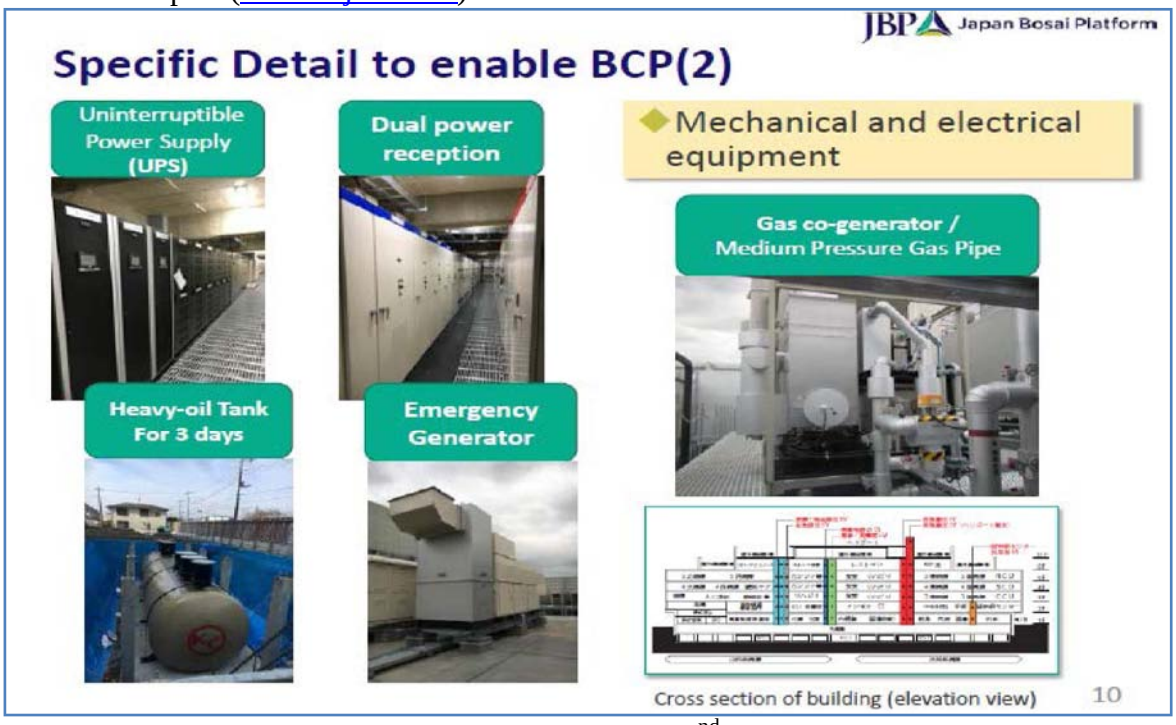


Fig. 3: Measures for Business Continuity Planning – 2nd stage (non structural components)

5. The Development of Tsunami Risk Reduction System by Mr. Kazuhiro Fukumoto

Established as Osaka Iron Works in 1881 by EH Hunter of England, Hitachi Zosen Corporation operates in Green energy and social infrastructure. Mr. Kazuhiro Fukumoto in his presentation described GPS wave meter, Flap-gate type sea wall that being evolved after facing devastating Japan-2011 earthquake tsunami. The impetus behind making Flap Gate wall was from the lesson learned by Japan, when great east earthquake generated Tsunami waves higher than the expected ones. These kinds of walls have been installed in several places in Japan to adjust the break water height and facilitating the prevention of backflow. The company has also been working on robust desalination plants, upgradation and maintenance of ageing infrastructures, state-of-the art of manufacturing GPS buoys for Tsunami warning system adopted by Japan Meteorological Agency (JMA - http://www.jma.go.jp/jma/indexe.html) and equivalent to Indian National Centre for Ocean Information Services (INCOIS - www.incois.gov.in).

