Disaster Resilient Study in Odisha

Gagan. B. Swain
Director (F&CA), GRIDCO

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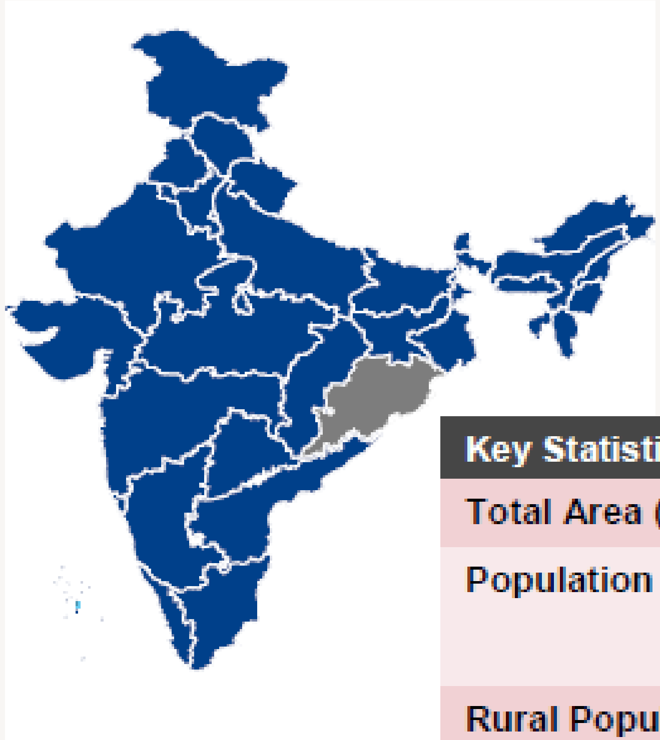
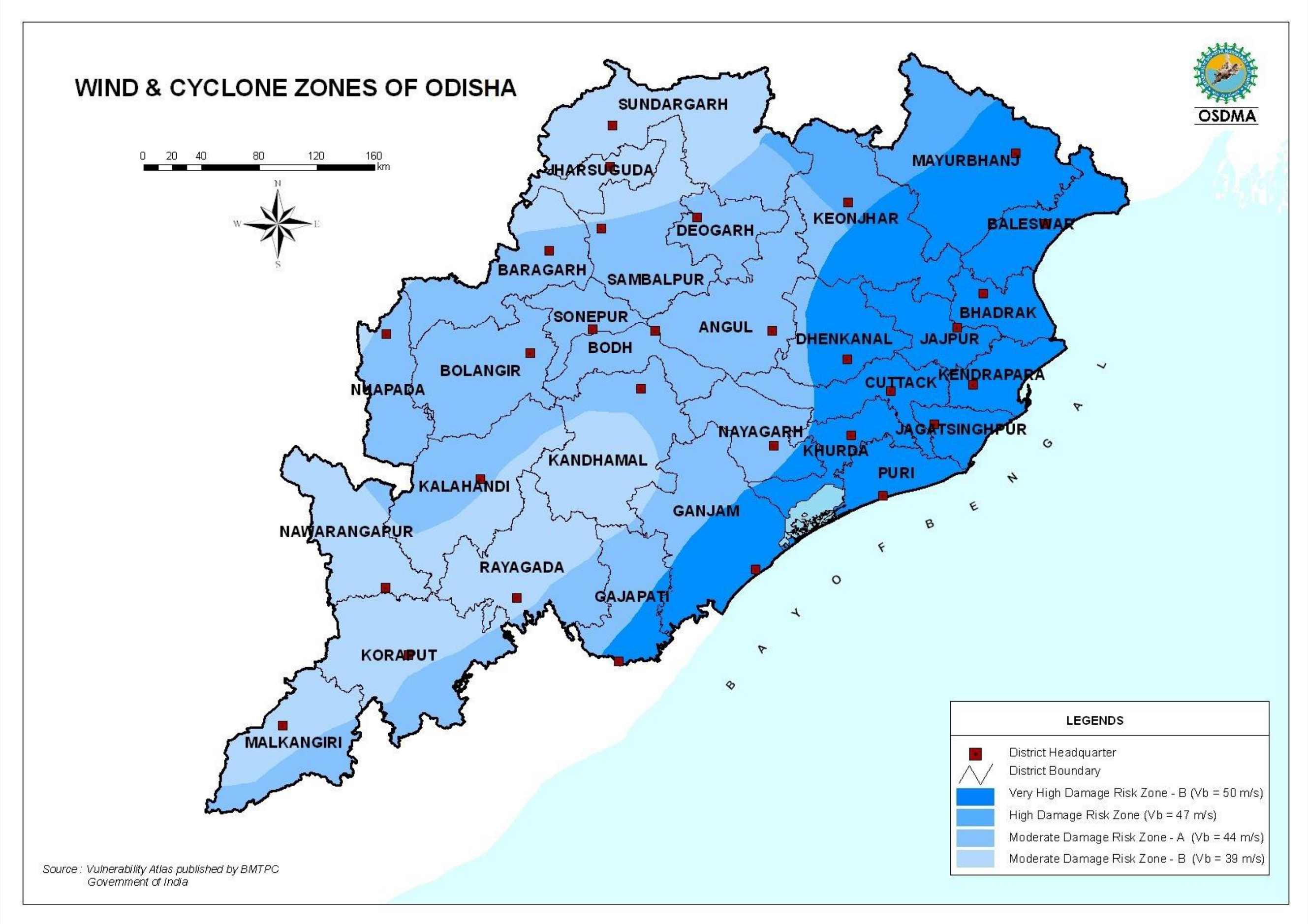
Odisha State Profile



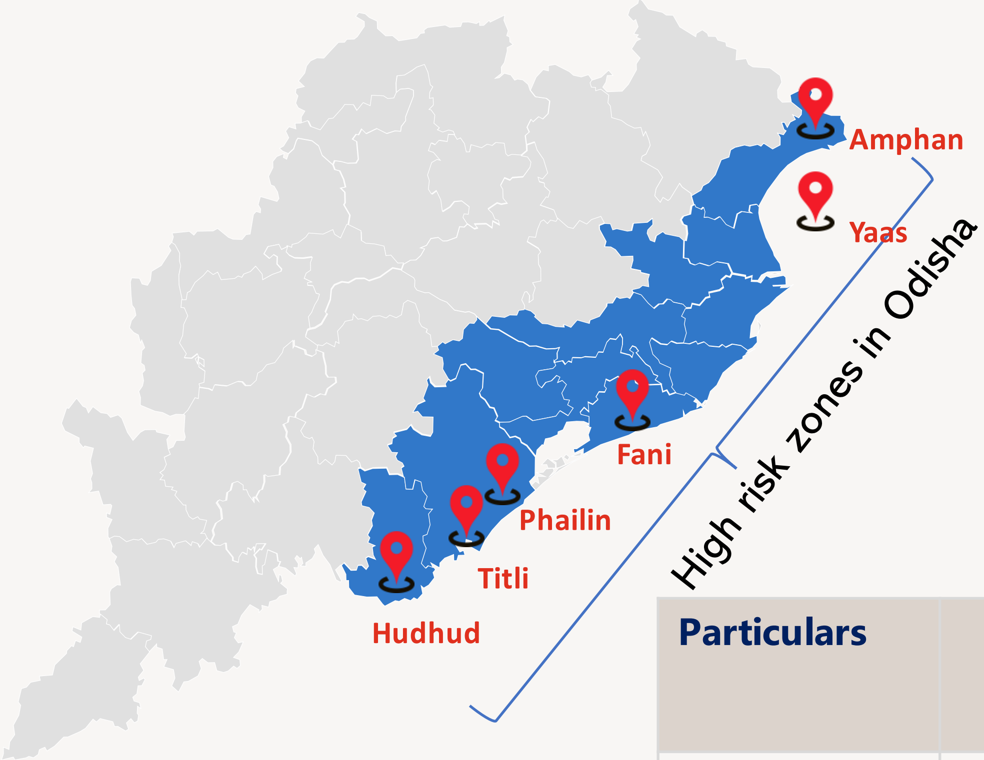
- Due to its subtropical location, Odisha is prone to various hydro-meteorological hazards such as cyclones, storm surges & floods.
- The State has two cyclone seasons, 1st during pre-monsoon period (Apr. - May) and 2nd during post-monsoon period (Sep. – Nov.).
- With the increase in population density in the coastal areas and depletion of mangroves and shelter belts, the state continues to be vulnerable to cyclones.

