Airport Infrastructure Resilience to Climate Change

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Outline

- Need for balanced & sustainable development
- CIDCO- Futuristic Planning of Navi Mumbai
- Navi Mumbai International Airport – building resilience
- Way Forward

Need for Balanced & sustainable development

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- Climate change and its repercussions are becoming more and more challenging. Environment is under stress due to increasing urbanization and the constant needs of development
- At the same time, infrastructure development is key to economic growth and cannot be avoided
- Coastal cities like Mumbai / Navi Mumbai, Kochi, Chennai and so on are specially vulnerable to this challenging tug of war between infrastructure development & protection of environment and the fragile coastal ecosystem

For Urban Planners, the challenge is in achieving a balance and creating resilient infrastructure

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Navi Mumbai – Futuristic Planning

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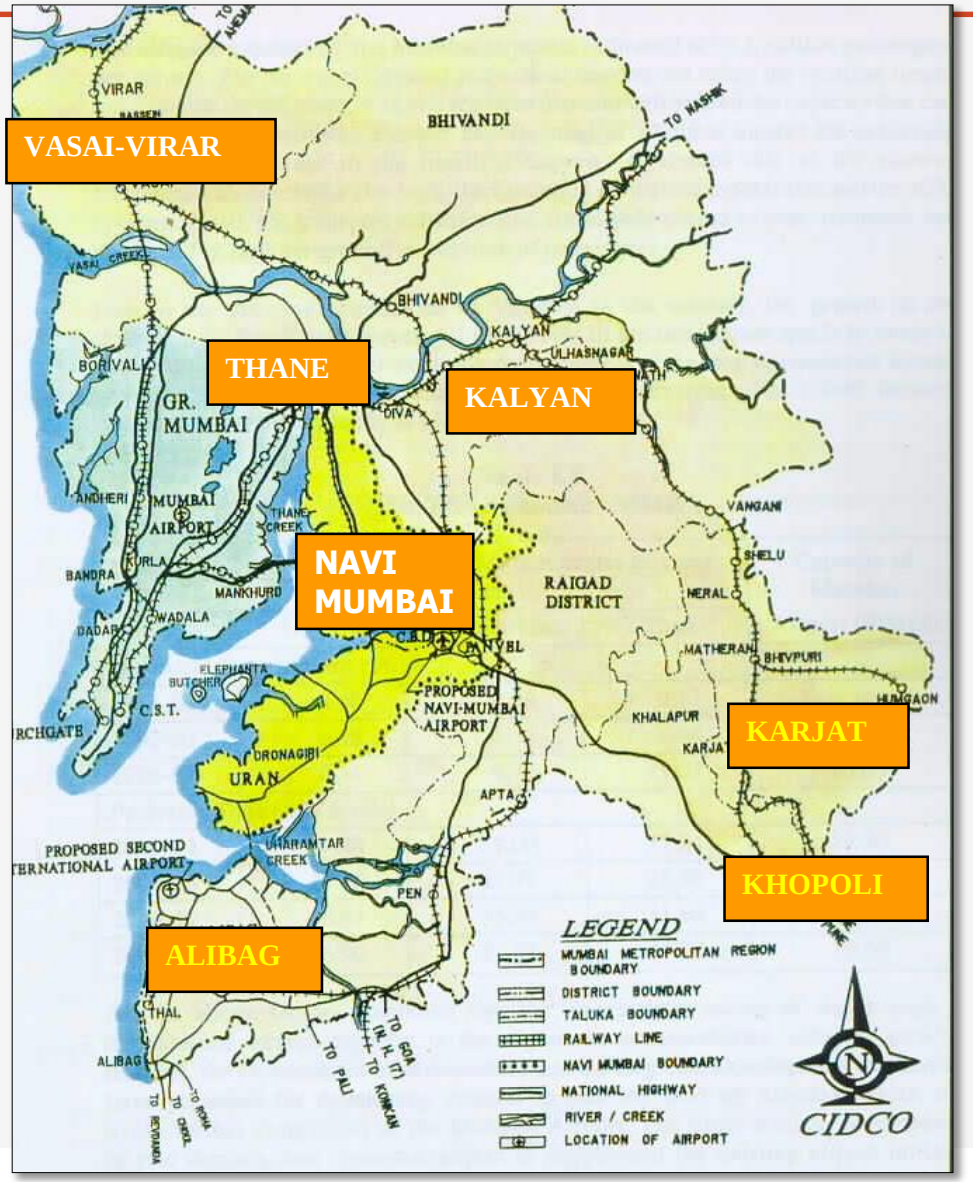
- Planned city , Centrally located in MMR
- Across the creek from Mumbai Island City
- Area 344 Sq.km Projected Population 4 Mln



Navi Mumbai – geographical setting

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- In Navi Mumbai, due to the unique geography, storm water gushes in from steep hills and is stopped by tide which raises water level by 4 to 5 meters in a matter of hours.
- Developable area lies between creek and Matheran hill ranges
- Low lying area prone to tidal submergence
- Avg. Annual Rainfall
  - **In Navi Mumbai-** 2500mm to 3000mm.
  - **Outside hill ranges-** 3000mm to 4000mm

