Q.1) Considering the recent earthquakes in Nepal and north eastern India, examine India's preparedness to handle high-intensity earthquakes, especially in seismically active zones. (150 words, 10 marks)

Introduction

According to **NDMA** and the **UNDRR**, over **60%** of India's landmass is vulnerable to moderate-to-severe seismic activity. Recent quakes underscore the urgent need for resilient infrastructure and community preparedness in **seismic zones III–V**.

Body

Recent Earthquakes and Their Implications

1. **Nepal Earthquake, November 2023:** A **6.4** magnitude quake in **Jajarkot** claimed over **150 lives** and shook parts of northern India, including Delhi and UP.
2. **Assam Earthquake, March 2024:** A **5.2** magnitude tremor hit **Sonitpur district**, exposing structural vulnerabilities in Northeast India's urban hubs.

India's Current Earthquake Preparedness

1. **Seismic Monitoring Network Expansion:** The National Centre for Seismology runs over **115** observatories that relay real-time earthquake data to national and state disaster agencies.
2. **Seismic Micro zonation and Risk Mapping:** Cities with populations over **5 lakh** are micro-zoned for seismic risk, helping in quake-resistant planning and safer construction practices.
3. **National Earthquake Risk Mitigation Project (NERMP):** NDMA's flagship program in **Zones IV and V** focuses on legal reforms, institutional training, and community-level disaster awareness.
4. **Awareness and Communication Drives:** NDMA conducts multi-platform campaigns promoting **"Drop, Cover, Hold"** and retrofitting awareness, especially in high-risk states.
5. **Earthquake Disaster Risk Index: NDMA**'s index helps quantify risks in cities across Zones IV and V, guiding priority interventions and preparedness investments.

Challenges and Limitations in Preparedness

1. **Weak Implementation of BIS Codes:** Despite **BIS 1893 guidelines**, most Tier-2 and Tier-3 cities show poor adherence, as noted in the **CAG report (2020)**.
2. **Outdated Urban Planning Norms:** Many municipal bodies still operate under town planning acts that don't incorporate seismic risk zoning.
3. **Lack of Early Warning Systems:** India lacks an earthquake early warning system, unlike **Japan** or **Mexico**; IMD alerts are issued only post-event.
4. **Poor Community Awareness:** Surveys by NDMA show only **30%** awareness of **"Drop, Cover, Hold" drills** even in quake-prone states like **Uttarakhand.**
5. **Slow Pace of Retrofitting:** Of **5,000** vulnerable schools identified in Himachal and Assam, less than **25%** have been structurally upgraded.

Way Forward

1. **Strengthen Compliance Mechanisms:** Make **BIS seismic codes** legally binding across states; enforce penalties for non-compliance in high-risk zones.
2. **Develop Earthquake Early Warning Systems:** Build real-time alerts leveraging AI and sensors, in collaboration with global best practices (e.g., **Japan's EEWS**).
3. **Mainstream DRR in Urban Planning:** Integrate **Sendai Framework principles** into master plans—risk-informed land use, zoning, and resilient infrastructure.
4. **Boost Community Preparedness:** Promote mass-scale public drills and education, in line with **Hyogo Framework's "Build Back Better"** doctrine.
5. **Global Collaboration and Knowledge Sharing:** Expand **CDRI's role** in facilitating tech transfer, seismic modelling, and regional quake resilience cooperation.

Conclusion

Enhancing seismic resilience is essential for building long-term disaster resistance. Aligning with the **Sendai Framework** and **fostering local-global synergy** can transform India's earthquake risk landscape while safeguarding lives and development gains.

Q.2) The recurring landslides in Himachal Pradesh and Sikkim have exposed gaps in development planning. Critically examine the role of unplanned infrastructure and deforestation in increasing landslide vulnerability. Suggest solutions. (150 words, 10 marks)

Introduction

According to the **Geological Survey of India (GSI)**, nearly **12.6%** of India's landmass is prone to landslides. The **2023** landslides in **Himachal** and the **2024** events in **Sikkim** reveal how deforestation and haphazard construction aggravate this risk.