Key Statistics	
Total Area (Sq. km.)	155707
Population	4,19,74,218 (3.47%)
Rural Population	3,49,70,562
Urban Population	70,03,656
Administrative Districts	30
Gram Panchayats	6225
Number of Blocks	314
Total Number of Villages	51,583



Odisha is prone to cyclones

which are growing in intensity and frequency



- Odisha has a **480 km** coastline – 6th longest in the India
- In last 10 years, Odisha has been impacted by 7 extremely severe cyclonic storms with wind speed >100 kmph – **highest in country**
- **11 cyclones** occurred over the Bay of Bengal in the last decade
- Over the last few years, the **intensity & frequency** of cyclones are increasing in the region
- Impact on Odisha power sector in last 10 years ~**INR 2,700 Cr.**

Particulars	Super Cyclone (1999)	Phailin (2013)	Hudhud (2014)	Titli (2018)	Fani (2019)	Bulbul (2019)	Amphan (2020)	Yaas (2021)
Districts affected (Nos)	14	19	11	17	9	9	4	13
Consumers affected (lakh)	2	38	7	9	30	15	45	30
Peak Wind Speed (km/h)	260-270	205-220	180-190	140-150	200-215	110-120	155-165	130-150
Power Sector Impact (Cr.)	**413**	**1,082**	**62**	**137**	**1,197**	**6**	**75**	**157**

* During cyclones, there is a sudden drop of ~30% in the state load

Case Study 1 | Cyclone Phailin

- Landfall at Gopalpur, Ganjam (Oct. 2013)
- Severe Cyclonic Storm with wind speed rising up to **260 kmph**
- Total losses were estimated at ₹260 billion

Damage to power infrastructure

Transmission (400, 220 & 132 kV)
- **93 EHT** towers
- **4,074 km** EHT lines

Distribution (33kV, 11kV & LT)
- **1,756** feeders
- **38,997** substations
- **36,134 km** LT Lines

Damage to power infrastructure
~INR 1082 Cr. (USD 130 Mn)

Electricity consumers impacted: 3.8 Mn

- Berhampur, the closest city to the point of landfall suffered devastation triggered by gale winds, with fallen trees, uprooted electric poles and broken walls in various places of the city.
- Large scale damage to distribution and transmission infrastructure

Learnings | Pre-disaster (Preparatory)

- Material – Stock taking and advance placement
- Equipment and vehicle – Mobilize and keep ready
- Supervisory staff – Keep groups ready in control rooms
- Alternate communication - HAM, SAT Phone, Bike messengers
- Advance meetings with critical consumers

Learnings | During-disaster

- Damage assessment – foot / vehicle surveys, GIS mapping of infrastructure
- Deployment of ERS Towers
- Parallel work on new towers – Emergency Rate contracts, materials mobilized from on-going sites

Case Study 2 | Cyclone Fani

Damage to power infrastructure

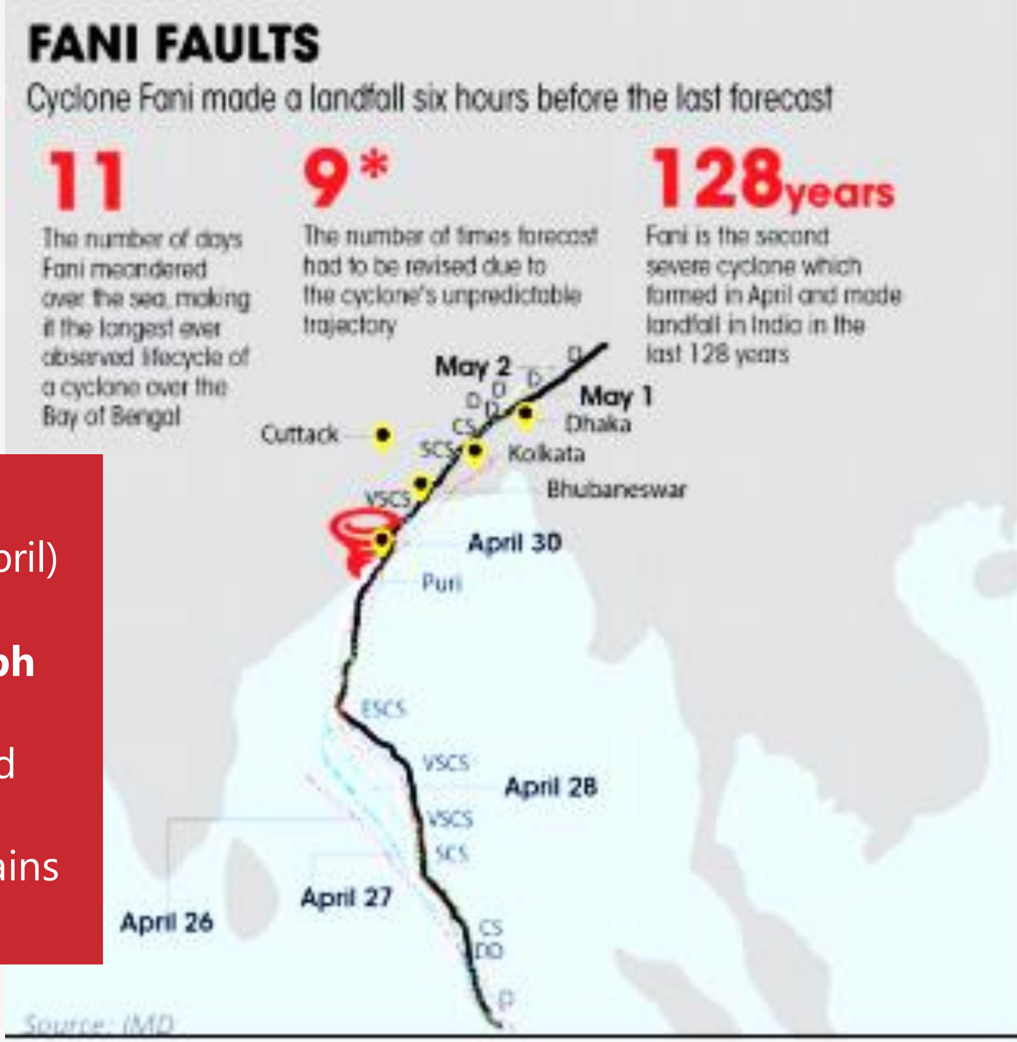
Transmission (400, 220 & 132kV)
- **116** EHT towers
- **2** EHT grids & **250 km** lines

Distribution (33kV, 11kV & LT)
- **2.2 lakh** poles
- **1.1 lakh km** lines
- **12,064** Transformers

Power infrastructure damage: INR 1197 Cr. (USD 143 Mn)

Electricity consumers affected: 3.0 Mn

- Departure from the norm- formed in pre-monsoon (April)
- Gale winds **175-185 kmph;** gusting to **215 kmph**
- Old towers standards not upgraded to the above wind speed
- High winds and torrential rains in Puri & Bhubaneswar



Learnings | Pre-disaster (Preparatory)
- Tree pruning
- Emergency procurement guideline, rate chart
- Manpower- Mobilize & hire, ready to deploy
- Equipment & vehicle- Mobilize & keep ready
- Consumables- Cash, diesel, water & cereals

Learnings | During-disaster
- Damage assessment – foot / vehicle surveys, GIS mapping of infrastructure
- Deployment of ERS Towers
- Parallel work on new towers- Emergency rate contracts, materials mobilized from ongoing sites

- Major damage to distribution infrastructure; less transmission impact
- Power disruption to critical consumers like hospitals, water pumps, state dept. offices
- Clogged roads and highways due to fallen trees, electricity poles, and lines

Case Study 3 | Cyclone Yaas

- Formation during monsoon (May 2021)
- Winds gusting up to 150 kmph
- High winds and torrential rains in Balasore & Bhadrak

Damage to power infrastructure

Transmission (400, 220 & 132 kV)
- No major damage

Damage to power infrastructure
~INR 157 Cr. (USD 18 Mn)

Distribution (33kV, 11kV & LT)
- **30,000** poles
- **23,000 km** Lines
- **1980** Power Transformer
- **1 Lakh** DTR affected

Electricity consumers impacted: 3.0 Mn

- Major damage to Distribution infrastructure
- Balasore, Bhadrak, Mayurbhanj, Jajpur, Keonjhar, Kendrapada & Jagatsinghpur majorly affecetd
- Cuttack, Angul, Dhenkanal, Khurda & Puri partially affected
- Oxygen Plants & COVID Hospitals were provided with uninterrupted power supply through back-up DG sets.

