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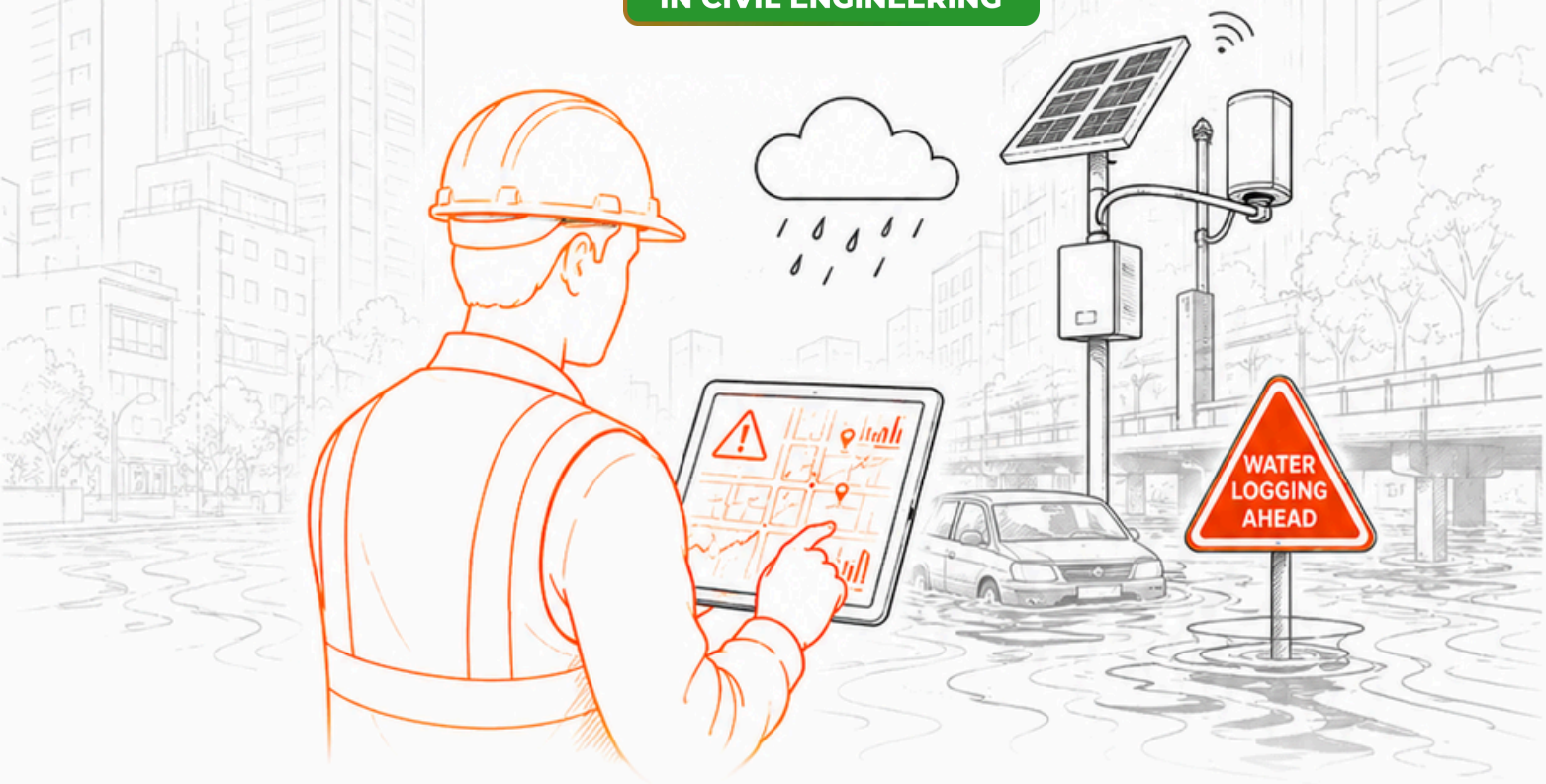
INNOVATION BOOT CAMP IN CIVIL ENGINEERING



Building Bharat Sampaark - National Civil Engineering Hackathon

Problem Statement : Early warning system for water logging in urban areas

Theme : Public Infrastructure

INITIATIVE PARTNERS

AICTE

NIUA राष्ट्रीय नगर कार्य संस्थान National Institute of Urban Affairs

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1. BACKGROUND

Urban flooding and water logging have emerged as one of the most critical infrastructure challenges facing Indian cities. Rapid urbanization, increasing impervious surfaces, inadequate drainage infrastructure, encroachment of natural drainage channels, climate change, and high-intensity rainfall events have significantly increased the frequency and severity of urban water logging.