Methods of Reclamation

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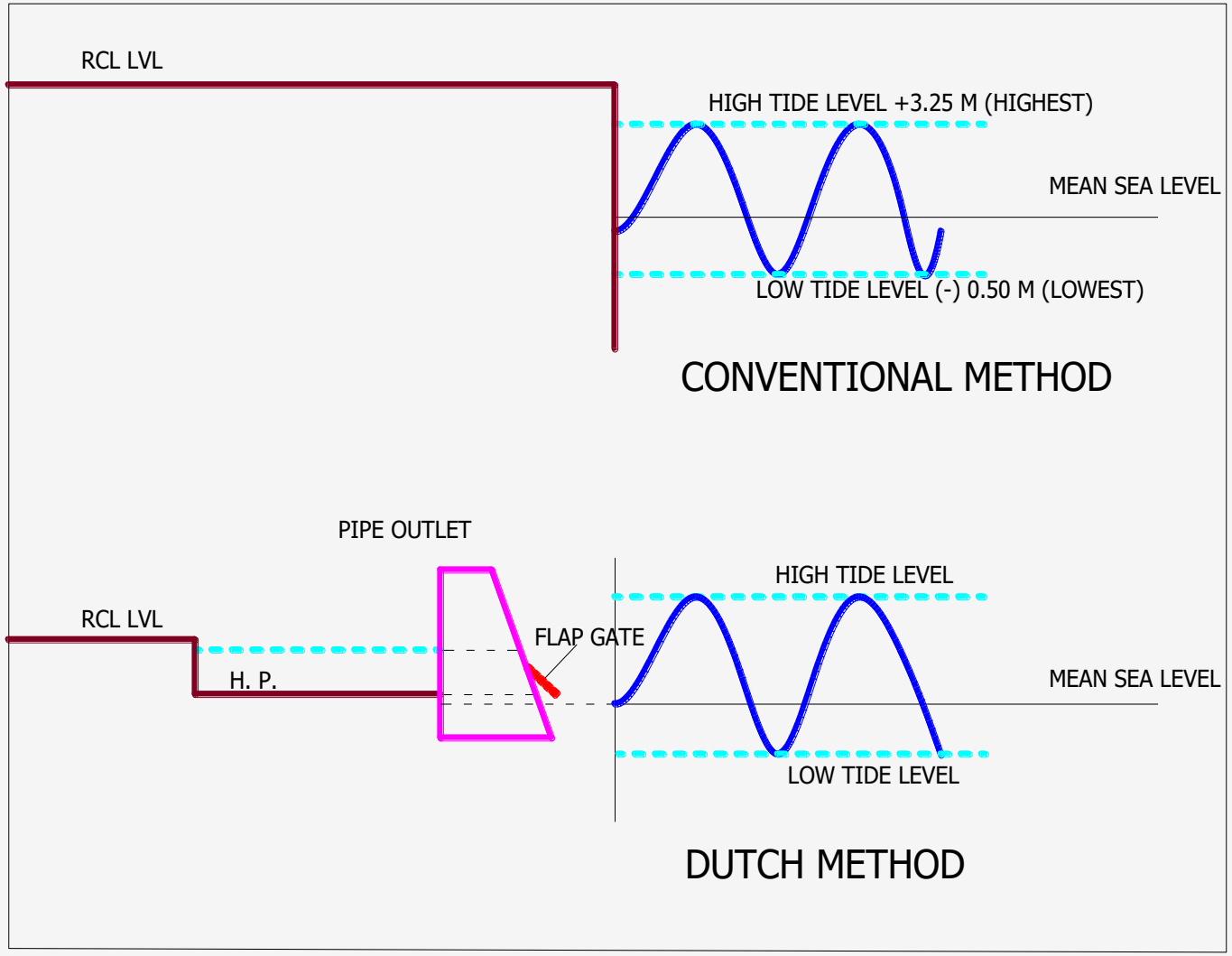


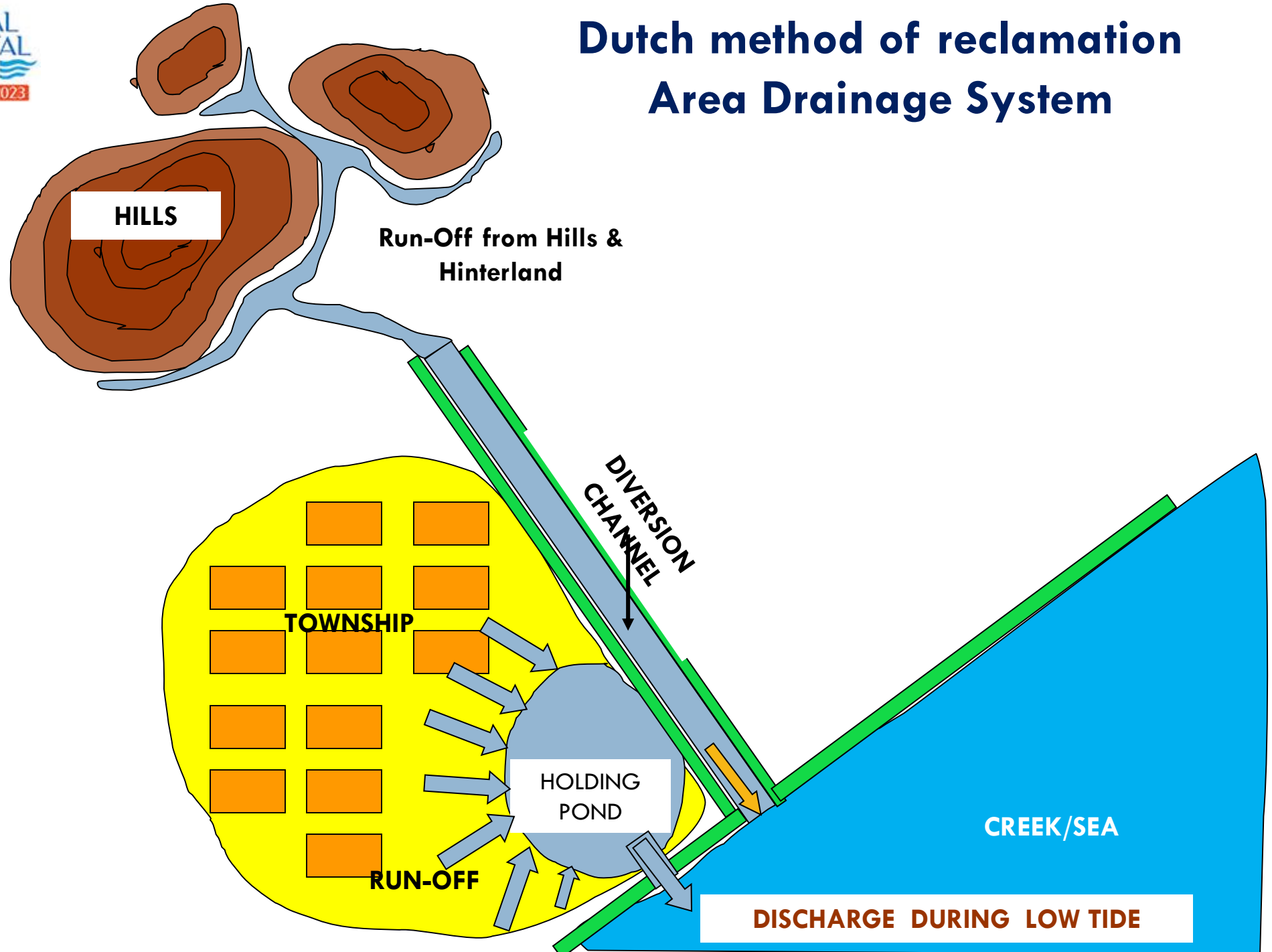
Conventional Method

- Reliability of protection against flood is very high
- Maintenance cost is low
- High capital cost
- Environment unfriendly
- Long term foundation settlement problem