Learnings | Pre-disaster (Preparatory)

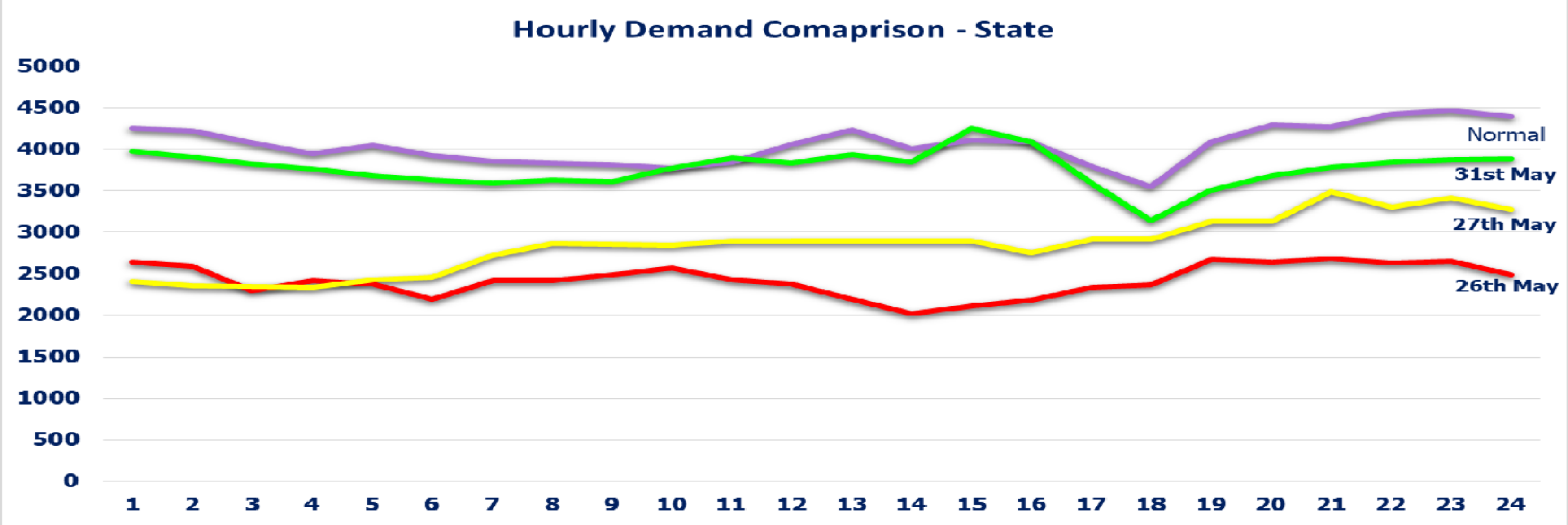
- Branch pruning of trees along T&D lines need to be taken up for summer & winter cyclone
- Advance tie-up and mobilization of Crane, Excavators, transportation, safety equipment etc.
- Line patrolling immediately on receipt of cyclone alert & rectification of vulnerable infra
- Alternate communication - HAM, SAT Phone, Bike messengers
- Advance meetings with critical consumers

Learnings | During-disaster

- Issue of advances to meet contractor/agency petty expenses & worker payments
- Coordination with local administration for avoiding law and order situation during restoration & reconstruction activities

Restoration Milestones - YAAS

CONSUMERS /INFRA	AFFECTED	RESTORATION						
Date	D0 26th May	D1 27th May	D2 28th May	D3 29th May	D4 30th May	D5 31st May	D6 1st June	%age
Consumers (Lakh)	**30.27**	20.12	26.27	28.87	29.86	**30.12**	**30.21**	
%age		66%	87%	95%	98.6%	99.5%	99.8%	
33 kV Feeder	**170**	164	169	**170**	-	-		100%
33/11 kV S/s	**366**	340	364	365	**366**	-		100%
11 kV Feeder	**1,201**	833	1,159	1,185	1,199	**1,201**		100%
DTR (Lakh)	**1.05**	0.65	0.89	0.99	1.03	1.04	**1.05**	100%



- District Hqrs & COVID Hospitals - power restored within 8 hours
- Oxygen plants - power restored within 12 hours
- Block Hqrs are restored within 24 hours
- 80% Public Water Works & PHC/CHC are restored within 48 hours.
- All Gram-Panchayats are restored by 1st June

Oxygen Plants & COVID Hospitals were provided with uninterrupted power supply through back-up DG sets.

Pre cyclone SOP

- Setting up of Control Room – Central, Circle, District level
- Tree trimming
  Strengthening vulnerable infrastructure
- Finalization of rate contracts for restoration works
- Pre-positioning of Materials from Central Stores to Emergency Stores
- Advance tie up and mobilization of Crane, Pole Masters, Hydra, Aska Lights, Submersible Pumps and DG sets
- Workforce deployment and setting up of communication matrix
- Supply restoration plan for critical installations
- Mock drills to check the efficacy of the system
- Supply of Satellite Phones/ VHF Sets/ Aska Lights
- Consumer awareness on safety
- Pre-fabrication of structural material for overhead network. Setting up Roadside Fabrication units/ Sub-Stores/ Community Kitchen etc.
- Formation of strategic clusters. Pre-allocate gangs along with Executive in-charge
- Responsibility assigned to Feeder Managers

Prior Preparations – Lowers the damage and restoration time

Snapshots of Pre cyclone preparation

Loading of Material

Positioning of Men & Material, Dry food and Water

Pre-Monsoon preparation

SOP during cyclone

- Coordination with Central Control Room, Discom & Transmission Control Room, SLDC & SDMA
- Balancing load & generation to prevent Grid black-out
- Isolate pre-identified feeders on breaching threshold wind speed
- Set up MIS preparation/reporting format/frequency
- Pre-assess the damage and fine-tune Restoration plan
- Adhering to safe practices

COVID TESTING OF WORKMEN

ADHERING COVID PROTOCOL

Post cyclone restoration SOP

- Patrolling of all lines and sub-stations before re-energization
- Charging of Feeders which are safe to charge and restore supply of affected area
- Quick assessment of damage in the affected area and its financial implication
- Addl. Resource Mobilization (men, material, vehicle, logistics & funds)- resource pooling from unaffected areas
- Priority restoration of critical infrastructure, e.g. Water Supply, Communication Towers, Hospitals, Railways etc.
- Deployment of senior level officials to vulnerable sites to ensure physical monitoring
- Co-ordination with various Departments & local authority
- Awareness for post-disaster restoration process and approx. duration
- Coordination with Suppliers/Manufacturers to increase/maintain required inventory
- Maintain Store rolling stock for future disasters

Snapshots of Post cyclone restoration

Restoration under adverse conditions

HEAVILY WATER LOGGED AREA

DIFFICULT TERRAIN

RESTORATION IN FLOODED AREAS

Safety Guidelines

- Personal Protective Equipment (PPE) like safety helmet & shoe, discharge rod, hand gloves and safety belts
- Work place SOP to be adhered strictly, as per Safety Policy
- Ground clearance & Vertical/Horizontal clearance between lines/sub-stations and from buildings/trees etc. to be maintained as per CEA norms.
- Dissemination if First Aid Box to all Gangs/Groups.
- During emergency, avail treatment from local health centre
- Maintain COVID appropriate behaviour during execution of work.