6. Introduction of Earthquake Early Warning system by Mr. Naoki Kuwamori

Introducing about seminal work on earthquake early warning system in Japan since 1987, NEC Corporation, a Fortune Global 500 company, which is mainly reputed for telecommunications-IT-Enterprise business solution since 1889, developed Earthquake Phenomena Observation System (EPOS), which enables notification to public since the year 2007. Mr. Kuwamori described how Japan has installed more than 5700km underwater optical cable through the active cooperation

from National Research Institute for Science and Disaster Resilience (NIED - www.bosai.go.jp/e/) equivalent to recently modernized National Seismological Centre, MoES, India www.moes.gov.in/programmes/national-centre-seismology. The company offers a scheme for developing Earthquake Early warning System (Fig. 4) and proposes a demonstration experiment for India (www.nec.com)

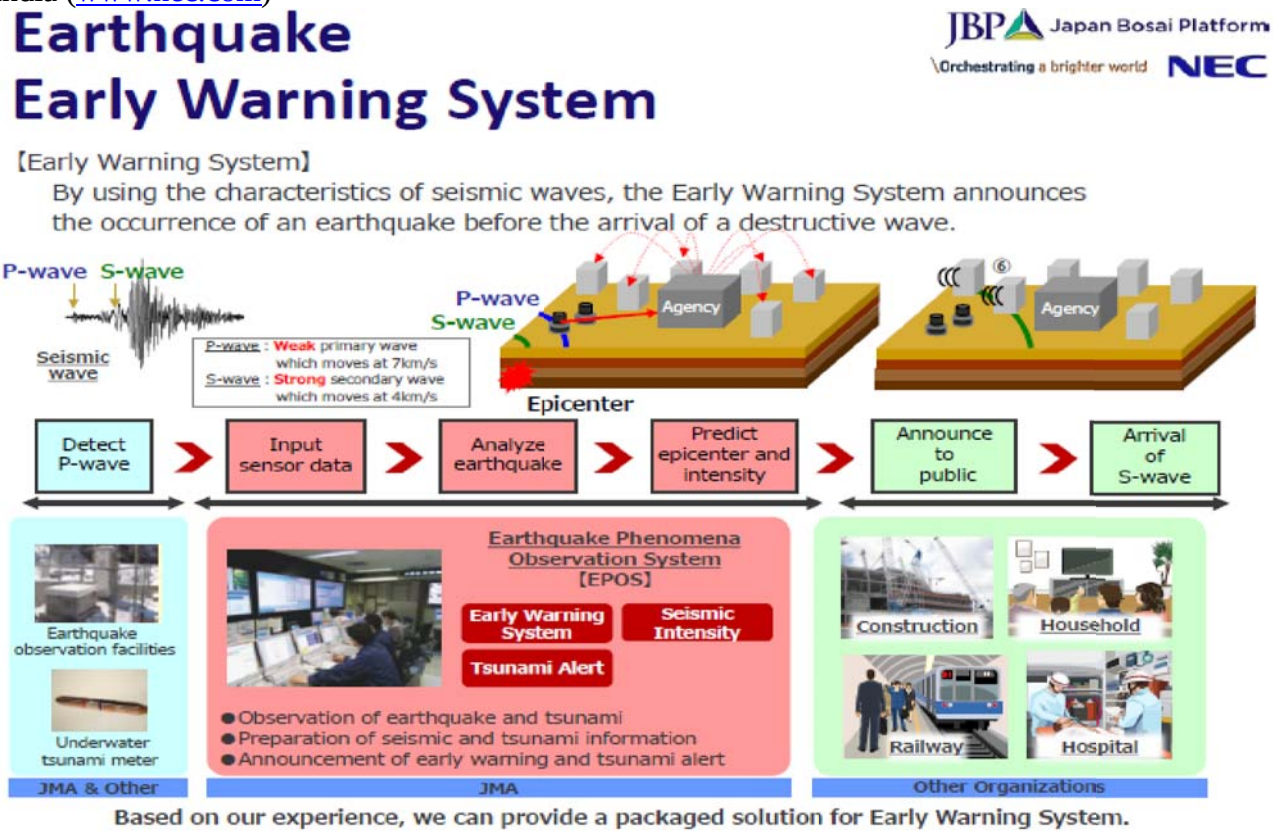


Fig. 4: Scheme of Earthquake Early warning System

7. Earthquake Sensor Alarm System by Kazuo Sasaki

Earthquake(EQ) guard is a sensor based alarm system used for detecting P-wave and after due signal processing it issues alarm to public. While presenting the system, My Kazuo Sasaki president of Challenge Co. Ltd., showed several onsite applications (about 1000 sets in Japan, Korea, Indonesia) of the same in school, nursery, nursing homes. The basic principle of operating EQ Guard is to detect P wave first before S wave arrives and controlled signals of the EQ Guard has been found very significant in shutting down chemical plants, nuclear facilities before dangerous waves strike. The benefit of this system includes a. it can work as stand alone aswell as local network with several other installations, b. Has the capability to function as regional earthquake alarm system that does not need nationwide dense seismometer network. The company offers cost effective applications for India with a free offer for a pilot in a span of 3 months (www.challengego.co.jp).