Polder or Dutch Method

- Faster dev. is possible
- 75 million cubic meter of earth work saved while developing Navi Mumbai
- Less capital cost
- Land required for holding ponds, pump houses etc
- Higher maintenance cost

Dutch method of reclamation
Area Drainage System



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Navi Mumbai International Airport

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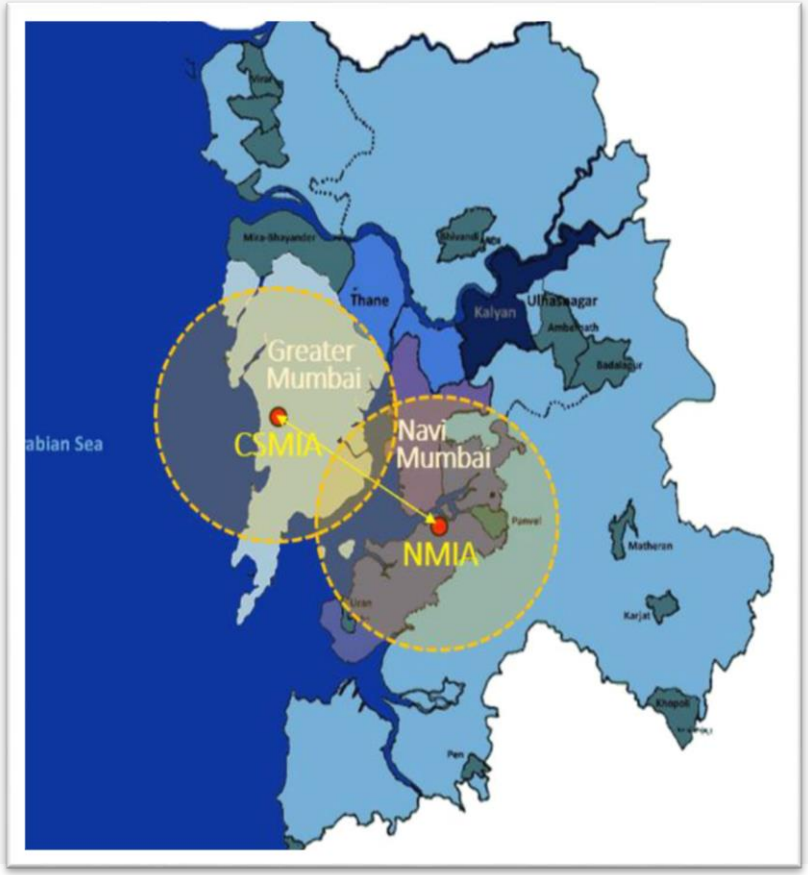
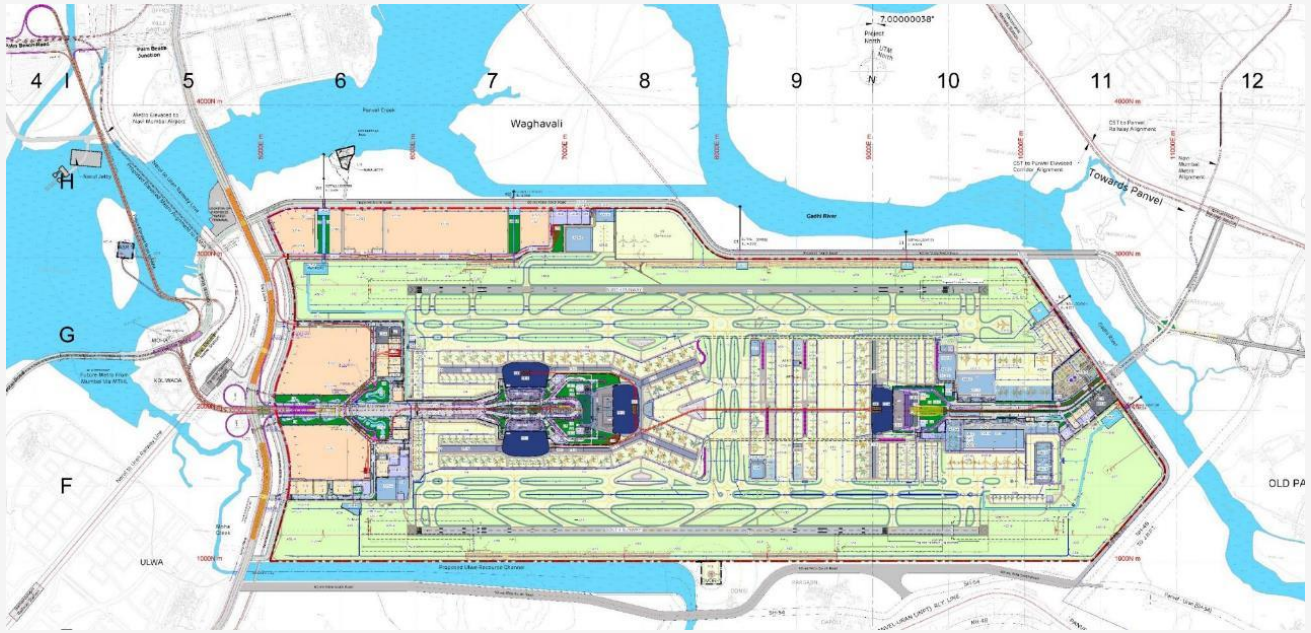
- 2nd International Airport for Mumbai Metropolitan Region
- Capacity 90 million passengers and 2.5 million tonnes of cargo per annum