Body

Recent Landslide Incidents and Their Impacts

1. **Himachal Pradesh, July–August 2023:** Over **400 people lost lives** due to landslides triggered by torrential rain, worsened by slope-cutting for roads and buildings.
2. **Sikkim, May 2024:** Flash floods and landslides disrupted **NH-10** and damaged key infrastructure, showcasing the compound impact of glacial melt, deforestation, and ill-planned roads.

Unplanned Infrastructure and Its Contribution to Vulnerability

1. **Slope Destabilization due to Road Cutting:** Roads are carved out using vertical cuts with no retaining walls, disrupting slope equilibrium and causing collapses during heavy rainfall. Example: **Kalka-Shimla r**oad damage in **2023.**
2. **Urban Expansion Without Hazard Zonation:** Rapid urban growth on fragile slopes like in **Shimla** lacks integration of hazard zonation maps into bylaws, inviting construction in high-risk zones — as seen in Summer Hill collapse.

3. **Hydropower Projects and Blasting:** Projects such as **Teesta and Parbati** employ uncontrolled blasting and tunnelling, altering geophysical stress and triggering landslides in weak zones.
4. **Poor Drainage and Runoff Management:** Inadequate stormwater management systems near roads and settlements increase waterlogging and lead to saturation-induced landslides — evident along **NH-707 in Uttarakhand**.
5. **Tourism-Driven Infrastructure Boom:** Hotels and homestays are often built violating slope angle guidelines, overwhelming natural resilience — such as unregulated **homestay clusters in Manali**.

Role of Deforestation in Triggering Landslides

1. **Loss of Natural Slope Binders:** Tree roots act as natural reinforcements; deforestation loosens topsoil, especially during the monsoon, making slopes prone to failure.
2. **Shifting Cultivation in North East:** Slash-and-burn practices in **Sikkim** and nearby regions reduce vegetative cover and natural water retention, amplifying erosion.
3. **Unregulated Logging and Plantation:** Forest cover loss for agriculture and timber in **Himachal's Kullu and Mandi valleys** has been directly linked with slope weakening.
4. **Failure to Implement CAMPA Funds:** Delays in compensatory afforestation under the **CAMPA** scheme have meant ecological restoration hasn't kept pace with deforestation.
5. **Encroachment into Forest Land:** Expansion of settlements and roads into designated forest zones violates the **Forest Conservation Act** and removes stabilising green cover.

Steps Taken by the Government

1. **Landslide Hazard Zonation Mapping by GSI:** The Geological Survey of India has mapped **85%** of vulnerable hill regions and shared this data with states to incorporate into town planning.
2. **National Landslide Risk Management Strategy (2020):** This strategy aims at institutional capacity building, risk zoning, landslide monitoring, and promoting community-based disaster risk reduction.
3. **Installation of Early Warning Systems:** Pilot projects in **Uttarakhand and Sikkim** include rainfall thresholds and sensors to issue alerts before slope failures.
4. **Eco-sensitive Development Norms in Hill States:** Draft guidelines by the **MoEFCC** promote low-impact construction, waste management, and slope-sensitive architecture in eco-sensitive zones.

Solutions Needed

1. **Mandatory Landslide Hazard Mapping:** Enforce **GSI-led zonation maps** in urban masterplans; restrict high-risk slope construction as per **NDMA guidelines**.
2. **Eco-sensitive Infrastructure Codes:** Promote stilt-based structures, terracing techniques, and deep drainage norms specific to hill regions in building bye-laws.
3. **Reforestation and Slope Bioengineering:** Launch intensive slope-stabilisation projects using vetiver grass, willow trees, and **bio-nets**, especially in landslide-prone districts.

4. **Institutional Coordination and Capacity Building:** Strengthen disaster cells in municipalities; improve convergence among PWD, Forest Dept, and NHAI under State DM Plans.
5. **Incorporate Global Best Practices:** Draw from **Japan's Sabo engineering techniques** to integrate resilience into hill development models.

Conclusion

Addressing landslide risk demands compliance with **NDMA's landslide mitigation guidelines**, integrating environmental safeguards with planning. Only then can we build resilient mountain regions that balance development with safety and ecological stability

Q.3) Disaster preparedness is the first step in any disaster management process. Explain how hazard zonation mapping will help in disaster mitigation in the case of floods. (150 words, 10 marks)

Introduction

Disaster preparedness, the first phase of the **UNDRR** disaster management cycle, focuses on reducing impact before disasters strike. As per the **Sendai Framework** and India's **2009 DM Policy,** preparedness is critical to flood mitigation.

