Collaborations: Critical Pathways for Resilient Flood Management – A case study from CMA

Ramachandran A, IITM/Okapi
Nivedita Shridhar, IITM/Okapi
Akshaya Ayyangar, Okapi
Parama Roy, IITM/Okapi
Ashwin Mahalingam, IITM

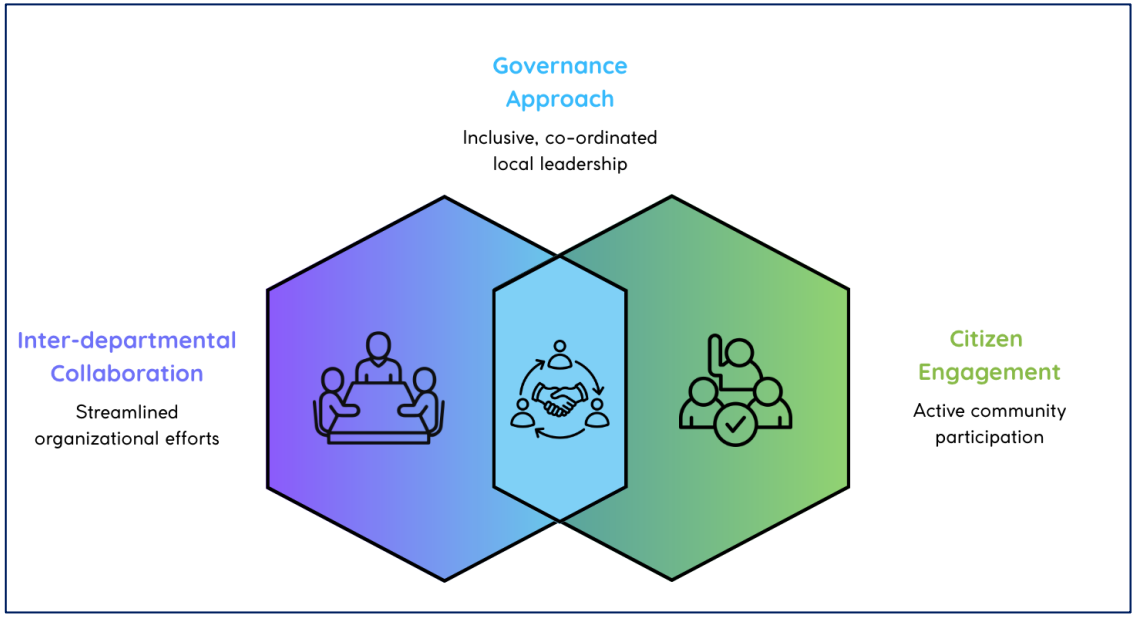
Cities of Care Conference

Shaping sustainable and equitable futures through the water-food-waste nexus

IIT Madras, January 30-31 2026

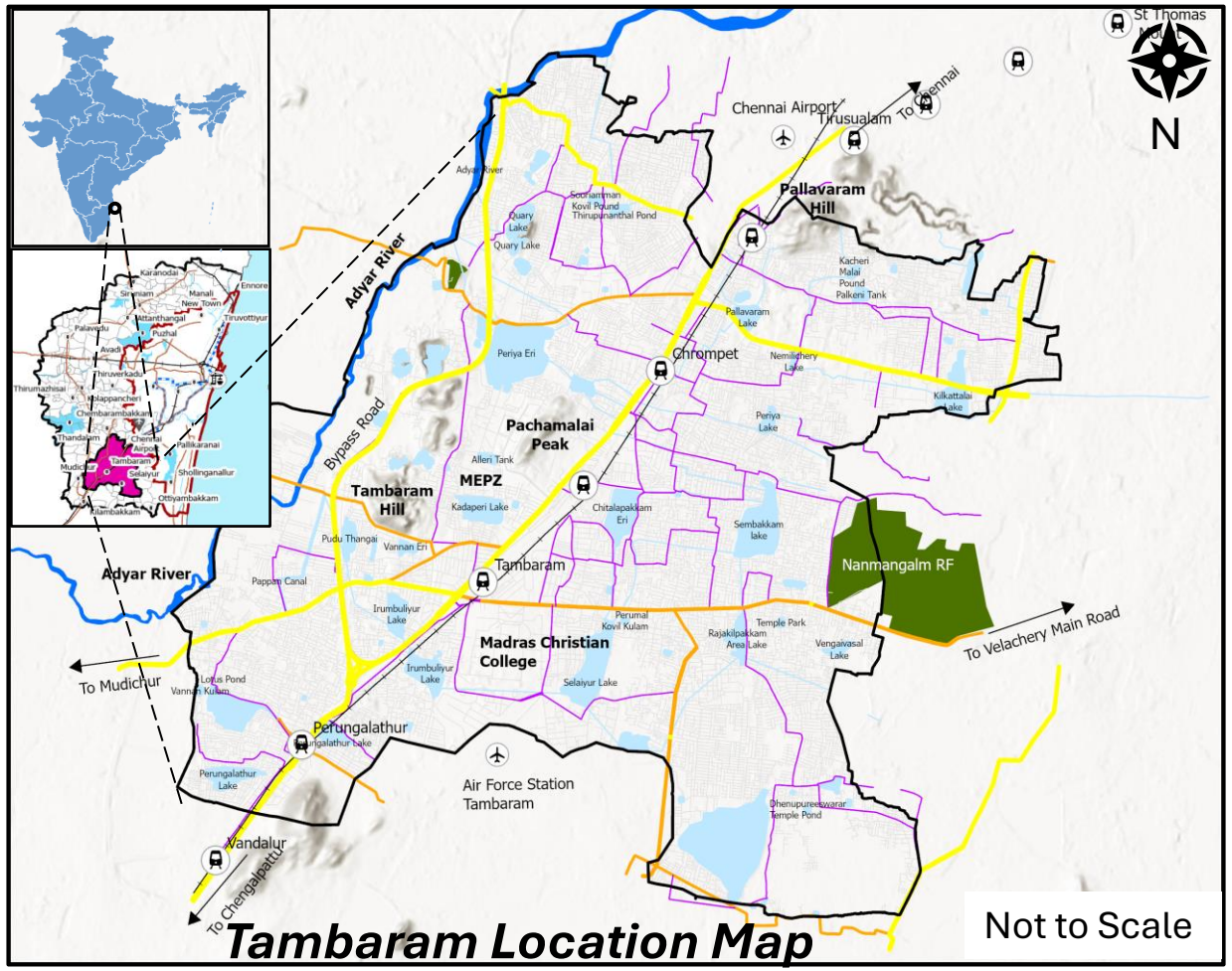
Setting the Context: Flood Resilience and Governance

- **Flood resilience extends beyond infrastructure** to the ability of governance systems to anticipate, coordinate, and respond to shocks (Moser et al, 2019; Woodruff et al 2021).
- **Collaborative, multi-sectoral governance** strengthens resilience by integrating institutional knowledge, resources, and capacities *(Djalante et al., 2011)*
- **Fragmented and centralized governance**, weak coordination, and limited participation often **turn hazards into disasters**



Flood resilience through governance networks

Why Chennai and Tambaram (CMA)?



Tambaram Location Map

- **Recurrent flooding** in Chennai highlights fragmented mandates and weak coordination across multiple flood management agencies
- The **2015 Chennai floods** exposed major governance failures, including poor coordination, unclear accountability, and weak information sharing among agencies.
- **Tambaram City Municipal Corporation (TCMC)** is a **newly formed ULB 2021** within the CMA, with evolving institutional roles
- **Rapid urbanization and governance transition in Tambaram** make it a critical case to examine amplified flood governance challenges

Research Goals & Objectives

Goals:

To examine how institutional structures shape **flood preparedness and response in** TCMC **using Social Network Analysis (SNA)** to inform resilient flood management.

Key Questions

1. Who are the key institutional actors and their actions across the disaster management cycle?
2. How do communication and collaboration networks among these actors' shape coordination, decision-making, and governance effectiveness in flood management?
3. What do these institutional network structures reveal about governance gaps and opportunities for strengthening flood resilience, including using a Digital Twin?