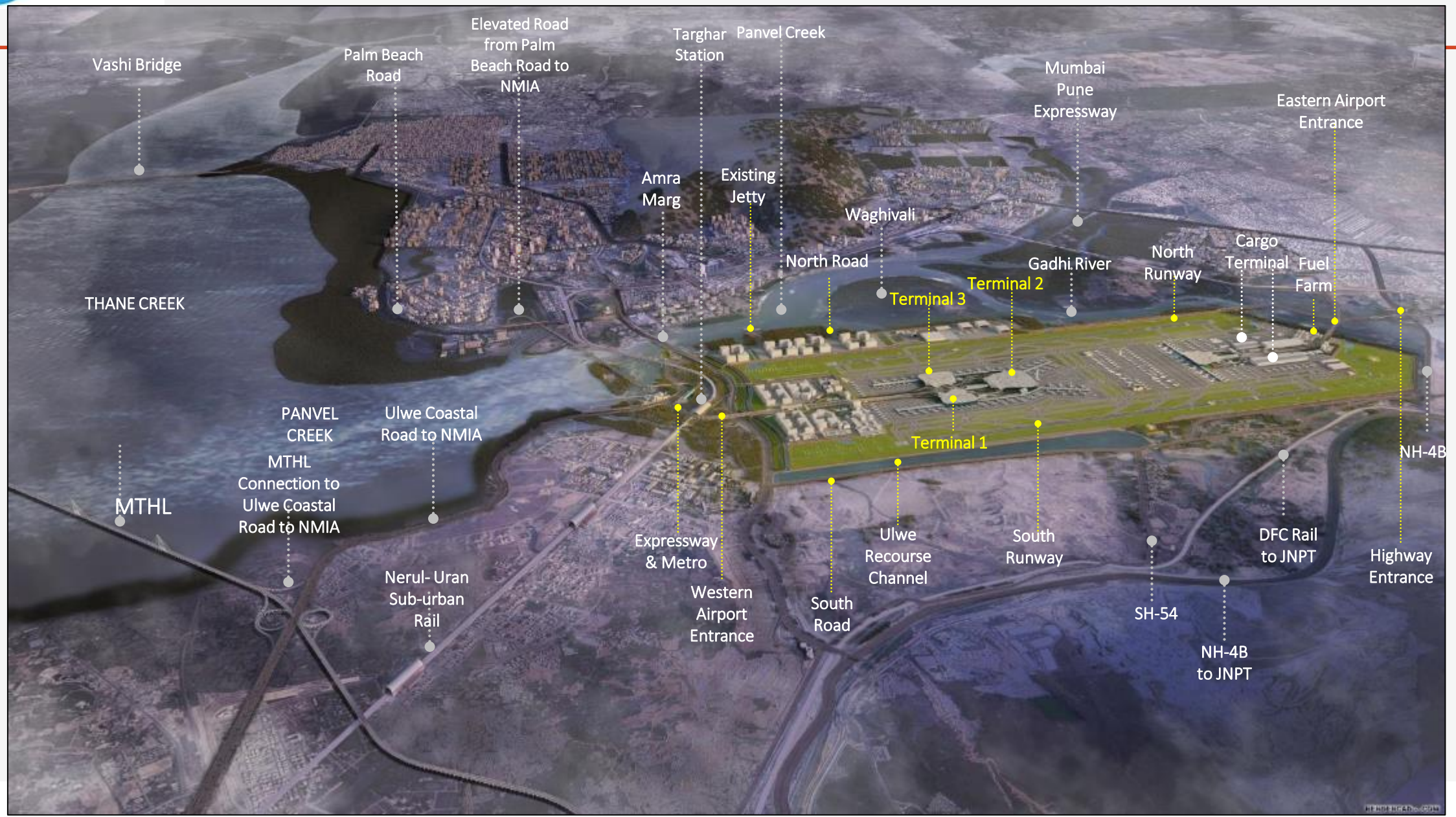




- **Runway**: Two Code-F parallel runways capable of independent & simultaneous operation
- **Number of Terminals** : 3 of 20 MPPA capacity each & 1 of 30 MPPA , interconnected to offer flexibility to passengers and airlines

Major economic trigger for MMR – creation of lacs of direct and indirect jobs

NMIA – Location & Linkages



NMIA - Planning for resilience

To make the city a better place to live, work and invest in

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- For NMIA, CIDCO had to deviate from its previous methodology
- The project involved Re-coursing of Ulwe Creek and Filling of the low lying areas
- Considering these major changes to the existing environment, Central Water & Power Research Station (CWPRS), Pune, was roped in to carry out studies, analyze and suggest plan of action for such airport development with built in resilience.

CWPRS Study Objectives

- Review of hydrology including rainfall of 26th July 2005.
- Estimation of PMP - 100 and 50 year return period rainfall and corresponding flood hydrographs for five rivers in Panvel creek.
- Predict rise in water levels due to all city developments with and without Airport.
- Estimation of safe grade elevation for airport area
- Design of Ulwe river diversion channel.
- Protection measures to minimize flooding.

Safe grade elevation of the Airport finalised based on CWPRS Studies 5.5m (HFL) and 2.5m free board – +8m