Body

Why Preparedness Is the First Step

1. **Risk Awareness and Education**: Pre-disaster campaigns, school drills, and local training boost readiness.
   Example: Coastal villages in **Odisha** conduct **mock drills** under the **GoI-UNDP Disaster Risk Reduction Programme.**
2. **Infrastructure and Resource Prepositioning**: Boats, shelters, food, and medicines are stocked in high-risk zones pre-monsoon.
   Example: **Assam and Bihar** use prepositioning strategies in flood-prone blocks.
3. **Evacuation Planning**: Includes hazard route mapping, identification of vulnerable populations, and shelter designation. Mandated under **NDMA's Flood Management Guidelines (2008)**.
4. **Forecasting and Early Warning Systems**: Real-time alerts from IMD and CWC aid in timely evacuation.
   Example: India's Flood Forecasting Network covers over **330 stations**.
5. **Institutional Capacity Building**: Training SDRFs, panchayats, and local bodies improves coordinated response.
   Example: The **National DM Plan (2019)** emphasizes multi-tier capacity development.
6. **Hazard Zonation Mapping**: Hazard zonation mapping classifies areas based on flood risk using hydrological data, satellite imagery, and GIS (NRSC, CWC).
   Example: The **National Flood Hazard Atlas** maps all flood-prone districts in India.

How It Helps in Floods

1. **Guided Land Use Planning**: Prevents construction in low-lying floodplains and preserves buffer zones.
   Example: **Post-2015 Chennai floods**, urban land-use plans were revised.
2. **Targeted Infrastructure Design**: Facilitates flood-resilient structures such as stilt houses and elevated roads.
   Example: Stilted buildings in **Assam's Kaziranga** region follow zonation inputs.
3. **Efficient Resource Allocation**: Prioritizes SDRF, boats, and relief camp deployment based on flood-prone zones.
   Example: Assam's district-wise flood preparedness plans use zonation maps.
4. **Insurance and Risk Transfer Mechanisms**: Zonation helps assess flood risk and set premiums for insured assets.
   Example: Crop risk assessments under **PMFBY** rely on flood hazard data.
5. **Data-Driven Community Preparedness**: Empowers local bodies to organize drills and public safety campaigns.
   Example: **Kuttanad basin in Kerala** uses zonation for community response planning.

Steps Taken by the Government

1. **National Flood Hazard Atlas (NRSC)**: Uses satellite data to map historical flood frequency across India.
2. **Urban Flood Management Guidelines (NDMA, 2010)**: Mandate hazard mapping integration in urban drainage and city planning.
3. **Real-Time Flood Forecasting (CWC + IMD)**: Over **330 telemetry-based stations** issue flood alerts nationwide.
4. **Amrit Sarovar Mission (2022)**: Aims to rejuvenate water bodies to reduce surface runoff in flood-prone areas.

Way Forward

1. **Implement Mihir Shah Committee Recommendations**: Suggests integrating river basin planning with flood hazard mapping for sustainable water and disaster governance.
2. **Digital Elevation Mapping (ISRO + NRSC)**: Accelerate use of high-resolution satellite imagery and LIDAR-based elevation models to improve micro-zonation of flood risks.
3. **Deploy IFLOWS/CFLOWS Systems**: Expand AI-based flood forecasting models like **Mumbai's IFLOWS** and **Chennai's CFLOWS** to other urban flood hotspots.
4. **Adopt Sponge City Principles**: Learn from **China's model** by integrating permeable pavements, urban wetlands, and rain gardens to absorb excess water.

Conclusion

Preparedness, aligned with the Sendai Framework, ensures resilience through early warning and hazard mapping. **Zonation-integrated planning** is key to meeting India's **sustainable disaster risk reduction** and climate adaptation goals.

Q.4) With record-breaking heatwaves affecting large parts of India in 2024–25, examine the socio-economic and health impacts of extreme heat. Evaluate the effectiveness of Heat Action Plans in building long-term resilience. (250 words, 15 marks)

Introduction

A heatwave, as per **IMD**, is declared when the maximum temperature exceeds **40°C** in plains, **37°C** in coastal areas, or **30°C** in hilly regions, with deviations of **4.5°C** or more. India witnessed record-breaking heat in **2024–25**, affecting health, livelihoods, and productivity.