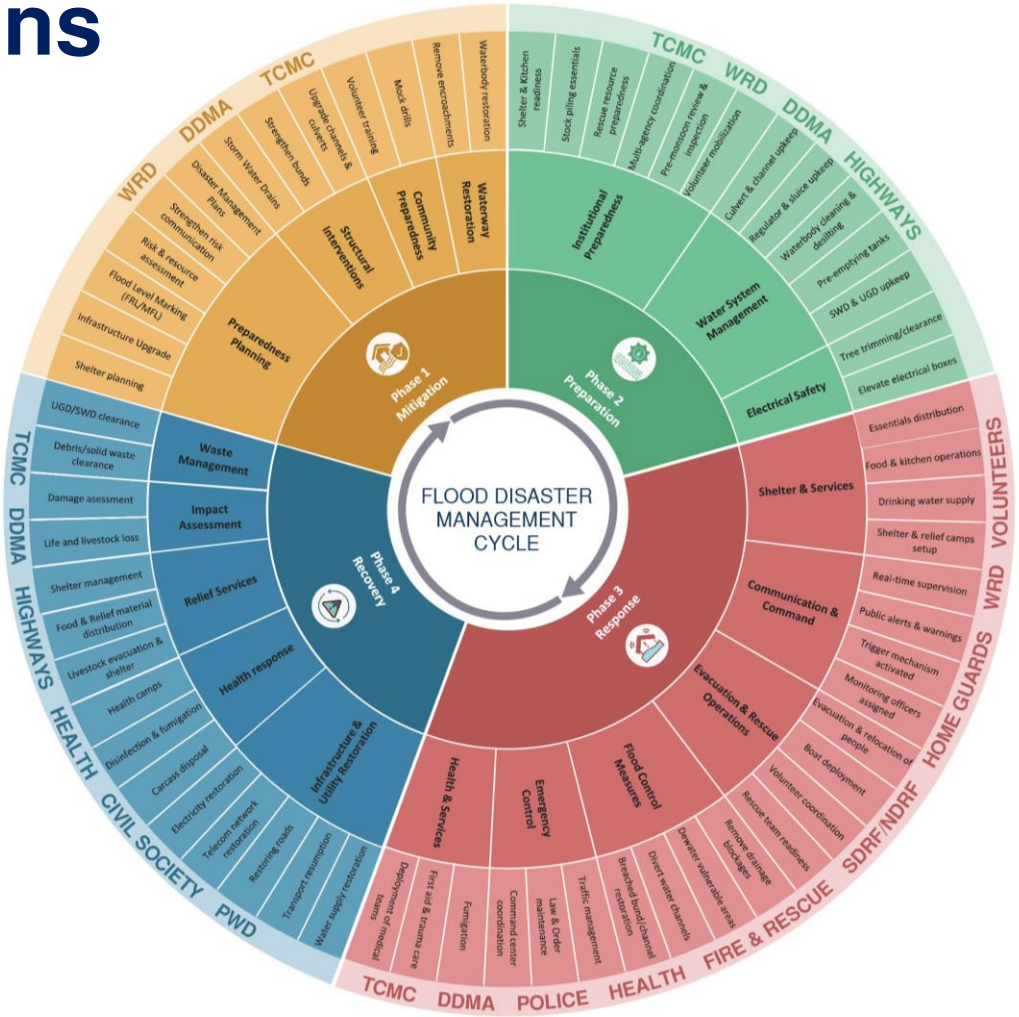
Methodology

Source: National Disaster Management Plan 2019

- **Mapping key stakeholders** and their actions across the disaster management cycle in TCMC
- **Social (Institutional) Network Analysis(SNA):** Used to unpack complex relationships and interactions among multiple flood governance actors (Stein et al., 2011)
- **Thematic Analysis of qualitative data:** Identifies patterns of meaning and perceptions related to flood governance experiences(Braun & Clarke, 2013; Herzog, 2019).
- ***Data Source:*** *Semi-structured interviews with stakeholders, workshop inputs, and Disaster Policy & Planning Document Assessment*