Safety Measures – Mission Zero Casualty

SAFETY OATH BY WORKMEN


COVID TESTING (RAT) OF WORKMEN


ADHERING COVID PROTOCOL


USE OF 'PPE' BY WORKMEN


STATE CONTROL ROOM

Disaster resilient infrastructure:

A proactive measure vis-à-vis response and restoration

Existing Electrical Network is not resilient

- Existing Distribution Lines and Structures are not designed as per wind zone-VI to withstand wind pressure of 250 Km/hr.
- Substations are located at low laying areas in coastal region, hence flooding can not be restricted.
- DP mounted Distribution substations are not designed to withstand wind pressure.
- CEA has included the suggestion of Odisha in its report recommending Disaster Resilient T&D system in coastal areas.
- New T&D infrastructure planned & under-execution in the State are compliant to disaster resilient norms.

Risk to Distribution Utilities

- Reconstruction / rectification of damaged power infra after cyclone is a challenging task.
- Huge funds requirement to bring back supply to normal condition within very limited period.
- During restoration period, it is difficult to maintain the quality of work.
- Due to power outage for long period, utilities incur huge revenue loss
- Huge Impact on the economic and emergency activities in addition to public inconvenience

Developing disaster resilient infrastructure is a long-term solution to minimize damage and quick restoration

Disaster Resilient Network Design- Approach

Preventive and mitigation measures for minimizing the damage to Power Distribution Network:

- **Within 20 km of coast** - Measures to design Cyclone resilient network in all new future construction
- **Within 20-60 km of coast** - Retrofitting of existing Distribution network infrastructure to increase their resiliency to Cyclone
- Design of new pole structures, Civil structure, line accessories which can sustain climatic changes and have better resiliency in the coastal area.

Network design components

- Underground cable system
- Rebar Lacing Pole
- Indoor Substation
- Splitting of Larger network sections
- Refurbishment of existing lines by use of rail poles / joist / Spun Poles
- Double Pole (DP) structure with Air Break (AB) Switch
- Pre-casted foundation for early restoration of the distribution line post cyclone
- Mobile Substations

UG cabling

Rebar lacing pole

Indoor substation

State schemes for disaster resilient infrastructure

Name of Scheme	Objective	Program Components	Status	Impact
SCRIPS (State Capital Region Improvement of Power System)	Program to achieve 24X7 uninterrupted power supply to critical installations through Cyclone Resilient Network	▪ UG Cabling ▪ Installation of CSS in place of conventional DSS ▪ Ring connectivity at 33KV, 11KV and LT level	• Implemented in Bhubaneswar & Cuttack City • Outlay of scheme – ~ INR 1,330 Cr.	• Critical installations continue to get uninterrupted Power supply even during Cyclone
ODSSP (Odisha Distribution System Strengthening Project)	Scheme for Strengthening the Distribution System	• Construction of 473 nos 33/11KV PSS, 33 kV & 11 kV Lines	• Implemented across all 4 Discoms • Outlay of scheme – ~ INR 5,643 Cr.	• Cyclone resilient design adopted for all PSS and lines constructed within 50 Km from the coastline
Puri UG cabling scheme (Nabakalebara project)	UG cabling of distribution lines in cyclone prone Puri town	• UG Cabling • RMU, Sectionalizers	• Implemented in Puri • Outlay ~ INR 260 Cr.	• Strengthening distribution infrastructure; minimal outage

State has submitted DPR of Rs.3,069 Cr. for disaster resilient power sector infrastructure to MoP, GoI under RDSS

Disaster Management by Odisha

- Odisha is managing Disasters like Cyclones for two decades
- Instituted Odisha Disaster Rapid Action Force (ODRAF)
- Established multiple Early Warning Dissemination System (EWDS)
- Early warning by IMD; better preparedness
- Standardized Evacuation & Shelter Management; Zero Loss of Life
- Dedicated Team at State Control Centre & GRIDCO Control Room
- CDRI has completed the study for creating Disaster Resilient Infrastructure
- Disaster Management Plan in place by Energy Dept.

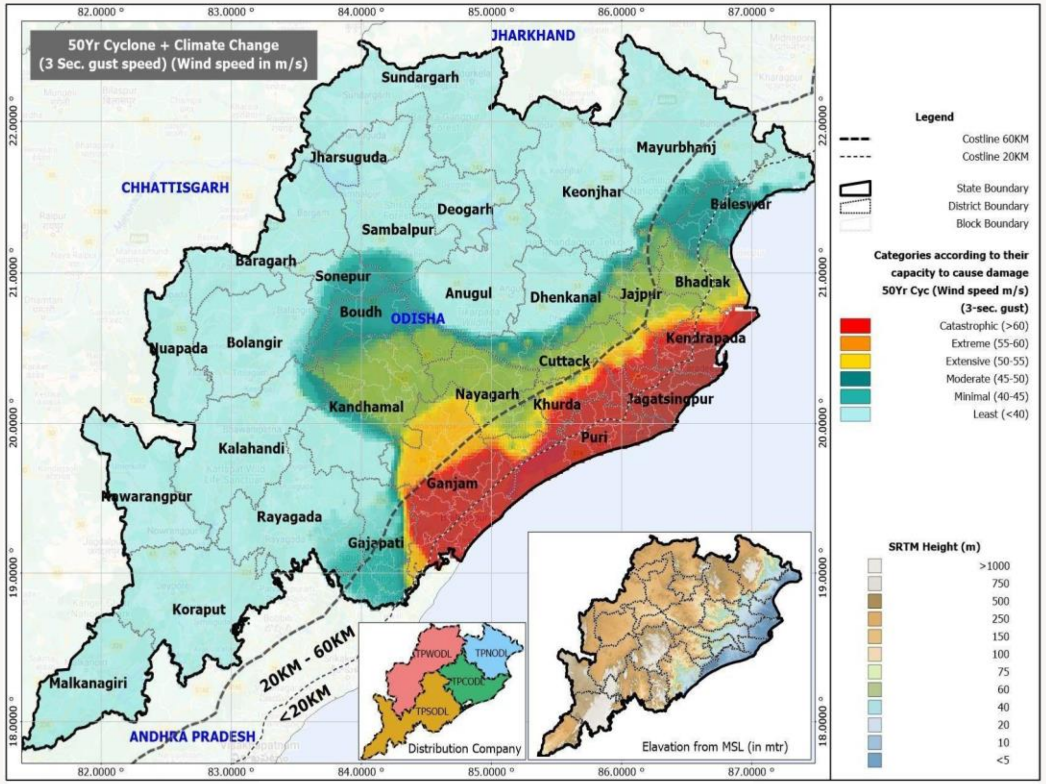
Odisha power sector study: Objective, Hazard Profile & Key Stakeholders

Study Objective: To understand the current level of infrastructure resilience to major hazards in Odisha and prioritise physical/operational recommendations to enhance the resilience of key infrastructure systems through an **Infrastructure Resilience Assessment Report** for Transmission and Distribution in Odisha.