Body

IMD Classification of Heatwaves

- **Heatwave**: Departure of **4.5°C to 6.4°C** above normal or temperature **≥ 45°C**.
- **Severe Heatwave**: Departure **≥ 6.5°C** or temperature **≥ 47°C**.

Rising Frequency and Intensity

- **Increased Incidence**: India recorded over **200 heatwave** days in the summer of **2024**, with states like **Rajasthan and Bihar** facing **>45°C** for extended periods.
  Example: **Phalodi, Rajasthan** touched **51°C** — India's highest ever.

Socio-Economic and Health Impacts

1. **Health Stress and Mortality**: Heat strokes and cardiovascular strain have increased, especially among elderly and outdoor workers.
   Example: Over **100** confirmed heat-related deaths in **Odisha (May 2024).**
2. **Reduced Labour Productivity**: **MGNREGA** and construction workers saw reduced work hours, lowering earnings.
   Example: **ILO** estimates India lost **5.8%** of working hours in **2023 due to heat**.
3. **Agricultural Losses**: Heat reduces crop yields and increases evapotranspiration.
   Example: **Wheat** production in **Punjab** declined by **10%** due to March heat spells.
4. **Water and Power Demand Surge**: Sharp rise in AC and pump use stresses grids and depletes groundwater.
   Example: **Delhi** faced 8-hour outages and **42%** power demand rise **(May 2024)**.
5. **Urban Poor Most Vulnerable**: Slum dwellers face unbearable indoor heat due to tin roofs, poor ventilation, and Urban Heat Island effects.
   Example: **Mumbai's** informal settlements recorded indoor temperatures **6–7°C** above ambient levels.

Heat Action Plans (HAPs): Effectiveness

1. **Localized Planning and Coordination**: Cities like **Ahmedabad** pioneered **India's first HAP** in **2013**, involving IMD, health departments, and urban bodies.
2. **Mortality Reduction**: **Ahmedabad** saw a **61%** drop in heat-related deaths over **five years** post-HAP implementation.
3. **Awareness and Behavioural Change**: SMS alerts, water stations, and public education reduced vulnerability in cities like **Nagpur and Bhubaneswar**.

4. **Still Limited in Coverage**: Only **23 of 100 smart cities** have functional HAPs. Implementation remains urban-centric and seasonal.
5. **Lack of Integration with Climate Policy**: HAPs often remain stand-alone documents, not linked with city masterplans or state disaster management strategies.

Government Interventions

1. **National Plan for Heatwave Action (2023)**: **NDMA**'s revised guidelines promote state-wise HAPs with focus on early warning systems, healthcare capacity, and inter-agency coordination.
2. **India Cooling Action Plan (ICAP)**: Launched by **MoEFCC** in **2019**, **ICAP** targets sustainable cooling and heat resilience with a **20–25%** reduction in cooling demand by **2037–38**.
3. **Early Warning Dissemination**: IMD issues color-coded heat alerts, reaching millions via **Doordarshan**, mobile apps, and district administrations.
4. **Amrit Dharohar and MISHTI Schemes**: Launched in **Union Budget 2023–24** to conserve wetlands and mangroves, enhancing natural cooling in urban peripheries.

Way Forward

1. **Strengthen Early Warning and Communication**: Use mobile alerts, local radio, and community workers for real-time advisories.
2. **Expand Cool Roofs**: Prioritize reflective materials in low-income housing clusters. Example: **Ahmedabad's Cool Roof Program** now covers **3 lakh sqm**.
3. **Adopt Global Best Practices**: Localize cooling models like **LA's cool pavements** and Singapore's vertical gardens.
4. **Integrate Urban Heat Mapping**: Use **IMD–ISRO** data to target zoning, shade infrastructure, and greening in high-risk areas.
5. **Learn from Seville, Spain**: First city to name and rank heatwaves, triggering faster response and public awareness.

Conclusion

Extreme heat events will intensify under climate change. Mainstreaming heat resilience in urban planning, guided by the **Sendai Framework** and **India Cooling Action Plan**, is essential to safeguard health, equity, and sustainable growth.