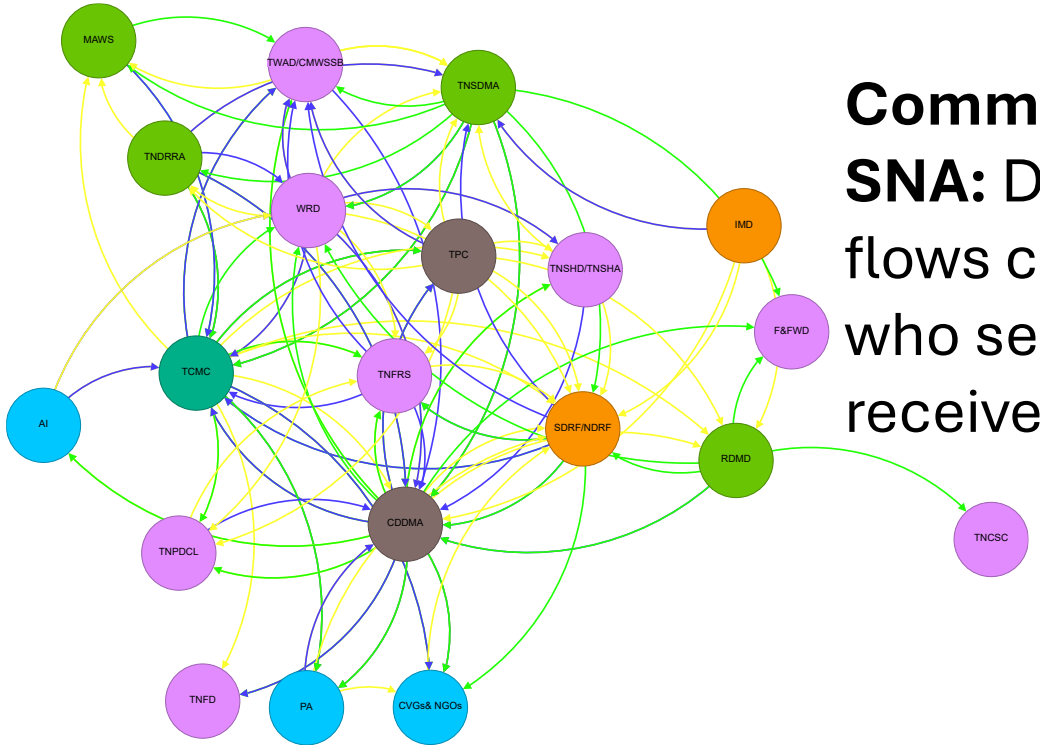
Mapping Key Stakeholders & Actions

- **TCMC, CDDMA and WRD** form the core institutional backbone of monsoon and flood management.
- Focus seem to be more on **response and recovery** compared to **long term mitigation and preparedness** based on number of activities
- **CMDA** is largely absent from operational flood governance, despite its critical role in long-term planning and mitigation.
- **Many agencies** engage only **during or after flood events**, underscoring coordination challenges