Every monsoon, major Indian cities experience:

- Road inundation
- Traffic congestion
- Damage to public infrastructure
- Disruption of emergency services
- Economic losses
- Damage to underground utilities
- Public health concerns
- Reduced mobility
- Delays in construction activities
- Loss of productivity

In most cities, municipal authorities respond after water logging has already occurred because current systems rely on:

- Manual inspections
- Public complaints
- CCTV monitoring
- Emergency field surveys

These reactive approaches provide limited time for preventive action.

The Indian construction and urban infrastructure sector requires an intelligent early warning system capable of predicting water logging before it occurs by combining real-time monitoring, hydrological analysis, weather forecasting, drainage network performance, and artificial intelligence.

Such a system would allow municipal authorities, disaster management agencies, contractors, emergency services, transport authorities, and citizens to take preventive measures before flooding becomes critical.

2. INDUSTRY PROBLEM STATEMENT

Design an innovative digital solution (hardware, software, or hybrid) capable of providing real-time prediction, early warning, monitoring, and decision support for urban water logging.

The proposed system should continuously collect and analyse environmental and infrastructure data to:

- Predict locations vulnerable to water logging
- Estimate water accumulation levels
- Issue timely alerts
- Support emergency response
- Improve drainage management
- Assist city administrators in proactive decision-making

The solution should be affordable, scalable, interoperable, and suitable for deployment across Indian cities.

Problem Statement
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3. CHALLENGE OBJECTIVE

Students are expected to design a solution capable of:

- Predicting urban water logging before it occurs
- Monitoring drainage system performance
- Detecting abnormal water accumulation
- Providing location-specific alerts
- Supporting emergency response planning
- Assisting municipal maintenance teams
- Improving resilience of urban infrastructure
- Reducing damage to roads and utilities
- Enhancing citizen safety
- Supporting smart city operations

4. REAL-TIME INDUSTRY NEED

Municipal corporations, Smart Cities, Public Works Departments, Metro Rail authorities, industrial townships, airports, ports, and highway authorities require intelligent systems that can proactively manage water logging.

Current challenges include:

INFRASTRUCTURE CHALLENGES

- Inadequate stormwater drainage capacity
- Blocked drain inlets
- Sediment accumulation
- Encroached natural drains
- Aging drainage infrastructure
- Flat terrain causing poor drainage

OPERATIONAL CHALLENGES

- No real-time monitoring
- Delayed field inspections
- Lack of predictive tools
- Poor coordination among departments
- Limited situational awareness during heavy rainfall

PUBLIC SAFETY CHALLENGES

- Vehicle breakdowns
- Traffic accidents
- Pedestrian hazards
- Electrocution risks
- Emergency vehicle delays
- Damage to underground utilities

ECONOMIC CHALLENGES

- Road restoration costs
- Property damage
- Business interruption
- Traffic congestion
- Increased maintenance expenditure

SERVICE DELIVERY CHALLENGES

- Delayed response to incidents
- Public complaints
- Lack of real-time information
- Reduced reliability of services
- Loss of public confidence

5. SCOPE OF THE CHALLENGE

Students may develop solutions for:

- Smart Cities
- Municipal Corporations
- Urban Roads
- Metro Rail Corridors
- Airports
- Industrial Parks
- Highway Underpasses
- Smart Campuses
- Railway Stations
- Bus Terminals
- Residential Townships
- Commercial Districts

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6. EXPECTED SOLUTION AREAS

Students may choose one or more engineering approaches.

A. REAL-TIME WATER LOGGING PREDICTION SYSTEM

Develop a platform capable of predicting:

- Water logging hotspots
- Expected water depth
- Time to inundation
- Flood duration
- Road accessibility
- Drainage system overload

Possible input parameters:

- Rainfall intensity
- Water level sensors
- Drain flow rates
- Terrain elevation
- Soil permeability
- Land use
- Historical flooding records

B. IOT-BASED WATER LEVEL MONITORING

Develop a sensor network capable of monitoring:

- Road water depth
- Drain water levels
- Canal levels
- Culvert flow
- Pump station status
- Reservoir levels

Possible sensors include:

- Ultrasonic sensors
- Pressure sensors
- Radar water level sensors
- IoT gateways
- LoRaWAN devices
- GSM modules

C. AI-BASED FLOOD PREDICTION ENGINE

Develop Machine Learning models capable of predicting:

- Flood probability
- Water logging severity
- High-risk zones
- Drainage capacity exceedance
- Flood recurrence
- Emergency response priorities

Possible inputs:

- IMD rainfall forecasts
- Historical rainfall
- Drainage performance
- GIS layers
- Topography
- Satellite imagery
- Sensor data

D. COMPUTER VISION-BASED WATER LOGGING DETECTION

Develop AI models capable of identifying:

- Road inundation
- Water depth
- Vehicle movement restrictions
- Floating debris
- Drain blockage
- Traffic congestion