Q.5) India's approach to disaster management is evolving from a reactive, relief-centric model to one focused on proactive resilience-building. Discuss the progress and challenges in achieving this shift. Also suggest measures to strengthen this transformation. (250 words, 15 marks)

Introduction

As per **UNDRR, Disaster Management** involves organized planning to reduce hazard impact. India is shifting from reactive relief measures to **proactive resilience-building** — a vital transformation for sustainable development in a disaster-prone country.

Body

Earlier Relief-Centric Approach

1. **Post-Disaster Focus**: Major policies centered on relief distribution and temporary rehabilitation after events rather than prevention or risk reduction.
2. **Revenue Department Control**: Disaster response was traditionally led by revenue officials, lacking multi-sectoral coordination and scientific input.
3. **Ad-Hoc Financing**: Funding was mostly routed through the **Calamity Relief Fund**, with little investment in preparedness or mitigation. (Replaced by **SDRF and NDRF in 2010***)*
4. **Lack of Dedicated Institutions**: Until **2005**, there was no central legislation or agency specifically mandated to address disaster risk reduction.

Shift to Proactive Resilience Approach

1. **DM Act, 2005**: Established **NDMA, SDMAs, and DDMAs**, institutionalizing prevention, preparedness, and mitigation strategies.
2. **Mainstreaming DRR in Development**: Planning Commission guidelines (2010) and later **NITI Aayog** emphasized integrating risk reduction into all sectoral plans.
3. **Early Warning Infrastructure**: **IMD**, **INCOIS**, and **BIS** enhanced forecasting systems for cyclones, tsunamis, and earthquakes.
   Example: Accurate prediction of **Cyclone Yaas (2021)** minimized casualties.
4. **Community Participation**: **CBDRR initiatives** involve locals in hazard mapping, mock drills, and preparedness activities.
   Example: **Odisha's cyclone shelters** managed by community volunteers.
5. **Global Leadership via CDRI**: India launched the Coalition for Disaster Resilient Infrastructure **(CDRI) in 2019** to promote global collaboration on resilient infrastructure systems.

Progress Achieved

1. **Urban Resilience Measures**: **AMRUT and Smart Cities** include climate-resilient infrastructure planning.
   Example: **Surat** integrated flood-resilient stormwater systems.
2. **Technological Platforms**: **Bhuvan (ISRO) and GEM (NDMA)** support vulnerability mapping and structural safety audits.
3. **Policy Recognition**: The **National Disaster Management Plan 2019**, updated in **2023**, aligns with the **Sendai Framework** and **SDGs**.
4. **Institutional Strengthening**: **NDMA guidelines** issued for schools, hospitals, and heritage sites improved sectoral disaster preparedness.

Challenges in Achieving the Shift

1. **Persistence of Relief Orientation**: Many states still emphasize ex-post compensation, ignoring long-term risk reduction investments.
2. **Limited Local Capacities**: Panchayats and ULBs lack funds, training, and autonomy to implement DRR plans.

3. **Poor Enforcement of Regulations**: Building code violations, CRZ breaches, and unsafe hill construction continue unchecked.
   Example: Land instability in **Joshimath, 2023**. The **Ravi Chopra Committee (2021)** had warned against unchecked infrastructure in the fragile Himalayan region.
4. **Slow Adoption of Science-Based Planning**: Recommendations of the **E. Parthasarathy Committee (2006)** on incorporating disaster risk assessments into environmental clearances and development planning remain under-implemented.

Measures to Strengthen the Transformation

1. **Legislate Local DRR Mandates**: Make **Local Disaster Management Plans** legally binding with performance audits.
2. **Incentivize Risk Reduction**: Encourage DRR investments through tax benefits, CSR obligations, and insurance discounts.
3. **Private Sector & PPP Models**: Engage corporates in resilience infrastructure, emergency logistics, and insurance products.
4. **Adopt Global Best Practices**: Follow **Japan's school preparedness model**—mandating regular drills, disaster education, and evacuation routes in every institution.
5. **Capacity Building of First Responders**: Regular training and provisioning of modern equipment to **NDRF, SDRFs**, and local volunteers must be prioritized for quick and effective response.

Conclusion

India must fully embrace the **Build Back Better** vision of **UNDRR**, shifting decisively from relief to resilience. This transformation will safeguard lives, infrastructure, and economic development from future disaster shocks.