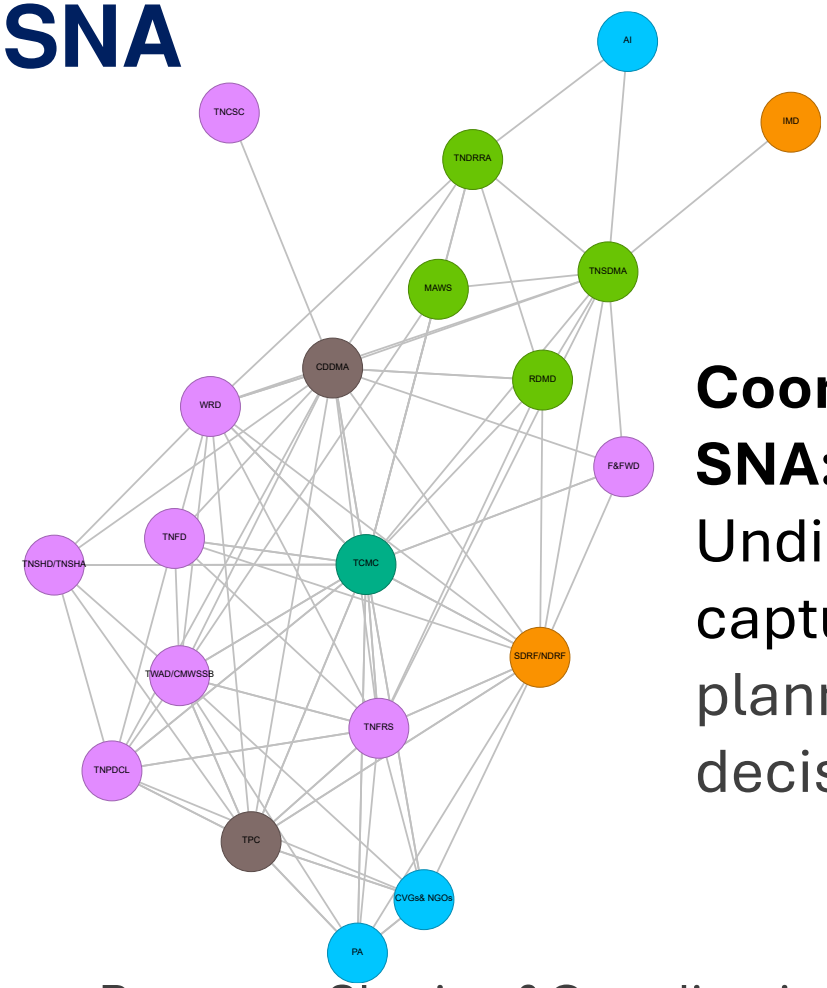


Stakeholders & their actions in all the phases

Communication & Collaboration SNA



Communication SNA: Directed flows captures who sends and receives



Coordination SNA: Undirected ties capture joint planning and decision-making

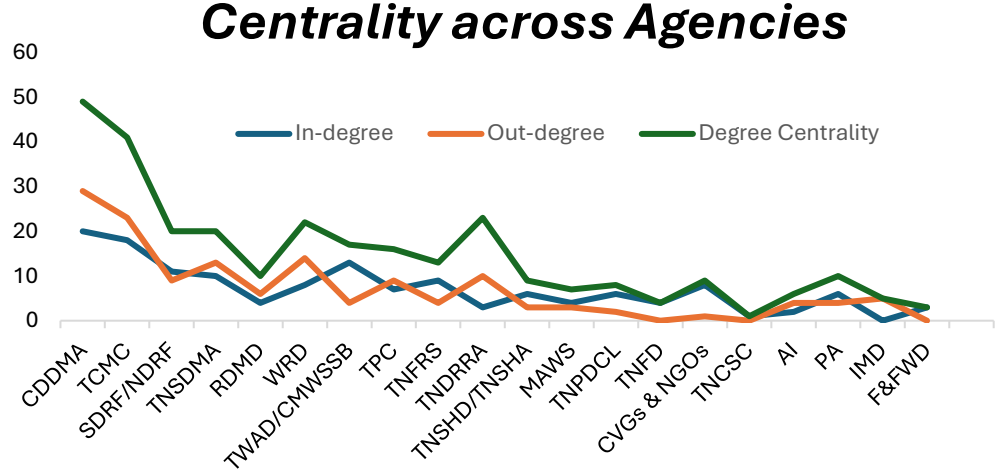
Legend

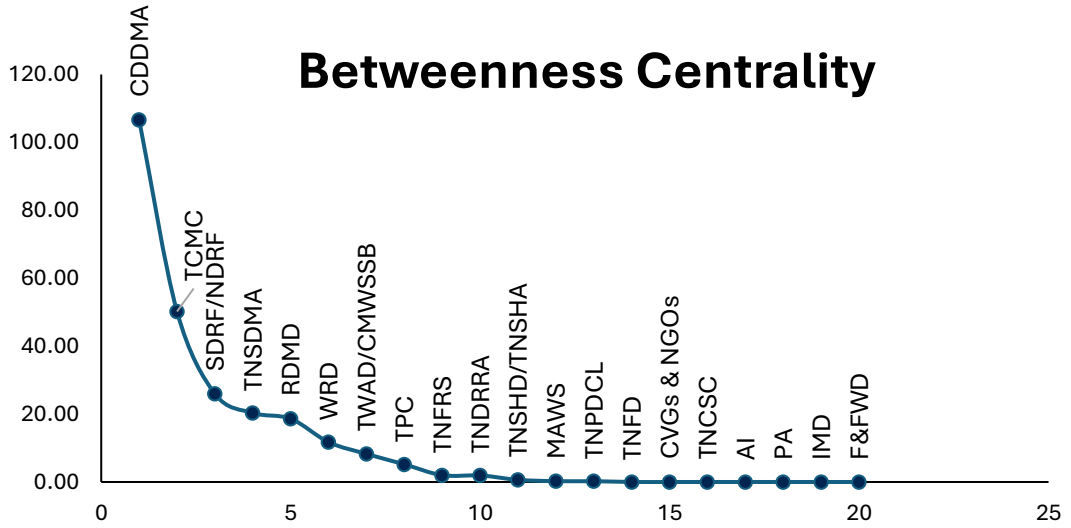
Command — Information — Advisory — Resource Sharing &Coordination

Local Body · District Level · State/District Level · State Level · Others · State/ National Level

Insights from Communication SNA

- **Hierarchical and moderately dense network** (density = **0.376**), with communication concentrated among few agencies
- **CDDMA and TCMC emerge as central coordinators**, with highest degree and betweenness centrality
- Interviews confirm **TCMC's operational dependence on CDDMA** for command, information, and approvals
- **WRD and TNDRRA remain under-integrated**, despite TNDRRA's **post-2019 risk-reduction mandate**