Key Disasters

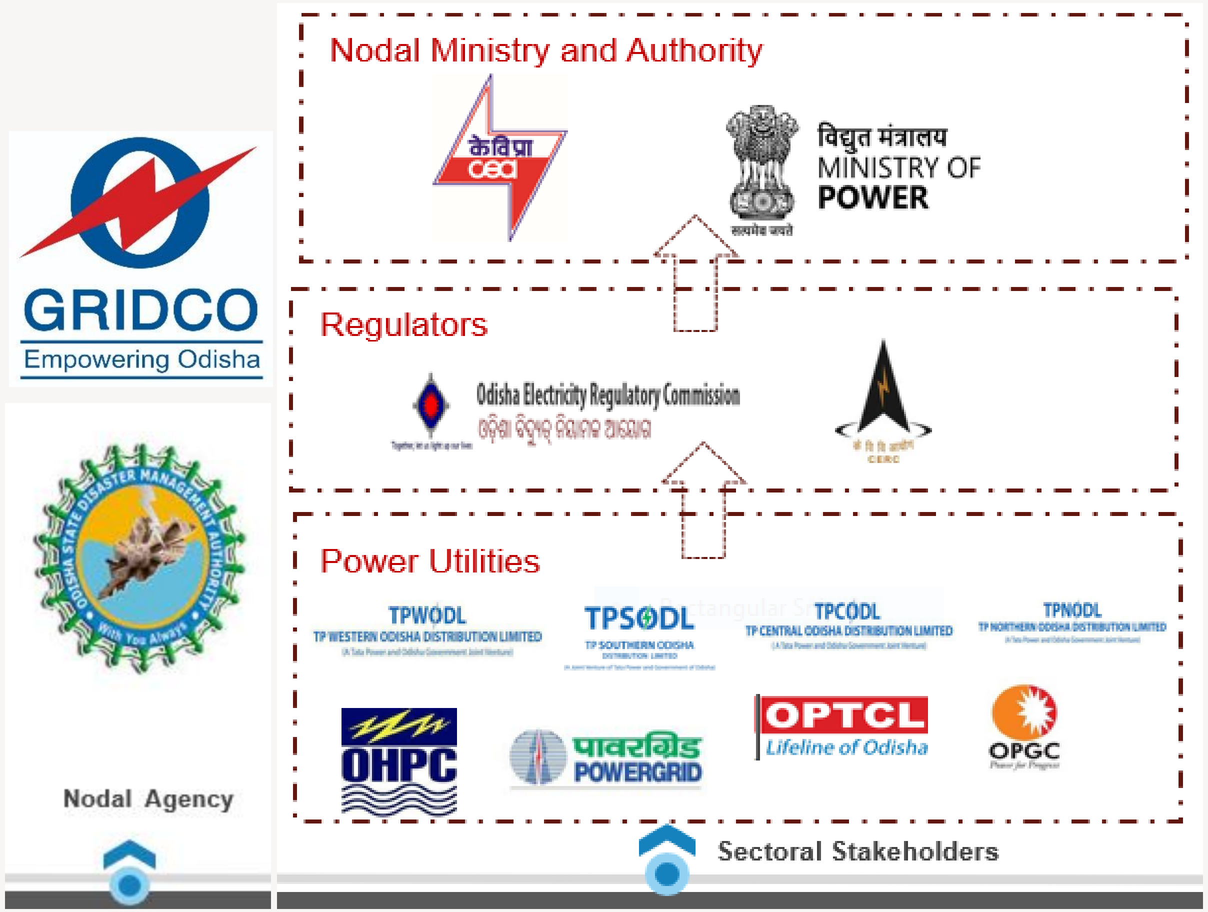
Cyclones

Floods



Cyclone Exposure: Wind Zonation Map for 50-year Return Period incorporating Climate Change in Odisha

Key Stakeholders



Scope of Odisha power sector study

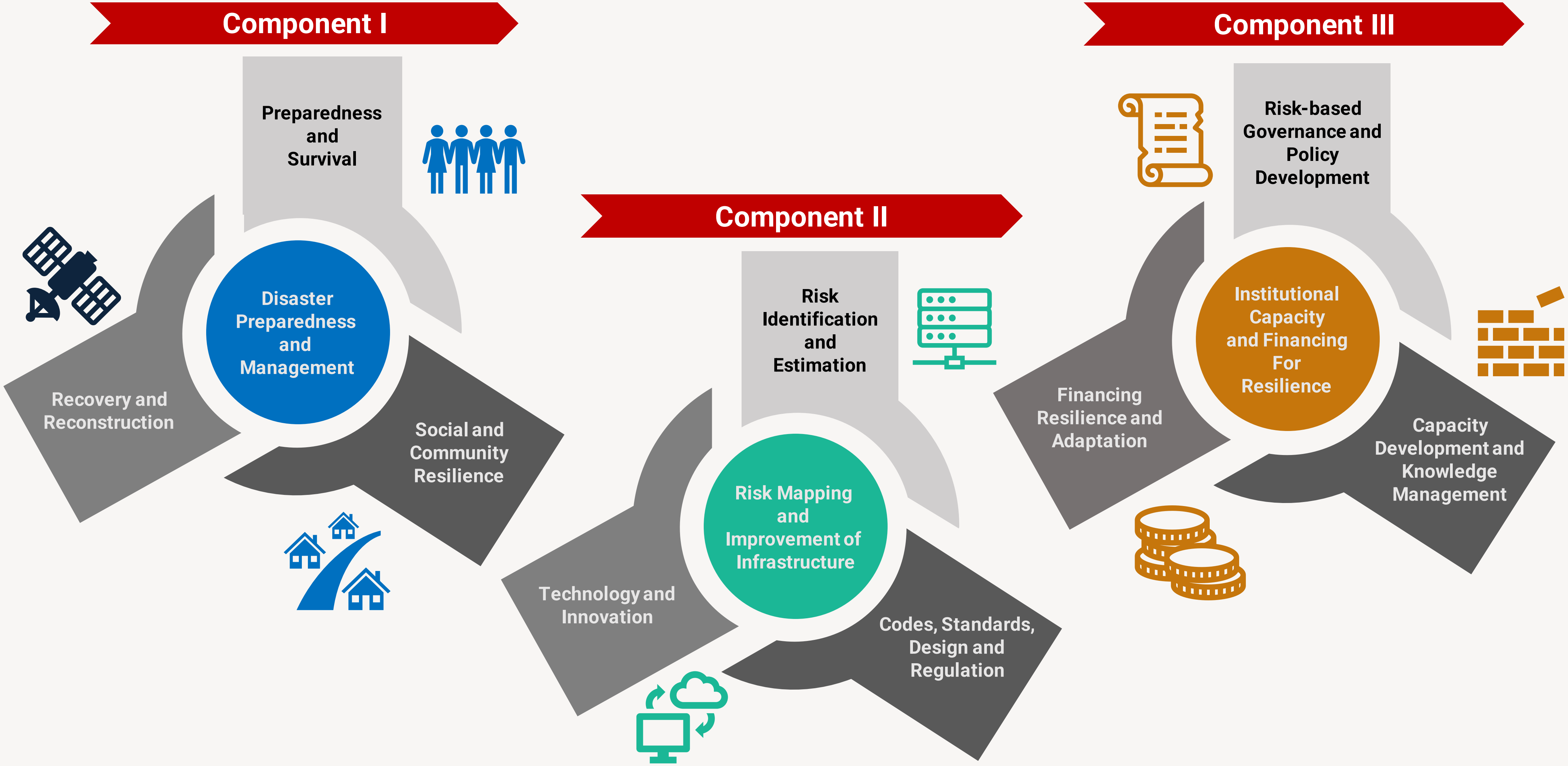
- **Component I: Disaster preparedness and management**
  1. Preparedness and survival
  2. Recovery and reconstruction
  3. Social and community resilience

- **Component II: Risk mapping and improvement of infrastructure**
  1. Risk identification and estimation
  2. Codes, standards, design and regulation
  3. Technology and innovation

- **Component III: Institutional capacity and financing for resilience**
  1. Risk based governance and policy development
  2. Financing resilience and adaptation
  3. Capacity mapping and development, and knowledge management