8. Real-time Tsunami Inundation and Damage Forecasting by Mr. Hiroshi Hiramoto

Giving brief about the Kokusai Kogyo Co. (Estd. 1947) in areas of technical services to energy, social infrastructure, environmental protection, DRR, Mr. Hiroshi Hiramoto described how geospatial based information technology was used for policy makers to effectively prepare for response and recovery. This system is found effective in decision making, DRR planning, inter-agency information sharing and keeping information up-date via intuitive geospatial information tools. The company provides DRR related services to Japan Government, both central and local level (B to G), businesses (B to B) and foreign countries via international development projects. Using its international exposure, the company offers following expertise to India: monitoring system at risky areas, resilient community planning, warning system and decision aids, map based administration and information sharing. A schematic of Indian Ocean tsunami damage forecasting is shown in Fig. 5 along proof of concept (PoC), deployment cost and possible partners from India. Recently (2017) Japan Govt. has deployed a super computer system for the forecasting of Tsunami damage and the company offers to establish the same in India. (www.kkc.co.jp/english/index.html)

9. Advanced Technology for Public Address System by Mr. KyosukeTanimura

TOA Corporation, a pioneer in manufacturing public address, Pro Sound and Communication system since 1934 and having business tie up with more than 124 countries, it has brought the importance of developing robust public address system. The worst experience faced during 2011 Tohoku earthquake tsunami, motivated the company to develop “Horn Array Speaker” with a range of 1km. An improvised system, called “slim array speaker”, which has been installed in more than 5400 location across Japan, includes intelligent public addressing with customized alarm, use of defined words to clearly inform what is happening where, etc. at the river banks, dams, seashores and tunnels. Clear cut evacuation guidance has been evolved to handle all kinds of disasters. A cost scheme for the application of the same technology is shown in Fig. 5 (www.toa.co.in)