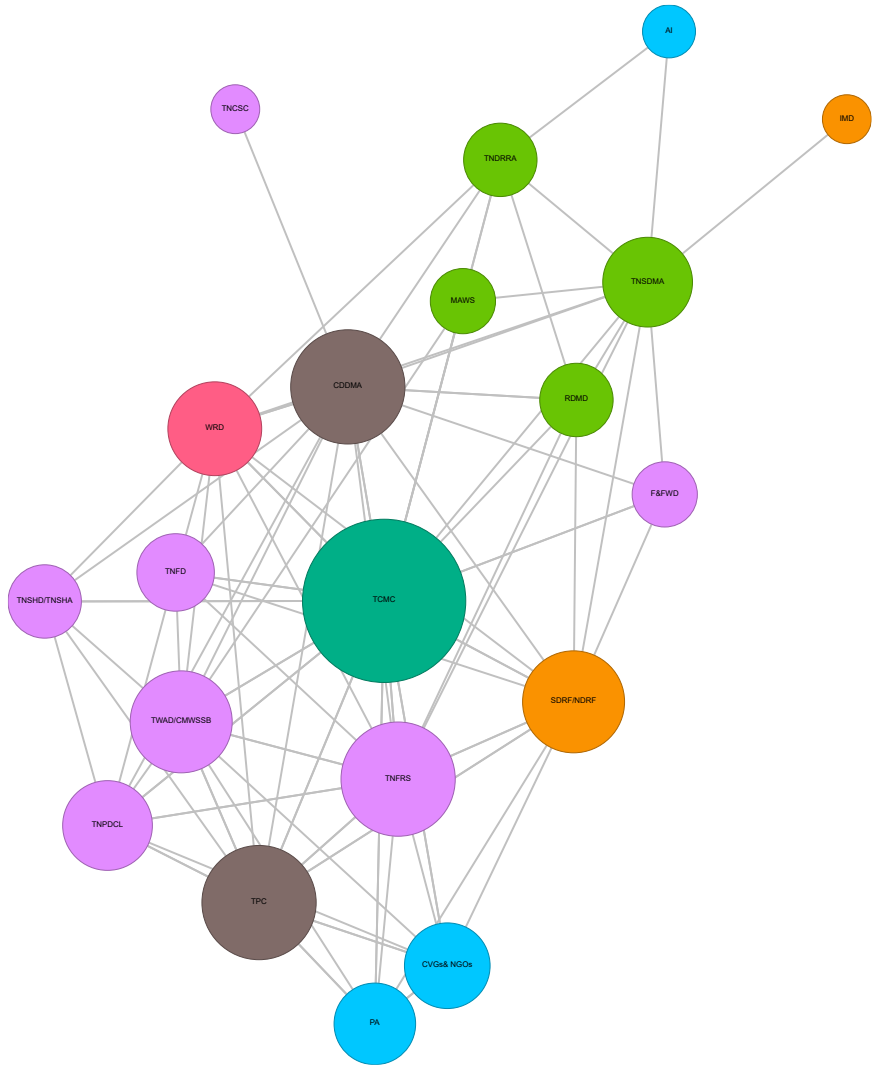




Graph showing Communication SNA analysis

Insights from Collaboration SNA

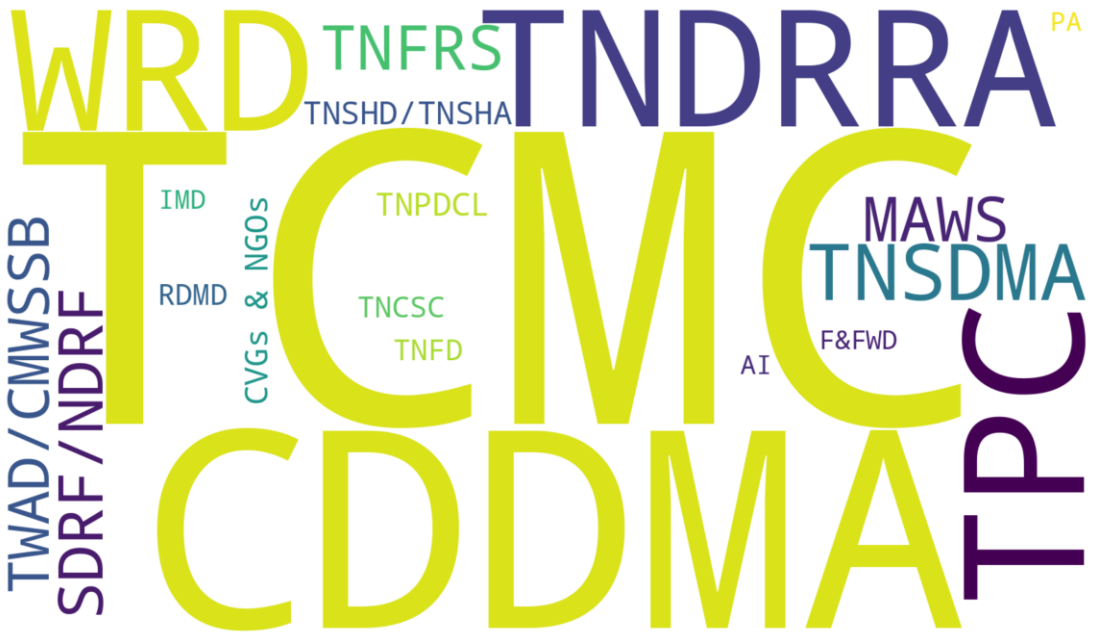
- **High Coordination Density:** Network density = 0.537 over half of all possible collaborative ties exist, showing a strong culture of joint working.
- **Operational Engagement**: TNFRS, SDRF/NDRF, TWAD/CMWSSB show frequent coordination in preparedness & response activities.
- **Network Structure Insight**: Collaboration is more horizontally distributed than communication, supporting collective action and problem-solving beyond formal channels.
- **Interview & Policy Insight:** Collaboration is policy-mandated but largely **reactive,** but becomes active during severe flood events.



Collaboration network shows TCMC with the highest degree (29), followed by CDDMA, TNFRS, and TPC (17) in moderately central roles.