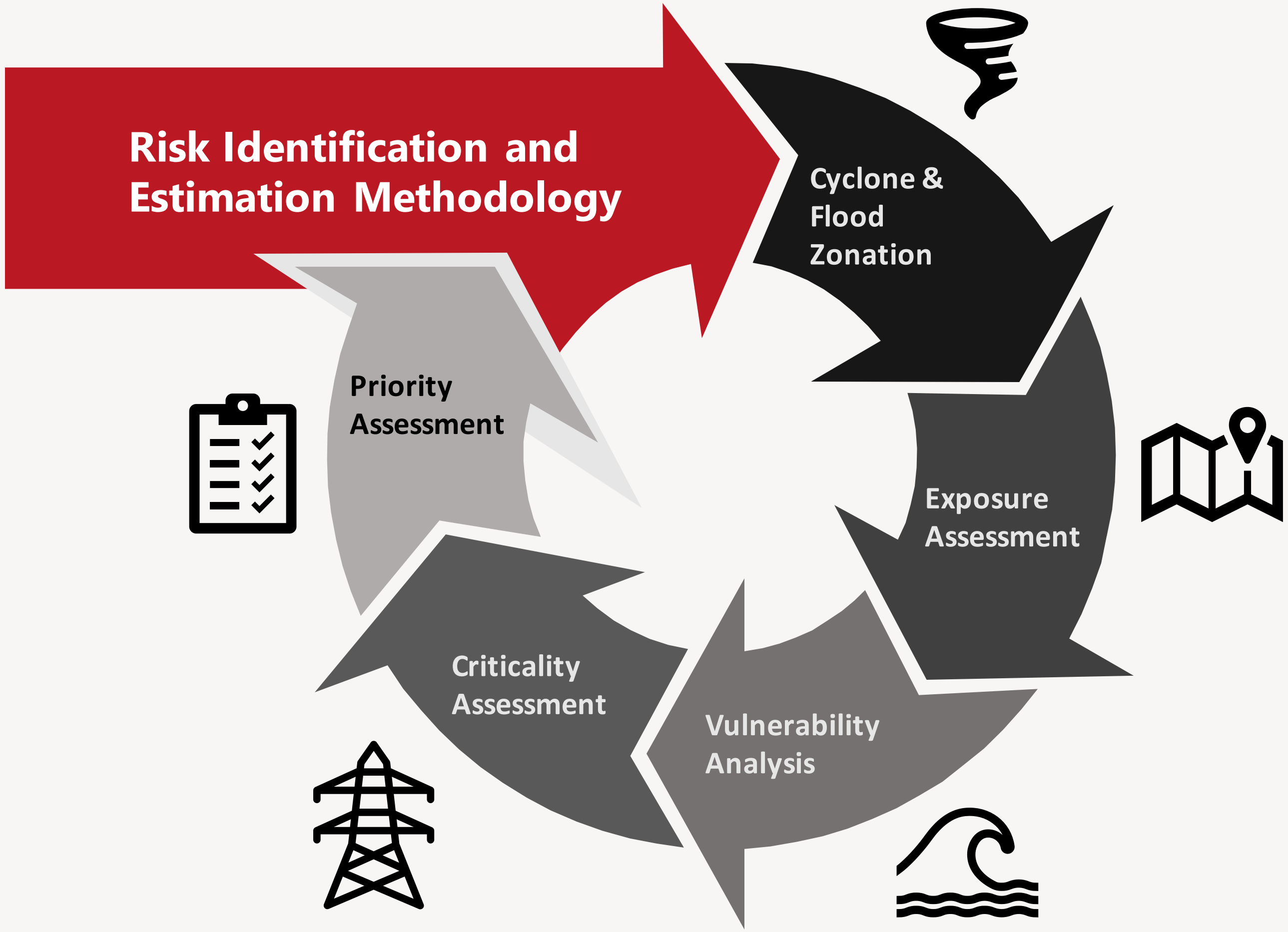
Introduction: Components of the Study

Risk Estimation, Policy Development, and Innovative Finance



Methodology: Risk Identification and Estimation

Exposure, Vulnerability, and Prioritization of Assets



Step 1: Cyclone Zonation and Flood Zonation

Cyclone Micro Zonation and 2D Flood Modelling → Cyclone and Flood Hazard Map

Step II: Exposure Assessment

Asset Map → Cyclone and Flood Exposure Maps

Step III: Vulnerability Analysis

Cyclone, Flood, and Multi-Hazard Vulnerability → Cyclone and Flood Hazard Maps

Step IV: Criticality Assessment

Importance Based and Risk Based → Critical Assets Map

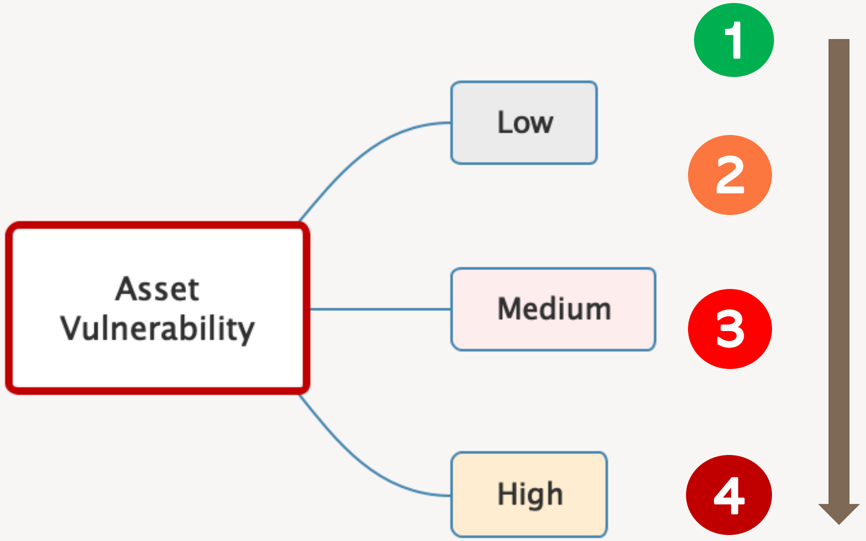
Step V: Priority Assessment

Prioritisation Matrix → Prioritisation Assets List

Methodology: Risk Identification and Estimation

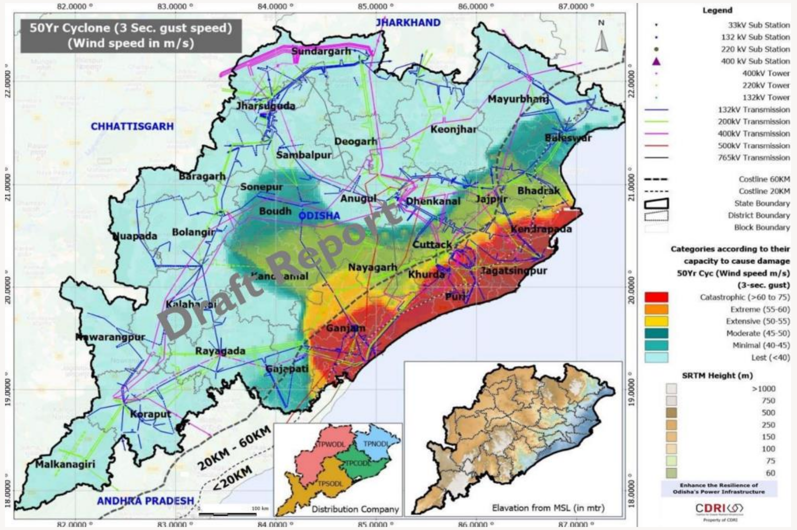
Vulnerability Assessment and Cyclone Exposure

16 Indicators based on their correlation with infrastructure vulnerability

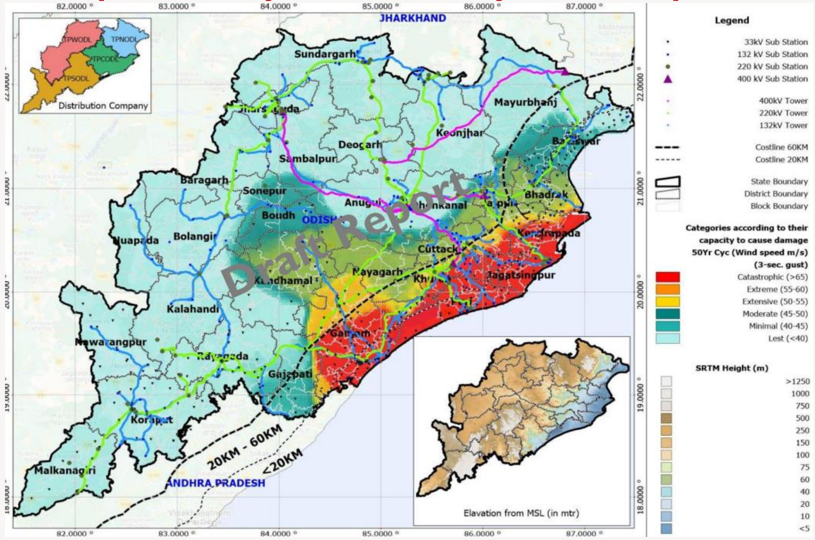


Each indicator was assigned a score on a scale ranging from 1 (indicating low vulnerability) to 4 (indicating high vulnerability)