Navi Mumbai International Airport

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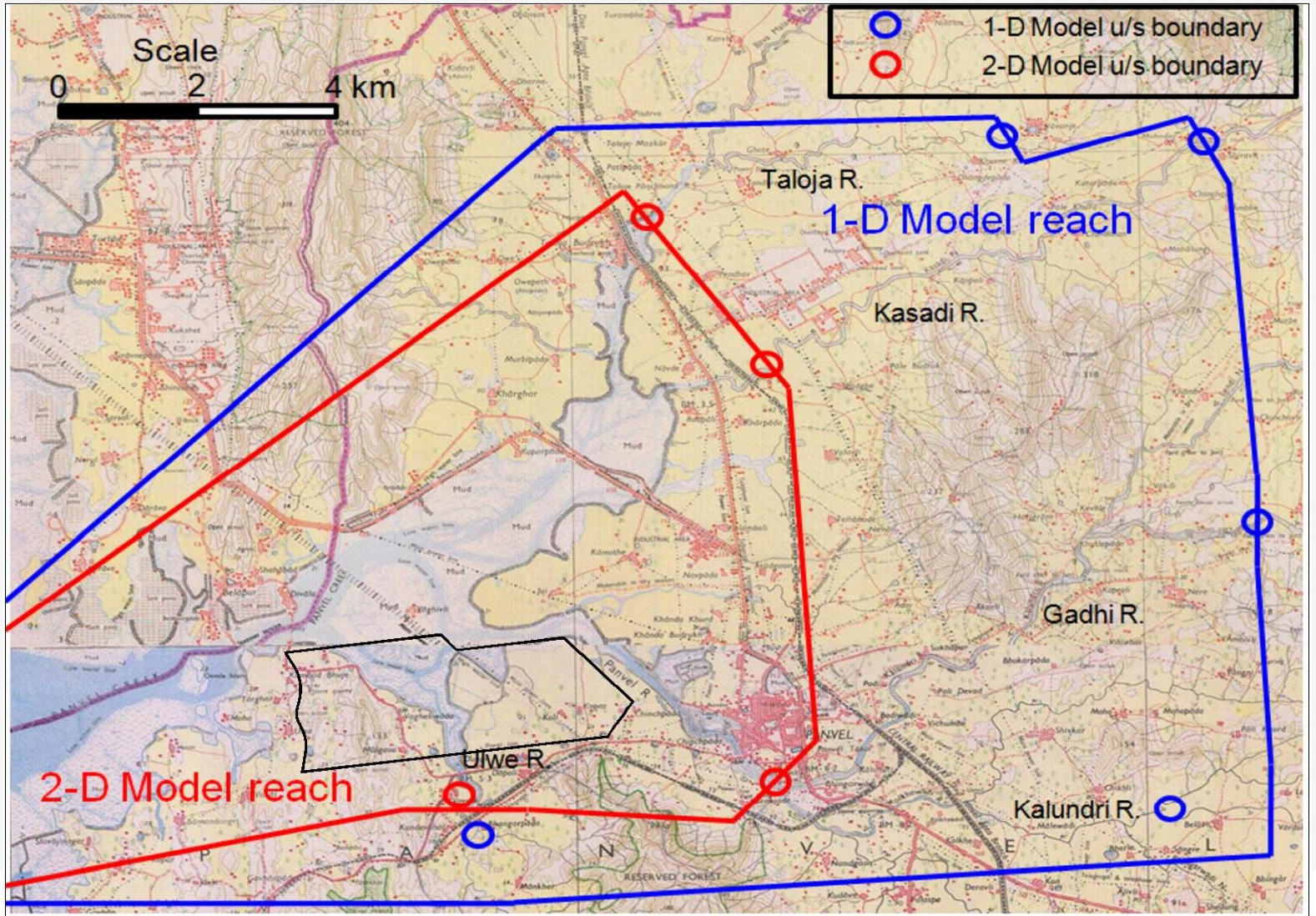
CWPRS STUDIES - Domain



Navi Mumbai International Airport: CWPRS STUDIES - Data collection

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- Topographical Data
  - Bathometry of Panvel creek upto tidal reach
  - Cross Sectional Data :5 to 10 km upstream of tidal reach along five rivers in the Panvel creek.
- Hydrological Data
  - Yearly maximum 1 day rainfall for rain-gauge stations in and around Panvel creek-Including extreme rainfall event of 26 July 2005 - Colaba and Santacruz stations data 50 to 100 years
  - Hourly rainfall records of rain-gauge stations creek-Including of 26 July 2005
  - Yearly maximum rainfall intensity (mm/hr) records - Colaba and Santacruz 30 years.
- Hydraulic Data
  - Tidal water level and velocity data at five locations in Panvel Creek @ 15 min interval for 1 Month
  - Recorded flood levels at different locations in Panvel creek on 26th July 2005 and July 1991.
  - Suspended sediment data at three locations in Panvel creek.

CWPRS STUDIES – Model Calibration & Validation

Model Calibration & Validation

- ✓ Calibration was done only for Tidal Data
- ✓ Validation was done for 26th July 2005 flood event .
- ✓ For 1D CHARIMA mathematical model was used
- ✓ For 2D MIKE 21 and Telemac – 2D mathematical model was used

Scenarios Considered

- ✓ Only tides without Airport/With Airport
- ✓ Tides and max. flood discharge without Airport and With Airport
- ✓ 6hrs storm - 100 years return period/ PMP
- ✓ 26 July 2005, Rainfall Event

CWPRS STUDIES – Outcome

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Factors Considered to arrive at safe grade elevation of the Airport:

- Max. Flood Level – 3.25m Highest High tide Level and PMP event
- Cyclone Induced Surges – Only in East Coast
- Wind generated waves – Least Probability – Area away from coast, sheltered by Mumbai Island, Thane Creek, Only 300 m opening of Panvel Creek, Presence of Islands i.e Elephanta/Butcher, Simultaneous occurrence of all events
- Sea level rise
- Tsunami – Least probability in the area
- Safe grade elevation of the Airport calculated based on the free board of 1.8m as per IRC norms for discharge > 3000 m3/s and 0.7 m for all other factors mentioned above.

Safe grade elevation of the Airport was finalised based on 5.5m (HFL) and 2.5m free board – +8m