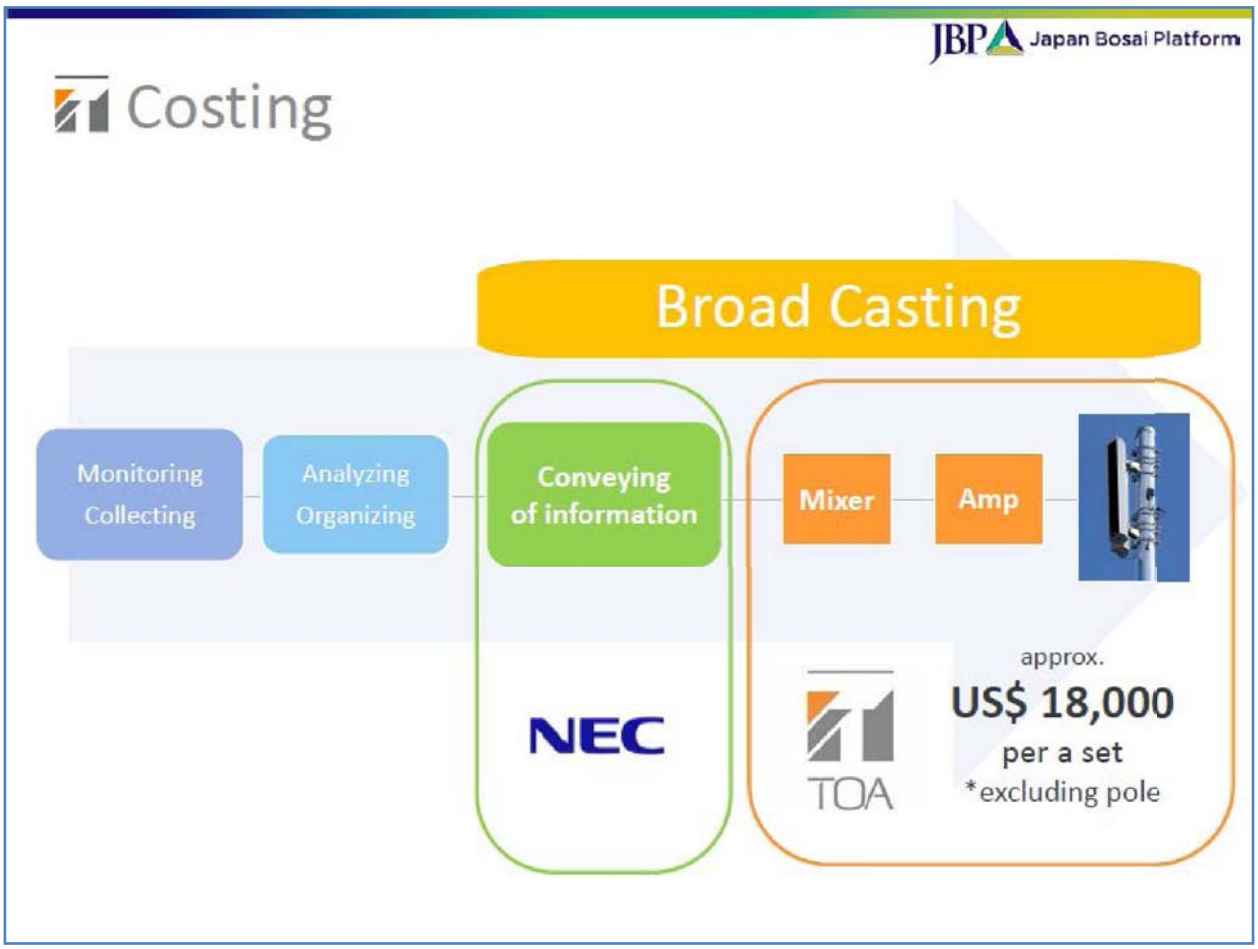


Fig. 5: Application and costing scheme for TOA HA-1010

PRIVATE SECTORS FROM INDIA

1. Giving brief about the Infrastructure Leasing & Financial Services Limited (IL&FS), in areas of various advisory and project development, Transportation Networks, Environmental Infrastructure & Services , Education and Technology, Area Development, e-Governance, Health Initiatives, Cluster Development, Finance, Power, Ports, Water and Waste Water, Urban Infrastructure, and Tourism by Mr. Mahesh Babu, MD, gave specific details of country's first fully integrated tunnel, 9.28 km long Chenani-Nashri Tunnel, located on the route of NH 44 in Jammu and Kashmir. Mentioning about wide scale solid waste processing within the country, the speaker mentioned the challenges of the Gazipur (near Delhi – Uttar Pradesh border), where several millions tones of solid wastes are piled up daily. The company has developed robust integrated GIS based decision support system for Solid Waste Management (www.ilfsindia.com/).

2. **Disaster Resource Partnership - An Engineering & Construction Industry Partnership for Disaster Risk Reduction and Response** by Lt. Gen Anil Mallick

Highlighting the various disaster Response roles in Jammu & Kashmir (2005) earthquake, Bihar (2008) flood, Leh (2010) cloud burst, Sikkim (2011) earthquake, J & K Avalanche (2012), Uttarakhand Flash Flood (2013), Lt. Gen Anil Mallick from Hindustan Construction Company talked on the following issues:

- Form an **ongoing collaboration between private industry, the public sector and humanitarian organizations** to leverage the core strengths and existing capacities of the Engineering & Construction (E&C) community.
- Ensures a **fast and effective deployment** of E&C expertise before, during and after a natural disaster.
- **Improves humanitarian response** through the direct application of engineering and construction skills and assets.
- Integration with sectors like Telecom and IT widens the scope of DRP and would help in **risk resilience and mitigation**.
- In the **immediate aftermath of a disaster**, a construction company already operating in the affected area is well placed to contribute labour, materials and equipment, as well as mobilizing networks and supply chains that can save lives and reduce suffering.