Transmission network exposure to cyclone with 50-year return period



Transmission and distribution sub-stations exposure to cyclone with 50-year return period



Key Findings for Odisha: Hazard Zonation, Asset Exposure, and Criticality

Hazard Zonation

As per the **50-year return period** cyclone zonation map, over **10 per cent** of coastal locations in Odisha will face wind speeds above **60 m/s**

As per the flood zonation map, **water depths** reached up to **1.13 meters** in several places

Asset Exposure

Wind speeds ranging from **50 to 60 m/s** detected in approximately **16 per cent** of the coastal areas

T&D assets extremely vulnerable to the severe storm, especially across **Puri, Jagatsinghpur, Kendrapada, and Ganjam**

Some DISCOMs have approximately **30 per cent** of the infrastructure exposed to flooding in a **100-year return period** scenario

Criticality Categorisation

Category-1: Feeding to **essential services** viz. medical, water supply pumping station, cyclone shelters, etc

Category-2: Based on loading (trunk lines)

Category-3: Based on feeding arrangement of substations viz. **Radial or Ring** system (to meet **N-1 contingency criteria**)

Key Findings for Odisha: Economic Losses and Vulnerability Analysis

Infrastructure Damage in Odisha	• Post assessment of 2019-20, damages to power infrastructure comprised of 28 tower (220 kV & 400 kV), 21 towers (132 kV) • 200 high tension poles were damaged with 11,077 distribution transformer and 79,485 km of low-tension lines. • 5,030 km of 33 kV lines and 38,613 km of 11 kV lines were also damaged (ADB, 2019).
Economic costs	The overall estimated damage cost came to be INR 11,597.7 million.

Over **30 per cent** of vulnerable distribution substations are located within 20 km of the seacoast.

Ageing infrastructure, with nearly **75 per cent** of distribution lines commissioned three decades ago.

Approximately **80 per cent** of poles are of joist or PSC designs, making them susceptible to high wind speeds.

Longer span lengths, specifically 70 meters or more, in **80 per cent** of the 33kV lines, heightening their susceptibility to damage.

Distribution Network : Vulnerability

Components	No.	Indicators	Parameters	Score	Remarks
Distribution 33/11 kV Sub Station (PSS)	1.	Year of Commissioning	• Less than 30 yrs. • More than 30 yrs.	1 4	Infrastructures outlived their services life are more at risk.
	2.	Type of PSS	• GIS • AIS – Indoor • AIS (Indoor -11kV & Outdoor-33kV) • AIS Outdoor	1 2 3 4	GIS are compact indoor system that reduces substation the areas compared to AIS. AIS predominantly exposed to outdoor environment
	3.	Building Standards/ Codes/ Design Spec	• Single Storey • Double Storey	1 4	Building vulnerable, by their roof type
	4.	Type of PSS power supply Source	• Ring type (Double source) • Radial type (Single Source)	1 4	Ring networks have dual source of supply than radial network with single source
Distribution- Lines	1	Year of Commissioning	• Less than 30 yrs. • More than 30 yrs.	1 4	Infrastructure outlived their services life are more at risk.
	2	Type of supporting structures/poles	• UG (Under Ground) / Narrow Base Lattice Structure / H-Pole/ H, Rail/ Tower (Lattice) • NBLS, JOIST, UG / Joist, Rail / Joist, Tower / Joist, H • Joist / MIX • PSC / Joist, PSC, Rail / Joist, Lattice / Joist, Tower	1 2 3 4	Poles with improved design such as NBLA/H-Pole are more resistance than, PSC joist PSC
	3	Span length (m)	• Up to 40 m • 40 to 50 m • 50 to 60 m • More than 60 m	1 2 3 4	Increased span length cause sagging that increases vulnerability
	4	Failure History	• No • Yes	1 4	Distribution or transmission line past failures increases the probable risk of breakdowns

Higher score denotes, higher criticality & vulnerability, where 4 is the most vulnerable and 1 is less susceptible

Transmission Network : Vulnerability

Components	No.	Indicators	Parameters	Score	Remarks
Transmission – Gird SS	1	Type of GSS	• GIS • AIS - Outdoor	1 4	GIS are compact indoor system while AIS exposed to outdoor environment
	2	Year of Commissioning	• Less than 30 yrs. • More than 30 yrs.	1 4	Infrastructure outlived their services life are more at risk.
	3	Failure History in past cyclones	• No • Yes	1 4	Past failures increase the probable risk of breakdowns
	4	Type of GSS power supply source	• Ring type • Radial type	1 4	
Transmission – Lines	1	Year of Commissioning	• Less than 30 yrs. • More than 30 yrs.	1 4	Infrastructures outlived their services life are more at risk.
	2	Type of Circuit	• Double (Multiple Source) • Single (Single source)	1 4	Double circuit have multiple sources making them less susceptible
	3	Span length (m)	• 400 kV line (>400 m) & 220 and 132 KV line >250 m • 400 kV line (<400 m) & 220 and 132 KV line <250 m	4 1	Increased span length cause sagging that increases vulnerability
	4	Failure History in past cyclones	• Yes • No	4 1	Past failures increase the probable risk of breakdowns

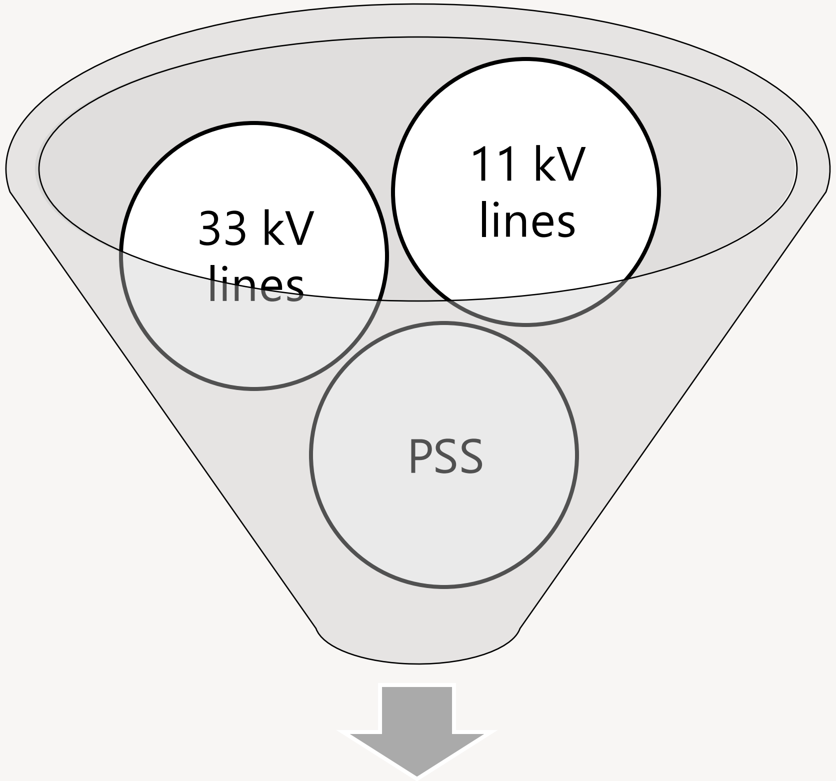
Higher score denotes, higher criticality & vulnerability, where 4 is the most vulnerable and 1 is less susceptible

Key Findings for Odisha: Asset Prioritization at the Utility Level

Critical lines, Vulnerability, Prioritization of Transmission Lines: A Snapshot

Critical lines, Vulnerability, Prioritization of OPTCL Transmission lines					
Name of EHT Line	**Zone**	**Distance from seacoast (in kms)**	**Critical**	**Vulnerability Level**	**Priority**
132 kV Chhatrapur - Balugaon SC	South	0-20	Yes	High	1
132 kV Chhatrapur - Ganjam SC	South	0-20	Yes	High	1
132 kV Balasore - Jaleswar SC	North	0-20	Yes	High	1

Critical Lines, Vulnerability, Prioritization of 11kV lines under TPNODL in Balasore district					
Name of PSS	**11 kV feeder name**	**Distance from seacoast (in kms)**	**Critical**	**Vulnerability Level**	**Priority**
Kacheripada	Soro	0-20	Yes	High	1
Iswarpur	Mangalpur	0-20	Yes	High	1
Oupada	Darkholi	0-20	Yes	High	1
Markona	Biranchipur	0-20	Yes	High	1
Jhatia/Gandibeda	Makahnpur	0-20	Yes	High	1



Priority – 1: Number of Assets across Utilities

Assets	TPNODL	TPCODL	TPSODL
33 kV lines	71	52	34
11 kV lines	144	138	146
PSS	5	18	2

Cost Benefit Analysis Methodology for Odisha Power Infrastructure

Step 1: Baseline Diagnosis

Identification of hazards in Odisha affecting power infrastructure
(past cyclonic events)

Step 2: Asset Prioritisation

Preparation of hazard zonation zones

Assessment of degree of vulnerability

Step 3: Investment Options

Prioritization of Critical Power Infrastructure

Investment options based on criticality and order of risk

Cost Benefit Analysis Methodology for Odisha Power Infrastructure

To evaluate the impact of Fani, the government funded projects being executed at the time of FANI have been considered as these projects were delayed in capitalization.