Findings & Recommendations

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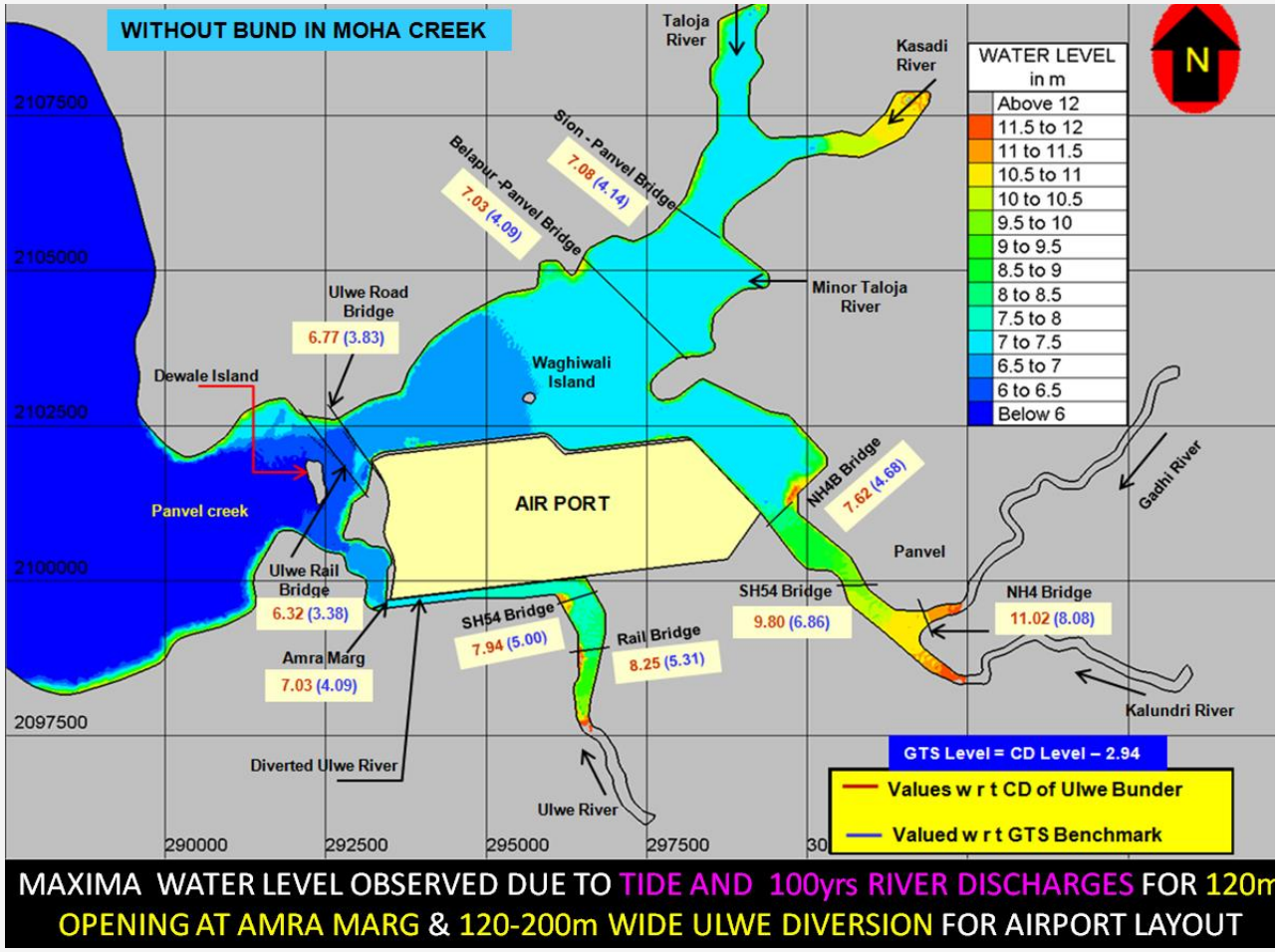
CWPRS Studies: Analysis of Results of 2D Telemac Studies

- Scenario - 120 m bridge on Amra marg & 200-120 m Ulwe diversion channel and Removal of Bund in Moha creek)
- In general there is no rise in water level in downstream and upstream of Panvel creek

- Predicted water levels in Ulwe river at SH-54 bridge without/with Airport are 4.24/5.00 for 100 yr RP indicating rise of 0.76 mt and 4.63/5.54 in case of PMP condition indicating rise of 0.91 mt.



Development level of Airport fixed and Master Drainage Plan for entire surroundings prepared based on CWPRS Studies which considered all climatic conditions including possible changes including tidal variations

Additional Environment protection measures

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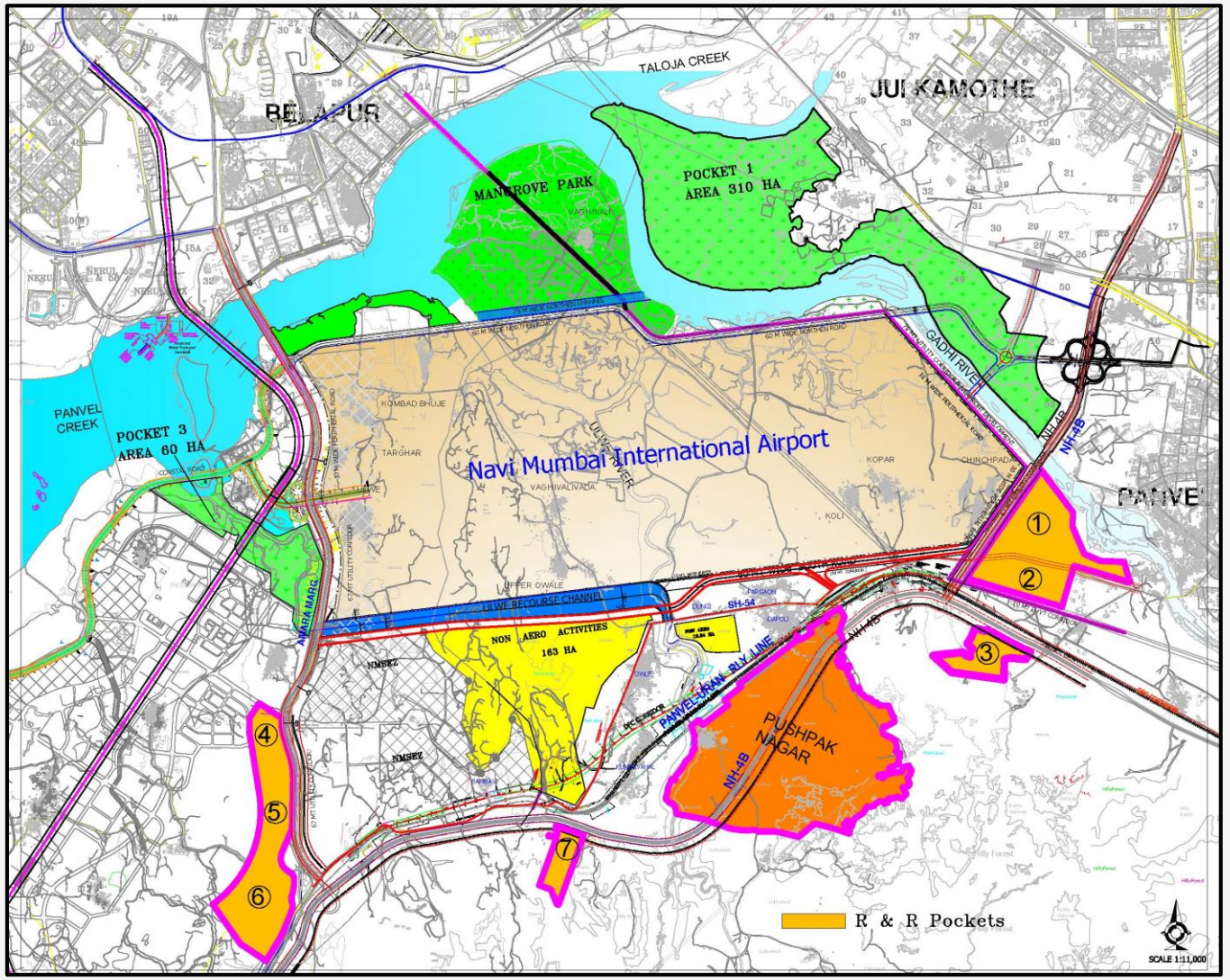
- Intensive mangrove plantation carried out all around the airport
- Navi Mumbai Development Plan modified by designating these mangrove areas as No Development Zone by creating a mangrove buffer along the airport boundary
- Regular environmental monitoring being carried out comprising river water quality, air quality and various other parameters
- All connectivity infrastructure for the airport being developed after seeking separate CRZ and Forest clearances
- Long term monitoring of Avian fauna through BNHS for identifying potential bird threats and preparation of mitigation plan