In leveraging the Assets, Services and Engagement of the E&C Community, the speaker recommended that:

- In the months following a disaster, the E&C industry has specific knowledge and technical expertise that is essential to promoting **early recovery**, particularly the reinstatement of critical infrastructure that is essential to establishing supply chains and making health and education facilities operational.
- The industry can **provide services such as damage and hazard assessment, hydrological surveys, seismic expertise, design, planning and programme management.**
- Early engagement in the relief and recovery phases means that E&C companies are well placed to contribute strategically to long-term planning of **reconstruction**, playing a critical role in **mitigating the risk of future disasters.**

At the last part of presentation, the speaker emphasized on the upgradation of Technology to meet Disaster Management Vision with special remark that Private Sectors in India are willingpartners and it needs to be inculcated as National assent in disaster Risk Reduction measure henceforth (www.hccindia.com).

Closing session

1. Worshop summary by Shri Kamal Kishore, Member NDMA

Acknowledging huge efforts taken up during the 2 days workshop and giving summary of all the 6 technical sessions, Shri Kamal Kishore stated two key points from each session. In session 1, India's ancient literature "Arthashastra", famine code-1880, dessert/watershed development program and Japan's effort in making white paper as and when each mega disaster hits the country were noted. In session 2, seismicity of Himalaya, which is different from what is faced in Japan. The seismic microzonation studies of Kolkata, Dehradunand paucity in the number of seismic stations (hardly few hundred in case India) where as more than 2000 no. in case of Japan were mentioned by Shri Kamal Kishore. The extensive studies taken up in Japan are highly significant and the evolving updates are noted. In session 3, complexity of designing bridges in earthquake prone areas, vulnerability of water infrastructures and eight specific goals as main take up from this workshop were mentioned. On Japanese side, development and management of disaster-proof infrastructures and role of site specific investigation by use of GPS, Laser profilers, drones, etc. were highlighted. In session 4, India's indigenous effort in establishing Tsunami warning system for the Indian Ocean rim countriesand earthquake early warning system at IIT-Roorkee were mentioned by Shri Kamal Kishore. In Japan meticulous studies taken up for the recent earthquakes and probability of more adversity likely be faced in near future were noted by him. In session 5, India's effective role in response, capacity building and revising DM plans at all levels were mentioned. Case studies of Bihar and Sikkim states were highly appreciated. Post great east Japan earthquake (2011) measures, specifically for the Sendai city were elaborated along with countermeasures against Tsunami and nuclear power plants outbursts. In session 6, Shri Kamal Kishore mentioned the trailer given on Day-1 about JBP and on Day-2 several technologies presented from nine companies of Japan, which are very much significant for India to adapt into its own requirement. From Indian side, experience shared by two private companies on GIS based decision support system and participation in the future Disaster management Vision of Government of India were highlighted.

2. Address by Mr Mamoru Maekawa, Vice Minister, Cabinet office, Japan

Mr Maekawa thanked India Governmentfor the successful organization of the 2 days workshop. He has offered all cooperation and assistance to establish effective S&T transfer in earthquake and Tsunami. He welcomes identifying specific areas of R&D among Indian and Japanese experts so that both country gets benefited.

3. Address by Dr. P.K. Mishra, Additional Principal Secretary to the Prime Minister, GoI

Thanking the organizers, Dr P K Mishra, pleaded both the Indian and Japanese institutions to develop a detailed follow up plan for cooperation. As noted from the thematic areas of the workshop, such as risk assessment, disaster resilient infrastructure, earthquake early detection and warning systems, disaster response, Dr Mishra sought to explore collective capacities to develop specific initiatives in all these areas. Those initiatives, according to him "should go beyond mere experience sharing to addressing specific problems. For example, can we look at doing a systematic analysis of how disaster control infrastructure in some specific part of the Ganga river basin be made resilient to multiple hazards – not just the current hazards but also future hazards? Or, can we look at what the last-mile-connectivity would mean in the case of early earthquake detection and warning in case of India? What kind of community leadership will be required for the effectiveness of such an early warning system?" "This workshop has revealed many opportunities for disaster risk reduction professionals in both the countries to learn from each other. How can we deepen this engagement? Can we identify specific areas where we can institute long-term mutual exchange programmes? Such exchange would need to go beyond cursory study tours to something deeper such as some joint research and development activity. Over a period of time, this will help us expand our cadre of professionals working on thematic issues discussed at this workshop".