First-order losses

The loss due to delayed capitalization has been incorporated in first order loss

Second-order losses

For second order risks, cumulative of revenue loss and **project impact for cyclones from 2013 to 2021** have been assessed in proportionate to the losses in FANI. i.e.,

Second order loss in other cyclone = (2nd order loss in FANI/Infrastructure damage cost in FANI) *Infrastructure Damage cost in another cyclone

Third-order losses

While the third order losses for FANI was first calculated by taking the following into consideration:

- **Population**
- **GSDP**
- **Total GSDP loss**
- **Share of industry**
- **Number of days in a year**
- **Average number of days**
- **Per capita income in 2019-20**
- **Number of people affected in cyclone hit areas**
- **Service sector and agriculture-allied sectors to GSDP**

Study Recommendations

Option 1: Retrofitting

- 33kV line: H-Pole, E250 grade steel ,(2x150x75) mm, 36.96kg
- 11 kV line : H-Pole, E250 grade steel, (2x125x65) mm, 28.82 kg
- PSS: Retrofitting of existing PSS and Proposal for new GIS PSS
- DTR: Plinth Foundation for 100kVA & above

Option 2: New Construction (Without UG Cable)

- 33 kV line: H-pole, E350 grade steel, (2x150x75) mm, 36.96kg
- 11 kV new line: H-Pole E250 grade steel, (2x125x65) mm, 28.82 kg
- LT new Line spun poles
- DTR: Plinth Foundation for 100kVA & above
- PSS: New 33/11kV GIS and Retrofitting of existing PSS

Option 3: New Construction (With UG Cable)

- UG Cabling: Urban areas considering priority and criticality.
- 33kV new line: H-Pole
- 11kV new line :H-Pole
- LT line: Spun pole
- DTR: Plinth Foundation for 100kVA & above
- PSS: New 33/11kV GIS and Retrofitting of existing PSS

Cost-Benefit Analysis: Total Investments and Infrastructure Types

Option 1

Retrofitting of Existing Lines

INR 22,691 Cr.

Retrofitting with H-Pole, E250 (2x150x75) mm, 36.96kg/m for 33kV line & H-Pole, E250 (2x125x65) mm, 28.82 kg/m for 11 kV line.

Option 2

Construction of New Lines

INR 25,628 Cr.

Construction of new lines with H-pole E350 (2x150x75) mm, 36.96kg/m for 33 kV line, H-Pole E350 (2x125x65) mm, 28.82 kg/m for 11 kV new line & spun poles for LT new Line in place of old lines.

Option 3

Upgrading to Underground Cable System

INR 26,992 Cr.

Underground cable system for distribution network in urban areas considering priority and criticality. H-Pole for 33kV, 11kV new lines and Spun pole in LT new lines for rural area.

DISCOM-wise Investment (in INR Cr.)				
DISCOM	Option 1	Option 2	Option 3	Total
TPCODL	8,610	9,707	9,914	28,231
TPNODL	7,296	8,254	8,593	24,143
TPSODL	6,785	7,667	8,486	22,938
Grand Total	22,691	25,628	26,992	75,311

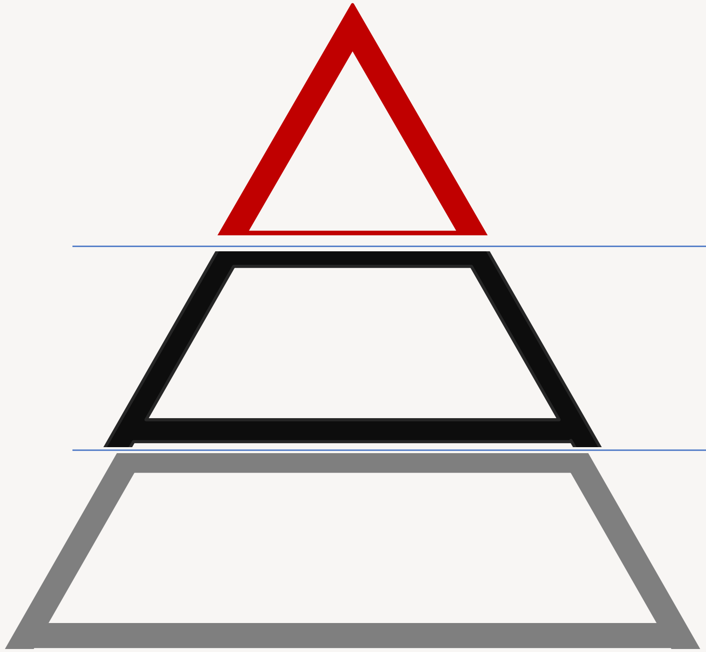
[1] Based on the cost-benefit analysis in the report

Challenges

1. Fund constraint: As per an rough estimate Rs.25,000 Cr. would be required for creation of disaster resilient distribution infrastructure in the State.
2. Regulatory constraint: Such huge expenditure by Discoms through tariff would give unreasonable tariff shock on consumers.
3. Standards for Wind Zone VI and Gaps in existing design practice
4. Capacity of the market (manufacturers & suppliers) to deliver during disasters
5. Institutionalization of past learnings and capacity building of T&D Utilities

Key insights: Risk-based governance and policy development

Benchmarking framework for effective risk-based governance and policy implementation



1.1 Policy interventions and target setting

Stakeholder collaboration, inclusion of "resilience" across all guidelines and plans reduced paucity of mitigation funds

1.2 Recommendations and supporting measures

Wind zonation maps, innovative funding mechanisms, Public-private partnerships for insurance, CAT bonds

1.3 Implementation framework and tools

Risk estimation, climate-risk data collection and management, Decision-support system, DMP and other guidelines, etc

Key insights: Risk-based governance and policy development

Policy interventions and target setting

Special focus on coastal and high-mountain regions

Policies and schemes to focus on Coastal and High-Mountain Regions as part of DRI initiatives

Power utility-focused disaster fund

Work with regulators to mandate the creation of a power utility-focused disaster fund where **at least 1.5% of annual revenue** is to be allotted*.

Cross-sectoral framework for stakeholder collaboration

Creation of framework (cross-sectoral) with Forum of Regulators, MoP and NDMA, OEMs, etc

Recommendations and Supporting Measures

Updated Codes and Standards

Newly updated wind zone map for all of India with most updated codes and standards

Climate Resilience Data Access Platform

Develop cross-sectoral Climate Resilience Data Access Platform for impact-based forecasting across critical infrastructure

Innovative Financial Windows for Adaptation and Mitigation

Providing adequate funding to include risk assessments in master plans and early project design (e.g. PPP, CAT bonds, reinsurance)

Implementation Framework and Tools

Inclusion of resilience assessment component across policies

Need for including a "resilience component" across policy framework (e.g. RDSS)

Incorporate "resilience" into infrastructure investments

Innovative disaster financing and risk-reduction financial instruments needed to incorporate "resilience" across investment and cash flows

Develop impact-based tools for decision support system

Impact-based forecasting and development of a decision support system

*CEA/MoP recommended

Thank You