Sustainability in NMIA Master Plan & Building Designs

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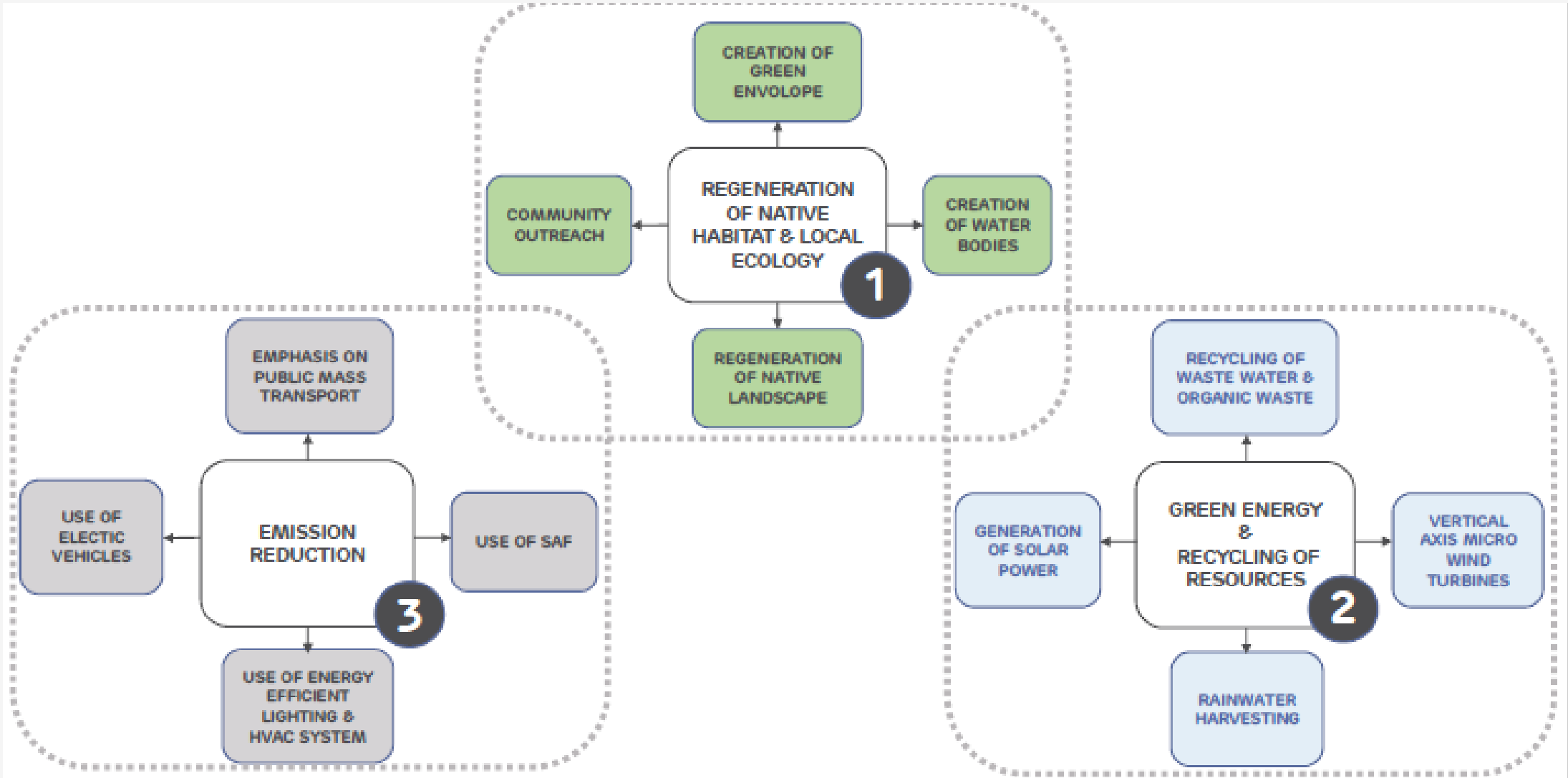

NMIA- Building a Green Airport

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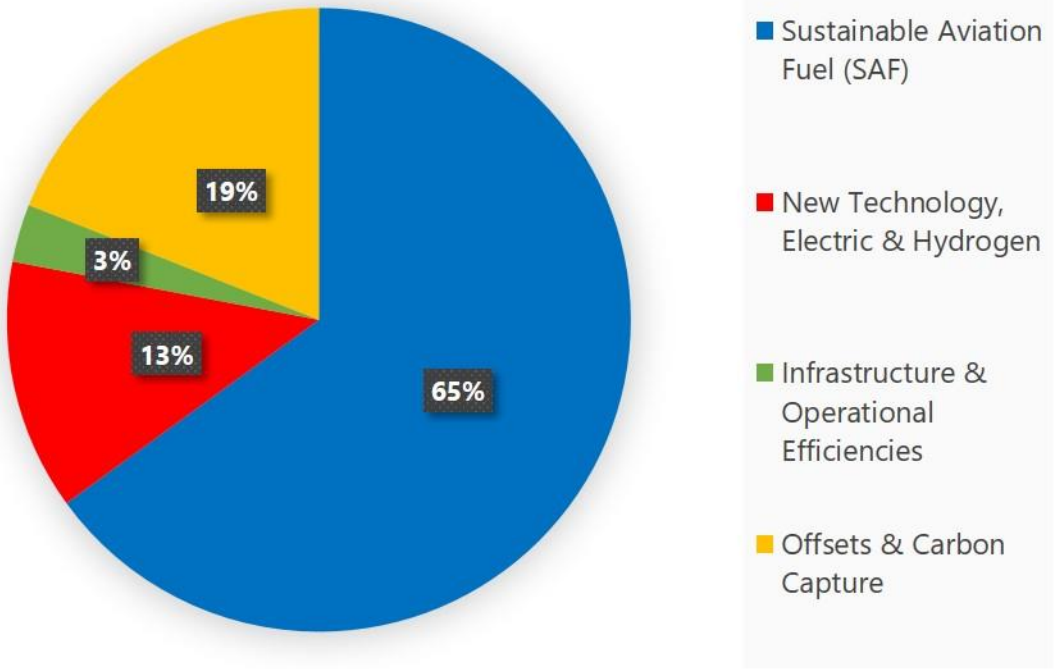
- ✓ Solar Energy generation on Airside & Roof top solar panels for all buildings
- ✓ EV on Airside & Landside
- ✓ Reduction of vehicular emissions within airport through induction of APM system
- ✓ Water retention tanks, Ponds & Water features
- ✓ Use of Sustainable Aviation Fuel (SAF) – it is estimated that it could contribute to around 65% of the reduction in emissions needed by aviation to reach net zero in 2050
- ✓ Tree plantation & large open spaces through sustainable landscaping
- ✓ Recycling of organic waste & waste water
- ✓ Skylights in terminal roof for increased natural lighting
- ✓ Provision of strong public transport systems to discourage use of private vehicles

