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research paper

ENVIRONMENTAL HAZARDS
Human and Policy Dimensions

Action-oriented resilience assessment of communities in Chennai, India

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Building resilience to disasters is indispensable in cities, like Chennai, India, which are challenged by emerging urban disaster risks caused by impacts of urbanization and higher probability of future disasters due to climate change. In this paper, an action-oriented resilience assessment (AoRA), consisting of 63 actions, divided into 21 parameters and 5 dimensions (physical, social, economic, institutional and natural), is defined which has the objective to enhance the resilience of communities of Chennai to climate-related disasters. On the basis of responses from the selected target group, community leaders (councillors) in the 155 wards, the local government of Chennai is the key stakeholder to implement the proposed actions in the AoRA. However, further findings underpin that a multi-stakeholder approach, involving communities, academia, private organizations and NGOs, is needed to create disaster resilient communities.

Keywords: Chennai; community resilience; disaster risk reduction

1. Introduction

Owing to the forecasted change of the earth's climate, it is expected that more intense and frequent natural hazards are likely to occur in the future (IPCC, 2007) which is expected to lead to impacts in the form of disasters that will severely challenge the well-being of human lives and the built and natural environment if no action is taken (World Bank, 2009). In combination with ongoing urbanization trends, particularly in developing countries, urban areas become hotspots for disaster risk (Munich Re, 2005; UNISDR, 2009).

The key character of cities constituting places with high population densities compared with villages in rural areas makes them inherently at risk to experience negative impacts of natural hazards (UNISDR, 2009). The lack of the provision of basic services, such as electricity, water, sanitation, etc., in rapidly growing urban areas in developing countries accentuates disaster risk (Satterthwaite, 2008). Although urban areas often function as economic drivers of a region, the consequences of unprecedented growth and physical expansion of the urban area often not only become visible in the form of deteriorating basic services, but can also lead to increasing poverty, unplanned development and struggling institutional capacities. To summarize briefly, the combination of impacts of climate change and urbanization make growing urban areas located in hazard-prone areas particularly vulnerable to disasters (Pelling, 2003; Satterthwaite et al., 2007).

Urban risk reduction has been following traditional risk assessment methods through hazard, vulnerability analysis, which, in turn, is linked to risk assessment. However, in the traditional assessment method, the capacity of the

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community and system is often ignored. Thus, the concept of resilience focuses increasingly these days to highlight the positive part of the system. As mentioned by Surjan et al. (2011), resilience of cities and communities are closely linked to many functions that cities perform under formal or informal systems of governance. The quality of life in a small town or peri-urban area is also in transition and often in turmoil. The critical factors affecting the quality of life are population and building densities; city plans, development regulations, zoning regulations and subdivision regulations; and building bylaws.

To address the issues mentioned in the preceding paragraph, building resilience to disasters through adaptation measures is now widely seen as indispensable to be integrated into urban planning (Godschalk, 2003; Klein et al., 2003; Satterthwaite et al., 2007; Cutter et al., 2008). Hence, various organizations, among others the World Bank (2009), the Rockefeller Foundation or Arup (Arup is a consulting company specialized in designing and planning for solutions in favour of sustainable development), introduce new concepts (hot spot assessment from the World Bank), ideas or solutions (e.g. rain water harvesting promoted by Arup) that are beneficial in the process of building resilient urban areas.

In this paper, the concept of resilience is applied to address the above-mentioned disaster risk in urban areas. Manyena (2006) and Norris et al. (2008) emphasize on the origin and wide range of applicability of the term resilience, beginning from the ecological field of science where the strength of different populations in reaching the previous equilibrium after a disruption is described (Holling, 1973) to how communities reduce the probability of (Bruneau et al., 2003), respond to and cope with a disaster (Twigg, 2007; Cutter et al., 2008). Thus, its ability to describe the performance of entities (e.g. cities), including different stakeholders and the natural environment before, during or after a disaster (Tobin and Whiteford, 2002; Nelson et al., 2007) makes the concept of resilience a viable theory to apply in larger socio-ecological systems such as communities (Adger, 2000; Carpenter et al., 2001). Although communities' ability to respond to a disaster depends not only on their individual and collective power (e.g. social capital and adaptive capacity), but also on wider aspects (economic, institutional and natural) which directly or indirectly affect their capacity and scope of action to respond to a disruption (Nelson et al., 2007), like a disaster.