Possible inputs:

- CCTV cameras
- Drone imagery
- Mobile cameras
- Smart city surveillance systems

E. GIS-BASED URBAN FLOOD DASHBOARD

Develop an interactive dashboard displaying:

- Live water levels
- Flood hotspots
- Drainage network status
- Rainfall distribution
- Pump station operation
- Traffic impact
- Emergency routes
- Asset vulnerability

F. CITIZEN REPORTING PLATFORM

Develop a mobile application enabling citizens to:

- Report water logging
- Upload geo-tagged photographs
- Share videos
- Report blocked drains
- Receive flood alerts
- View alternate travel routes

G. SMART DECISION SUPPORT SYSTEM

Develop an intelligent platform recommending:

- Pump deployment
- Emergency drainage operations
- Road closures
- Maintenance priorities
- Resource allocation
- Public warning messages

H. PREDICTIVE MAINTENANCE PLATFORM

Develop AI capable of predicting:

- Drain blockage
- Pump failure
- Water logging recurrence
- Maintenance requirements
- Critical infrastructure failures

The proposed solution areas can be implemented individually or integrated into a comprehensive early warning ecosystem for water logging management in Indian cities.

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7. INNOVATION EXPECTATIONS

Students are encouraged to integrate:

- Artificial Intelligence
- Internet of Things (IoT)
- GIS
- Remote Sensing
- Digital Twins
- SCADA
- Computer Vision
- Machine Learning
- Predictive Analytics
- Cloud Computing
- Edge Computing
- Drone Technology
- Satellite Data
- Weather Forecast APIs
- Low-Power Wide-Area Networks (LPWAN)

The emphasis should be on creating a predictive, resilient, and scalable urban flood management system.

8. TECHNICAL EXPECTATIONS

The proposed solution should demonstrate robust engineering architecture.

HARDWARE

- ESP32
- Arduino
- Raspberry Pi
- Ultrasonic Water Level Sensors
- Radar Water Level Sensors
- Pressure Sensors
- Flow Meters
- Rain Gauges
- GPS Modules
- LoRaWAN Communication Devices
- GSM Modules

SOFTWARE

Frontend
- Flutter
- React Native
- Angular

Backend
- Node.js
- Django
- Spring Boot

Database
- PostgreSQL
- MongoDB
- Firebase

ARTIFICIAL INTELLIGENCE

- TensorFlow
- PyTorch
- OpenCV
- YOLO
- Time Series Forecasting
- Anomaly Detection
- Deep Learning
- Predictive Analytics

CLOUD

- AWS
- Azure
- Google Cloud

INTEGRATION

Teams are encouraged to integrate with:

- Smart City Integrated Command and Control Centres (ICCC)
- Municipal GIS Systems
- SCADA Platforms
- Disaster Management Centres
- Weather Forecast APIs
- Digital Twin Platforms
- Traffic Management Systems
- Emergency Response Systems

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9. PERFORMANCE EXPECTATIONS

The proposed solution should demonstrate measurable improvements in one or more Key Performance Indicators (KPIs), such as:

- Prediction accuracy (%)
- Warning lead time (minutes/hours)
- Water level estimation accuracy
- Reduction in emergency response time
- Reduction in flood-related disruptions
- Sensor reliability
- False alarm rate
- System uptime
- Geographic coverage
- Decision support effectiveness
- Citizen alert delivery time

Teams should validate performance through prototype demonstrations, simulations, hydrological modelling, or comparative analysis using historical rainfall and flood events.

10. DESIGN CONSTRAINTS

The proposed solution should consider:

- Heavy monsoon rainfall
- Intermittent internet connectivity
- Outdoor environmental conditions
- Power availability
- Vandal resistance
- Low maintenance requirements
- Affordable deployment
- Scalability across large urban areas
- Ease of retrofitting
- Cybersecurity and data privacy

Solutions should account for Indian urban realities, including dense built environments, mixed drainage systems, varying municipal capacities, and budget constraints.

11. USER EXPERIENCE EXPECTATIONS

The solution should:

- Operate on Android, iOS, and web platforms
- Support multilingual interfaces (हिंदी, தமிழ், বাংলা, English)
- Provide intuitive GIS-based dashboards
- Enable offline data collection with cloud synchronization
- Generate automated alerts via SMS, mobile notifications, email, or web portals
- Offer role-based access for municipal engineers, disaster management authorities, contractors, and city administrators
- Present actionable recommendations rather than only raw sensor data

A seamless, reliable, and actionable user experience is essential for proactive decision-making and effective urban flood management.