IATA's strategy towards net zero

Achieving net zero by 2050 will require a combination of maximum elimination of emissions at source, offsetting and carbon capture technologies



NMIA - Sustainability in Planning & Design

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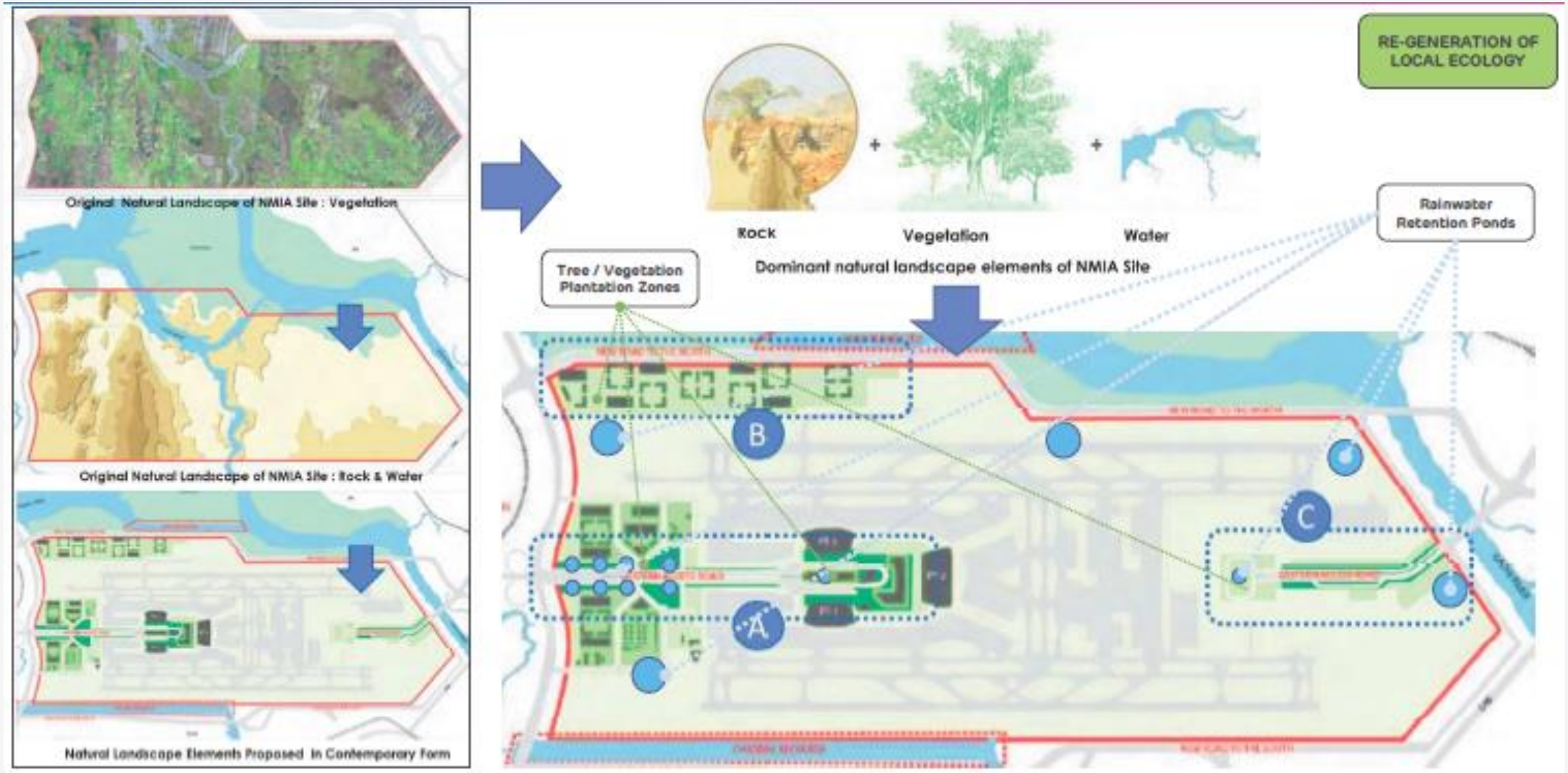

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Way forward

According to the Coalition for Disaster Resilient Infrastructure (CDRI) survey ,

> *"Across regions, airports expect extreme storms and winds, extreme precipitation and third-party systems failures to result in partial infrastructural restrictions, flight delays and indirect economic loss to airport partners"*

The main effects of climate change will be much more evident three or four decades from now and much of the airport infrastructure erected today will be functioning in the new climate

Way forward

- One study has identified the key priorities for action to develop climate change resilience for the aviation sector as : Identifying knowledge gaps, Raising awareness and Promoting collaboration
- All airports should carry out risk assessments / periodic vulnerability assessments of existing and new infrastructure in order to think ahead, reduce risks and costs and develop a resilience strategy
- Minor adaptation investments in already planned and ongoing projects can have a positive impact and save on future resources
- Climate resilience measures should be an integral part of measures being taken to enhance airport capacity to accommodate a greater number of passengers and flights
- Such anticipatory measures for building resilience in airports should be consolidated into an enabling – not restrictive – regulatory framework, which would lead to collaborative efforts between the airport operators, airlines, airport planners and policy makers

Thank You