Implications for Flood Governance in TCMC

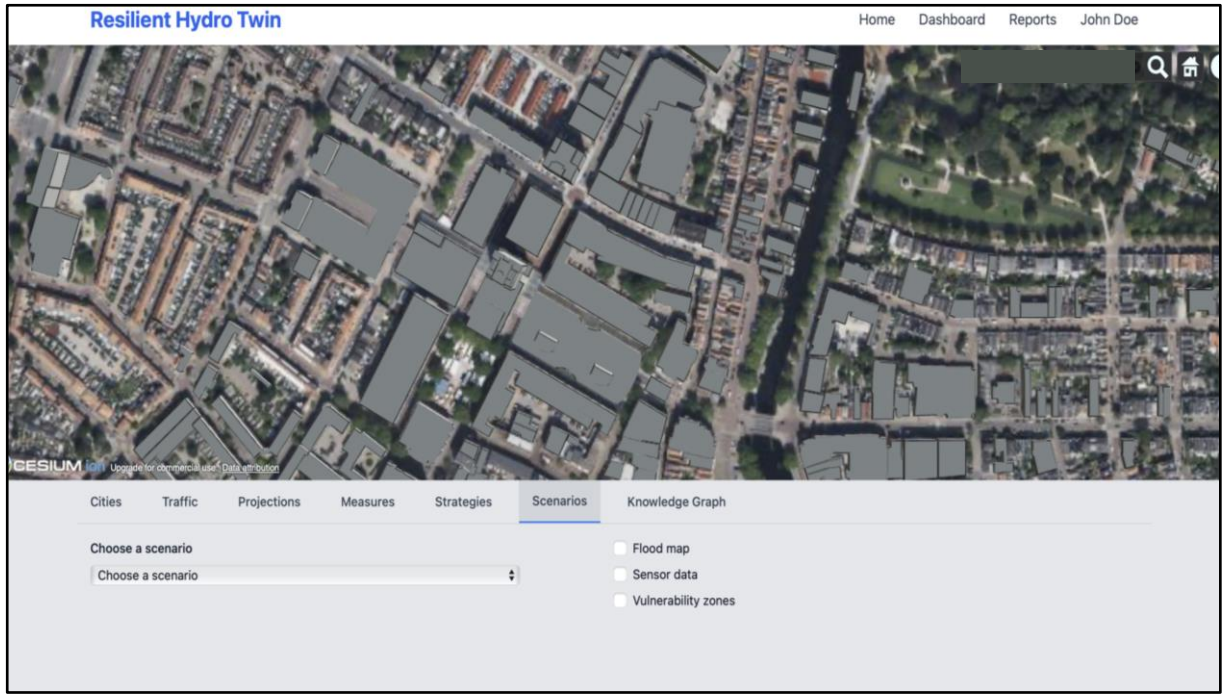
- Flood governance in Tambaram is **highly centralized**, with TCMC and CDDMA acting as major actors
- **Hierarchical communication** creates dependency and bottlenecks, increasing vulnerability during extreme events
- **Integrate planning and infrastructure agencies** (e.g., CMDA, WRD) more strongly into operational flood governance to link long-term risk reduction with response mechanisms.
- Collaboration exists but is largely **event-driven and reactive**



Flood governance in Tambaram is shaped by a few dominant institutions, while many agencies and community actors play peripheral, largely reactive roles.

Recommendations

Digital Twin enables integrated flood governance by linking hydrologic, hydraulic, and resilience data for coordinated decision support.



Source: Resilient HydroTwin Project

- Strengthen inter-agency coordination by formalizing communication protocols beyond emergency periods
- Institutionalize knowledge-sharing platforms linking TCMC, WRD, CMDA, utilities, and disaster management agencies
- Reposition flood governance from response-heavy approaches towards preparedness and mitigation
- Support more evidence-driven decision making-long and short term
- Embed community participation and citizen-generated data into flood monitoring and response systems

UofT INDIA FOUNDATION | UNIVERSITY OF TORONTO | SCHOOL OF CITIES | INDIAN INSTITUTE OF TECHNOLOGY MADRAS | SCHOOL OF SUSTAINABILITY IIT MADRAS

Thank You!

RESILIENT HYDROTWIN

FLOOD RESILIENCE
Through participatory Digital Twins