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12. EXPECTED DELIVERABLES

Each participating team should submit:

A. INDUSTRY PROBLEM ANALYSIS

- Existing urban flood management practices
- Current limitations
- Stakeholder analysis
- Review of global and Indian best practices

B. PROPOSED SOLUTION

- Engineering concept
- Working principle
- Innovation
- Technology stack
- Expected benefits

C. PROTOTYPE

A working prototype demonstrating:

- Sensor integration
- AI prediction engine
- GIS dashboard
- Mobile application
- Alert generation system
- Decision support platform

D. TECHNICAL DOCUMENTATION

Include:

- Hydrological concept
- System architecture
- Hardware design
- Software architecture
- AI methodology
- Database structure
- APIs
- Cybersecurity considerations
- Scalability strategy

E. VALIDATION STRATEGY

Teams should provide one or more of the following:

- Rainfall simulations
- Hydraulic modelling
- GIS analysis
- Prototype testing
- Historical flood event validation
- Cost-benefit analysis

F. BUSINESS MODEL

Describe:

- Target customers
- Commercialization strategy
- Deployment model
- Cost analysis
- Return on Investment (ROI)
- Scalability across Indian cities

G. DEMONSTRATION VIDEO

A 5–7 minute video including:

- Industry challenge
- Proposed solution
- Prototype demonstration
- Performance evaluation
- Expected impact

H. PITCH PRESENTATION

Maximum 10 slides covering:

- Industry Challenge
- Existing Problems
- Proposed Innovation
- Engineering Design
- Technical Architecture
- Prototype Demonstration
- Validation Results
- Business Model
- Industry Impact
- Future Roadmap

13. EVALUATION PARAMETERS

1. UNDERSTANDING OF INDUSTRY PROBLEM

Clarity, depth, and relevance of problem identification and analysis.

2. INNOVATION AND ORIGINALITY

Uniqueness of idea, creativity, and novelty of the proposed solution.

3. ENGINEERING AND TECHNICAL FEASIBILITY

Soundness of engineering approach, technical robustness, and feasibility of implementation.

4. QUALITY IMPROVEMENT AND STRUCTURAL SAFETY IMPACT

Potential to improve infrastructure reliability, safety, and reduce flood-related risks.

5. SCALABILITY AND INDUSTRY READINESS

Potential for large-scale deployment, interoperability, and readiness for real-world adoption.

6. BUSINESS VIABILITY

Financial viability, cost-effectiveness, ROI potential, and sustainability of the business model.

7. PRESENTATION AND DEMONSTRATION

Quality of presentation, clarity of communication, effectiveness of demo, and overall impression.

Solutions that demonstrate innovation, technical excellence, real-world impact, and measurable improvements in urban flood resilience will receive the highest recognition.

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14. EXPECTED INDUSTRY IMPACT

A successful solution should:

- Enable proactive identification of water logging hotspots before flooding becomes critical.
- Improve preparedness of municipal corporations, Smart Cities, and disaster management agencies through timely early warnings.
- Reduce traffic disruption, property damage, and risks to public safety during heavy rainfall events.
- Support optimized operation of stormwater infrastructure, pumping stations, and emergency response teams.
- Improve coordination between urban local bodies, transport authorities, utility providers, and emergency services through shared real-time information.
- Enhance resilience of urban infrastructure against extreme rainfall and climate change.
- Reduce maintenance costs through predictive asset management and targeted interventions.
- Improve citizen confidence by providing reliable alerts and actionable travel information.
- Support data-driven planning for future stormwater drainage improvements and climate-resilient urban development.
- Contribute to the objectives of the Smart Cities Mission, AMRUT, urban flood resilience programmes, and the national vision of Viksit Bharat 2047.

15. STRETCH GOALS (BONUS)

Teams seeking advanced recognition may incorporate:

- Digital Twin integration for real-time simulation of stormwater drainage networks and flood scenarios.
- AI-driven fusion of weather forecasts, radar rainfall, IoT sensor data, CCTV feeds, and citizen reports for highly accurate predictions.
- Dynamic flood routing and safe evacuation recommendations using GIS-based navigation.
- Autonomous drones for rapid flood reconnaissance and post-event damage assessment.
- Integration with adaptive traffic signal systems and variable message signboards to manage traffic during water logging events.
- Carbon and economic impact assessment quantifying avoided losses through early intervention.
- Open APIs enabling seamless integration with Smart City ICCCs, SCADA systems, municipal GIS platforms, disaster management portals, and emergency communication systems.
- Generative AI-assisted incident summaries, resource allocation recommendations, and automated response planning for municipal authorities.

Solutions that demonstrate high prediction accuracy, meaningful warning lead times, affordability, interoperability with existing urban infrastructure, and measurable reductions in flood impacts will receive the highest consideration.

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Thank You!

TO ALL PARTICIPANTS, MENTORS & PARTNERS

"Desh को बनाना है। कुछ कर के दिखाना है।"

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has begun...

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