3. Valedictory Address byMr. Kiren Rijiju, Hon'ble Minister of States for Home Affairs

Narrating a brief account of the Indian PM's 10 point agenda during AMCDRR-2016, Mr Kiren Rijiju, said "Science and Technology holds great potential in DRR and DRM. This is because the task of managing disaster risks and disaster events is contingent on scientific knowledge, while investment in DRR requires evidence-based risk management models and techniques. It is not possible to deal with hazards like earthquakes without understanding how parts of the Earth's crust interact with each other. In turn, such understandings help in designing quake-resistant buildings, EEWS, etc. When combined with good management practices, for example Critical Infrastructure Protection, one can build disaster-resilient infrastructure across a nation". "Additionally, detailed Hazard Maps and 'Human Settlement Layer (HSL) for Developing Exposure Models' can assist in DRR. Aerial imaging with aircraft and UAVs, and remote sensing, when combined with Geographical Information Systems, can help build Situation Awareness swiftly in the wake of a disaster. The development of accurate Early Warning systems for cyclones, tsunamis, rainfall, cloudbursts, flooding, etc are yet another example of how research and technology are contributing to both DRM as well as Disaster Management".He mentioned that through such interaction workshop, an excellent platform has been created for the companies from both countries to interact and identify specific areas of cooperation in Disaster Risk Reduction. At last he expressed "I am very happy to note that there are a number of areas of technical cooperation which would benefit the people of both countries. We are committed to take this forward in right earnest".

3. Dr. V. Thiruppugazh, Joint Secretary, NDMA presented vote of thanks in the closing ceremony.

Way forward

This workshop set out to develop a specific bilateral Action Plan on areas of cooperation under the broad theme of Disaster Risk Reduction. Both Japan and India gotbenefitted from the exchange of ideas on good practices, lessons learned and latest technological advancements in the area of disaster risk management. Experts from Japan shared the recent advancements in their country in the area of earthquake detection and earthquake early warning systems. India also has been afforded an opportunity to learn how Japan is committed in making its infrastructure resilient to present and future disaster risks.With India's robust policy, legal framework, institutional structures and capacity building activities, it has been able to take giant leaps in the field of disaster response, early warning and emergency preparedness. India, for the first time in the region, conducted two joint exercises, one for SAARC Countries and the others for BIMSTEC, where response teams from these countries jointly responded to the simulated disaster situations.

Sendai Framework, highlights the importance of regional approach and regional cooperation. In addition to regional cooperation, India also needed to have bilateral cooperation for sharing experiences, learning lessons, exchange of best practices, for technical cooperation and technology transfer. In this context, this conference which has the participation of experts, administrators, and private sectors from both the countries will help to charter a road map for working together in future. The technical sessions of the conference have been aligned with the four priorities of Sendai Framework. The session on risk assessment is part of the first priority which is understanding risk. The session on policy framework is an important component of disaster governance. The session on resilient infrastructure is the third priority of investing in resilient infrastructure. Two sessions devoted to early warning, preparedness and response are directly related to the fourth priority of enhancing disaster preparedness for efficient response and to build back better in recovery, rehabilitation and reconstruction. Any policy framework on Disaster Risk Reduction cannot stand in isolation. So it's important to bring coherence between Sendai Framework, Sustainable Development Goals and Paris agreement for climate change. Hence, the challenge is to evolve, country level policy framework for DRR, bringing this coherence.

Some of the important highlights as way forward from this workshop are:

- **Education:** International Masters Degree Program; 1 for each Sector: Hosted in India with faculties hired from all over the globe
- **Standards:** International Best Practices Exchange Program; 1 for each Sector Hosted in India
- **Professional services:** System for Licensing of Engineers in India; 1 for each Sector encompassing International Best Practices
- **Techno-legal regime:** System for Peer Review of New Infrastructure in India
- **Retrofitting of structures:** International Critical Infrastructure Assessment & Retrofit Program
- **Human resource Development:** International Skilled Worker Development Program
- To continue with the dialogue on Earthquake Early Warning Detection & warning dissemination system; Mock drill/preparedness exercise; school safety

Indo–Japan Cooperation can champion this cause in many countries, including no. of Pilot infrastructure Development Projects in India.

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Disaster Risk Reduction


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