Although building resilience to disasters is seen as an approach to protect human lives and infrastructures, the question is how can resilience be effectively built and mainstreamed in a city and also who are the actors involved in this process. The adoption of the Hyogo Framework for Action 2005–2015 emphasizes on the need to mainstream efforts which reduce disaster risk (UNISDR, 2005, 2007). Therefore, in a first attempt, a Climate Disaster Resilience Index (CDRI) was undertaken to understand the climate-related disaster resilience of the 10 administrative zones of Chennai, India, based on physical, social, economic, institutional and natural dimensions. This multi-dimensional approach allowed the integration of various disaster risk, mentioned before, which are challenging cities' capacities to withstand, cope and recover from expected more frequent and severe climate-related disasters (Joerin and Shaw, 2011).

In a second step, following this CDRI assessment, an action-oriented resilience assessment (AoRA) is proposed as a subsequent tool to examine the responsibilities of different stakeholders (local government, communities, academia, private organizations and NGOs) in implementing defined actions aimed at enhancing the resilience of Chennai to disasters. Thus, this AoRA links the findings from the CDRI assessment in Chennai to issues of planning for climate-related disaster resilient urban communities. The development and application of the AoRA, as a tool to define specific actions and the stakeholders responsible for their implementation, is the key interest of this paper.

The structure of this paper is as follows: firstly, the concept of resilience is linked to how

communities are understood and can be planned disaster resilient, and also why there is a need of the AoRA; secondly, based on the CDRI the methodology of the AoRA is explained; thirdly, the AoRA applied at the ward level of Chennai discloses the responsibilities of different stakeholders in implementing actions enhancing the resilience to disasters; and finally, key points are discussed.

2. Planning or resilient urban communities

Resilience is applied in various fields of science and has the potential to explain a wide range of issues, for example, from the capacity of a material to sustain a stretching (physical science) to how a system (ecological, social) can return to its previous equilibrium after a disturbance (Norris et al., 2008). Before attempting to link this term to how disaster resilient urban communities look like, a differentiated understanding of what constitutes a community is needed. According to Chavis and Wandersman (1990), two key types of communities need to be highlighted: place-bound (with clear boundaries) and interest-based groups of people with no clear boundaries (Chavis and Wandersman, 1990; Murphy, 2007). However, both types are characterized as social systems where people have a certain degree of interdependence and interaction, developed networks and social capital. An example of a place-bound community in an urban area is a neighbourhood with defined political boundaries, like a ward, whereas an interest-based community is developed through the intense interaction of its members based on common interests (Murphy, 2007).

In the context of urban areas, Norris et al. (2008, p. 128) argue that 'communities are composed of built, natural, social, and economic environments that influence one another in complex ways'. Thus, communities may not be restricted to people-formed social units, but may also be understood in a wider sense, including 'non-human' aspects. As a result, the term community needs to be used carefully, as depending on the situation its meaning changes. In this paper, the selected 155 wards of Chennai for the AoRA study shall represent each of them an individual community with physical, social, economic, institutional and natural characteristics within defined political boundaries.

Attempting to connect the understanding of communities with the concept of resilience, various scholars (Adger, 2000; Paton and Johnston, 2001; Bruneau et al., 2003; Allen, 2006; Twigg, 2007) regard the extent of people's abilities to respond to a disturbance (e.g. disaster) to be shaped by the political, economic, physical and natural context of their environment where they are embedded in. According to Twigg (2007), a resilient community is one which is capable of absorbing, managing, and recovering from a disaster. Thereby, the focus lies on how people in a particular community are themselves capable in coping with a disaster situation. Bruneau et al. (2003), Cutter et al. (2008) and Tobin and Whiteford (2002) conceptualize community resilience as being not only relevant during an emergency, but put much more emphasis on the cyclic character of community resilience. That means, a resilient community is one which is not only expected to be capable to absorb, maintain and recover from a shock, but also adapt and increase its coping capacity to reduce the probability of being adversely affected by a future disaster. Reflecting on the term resilience from this perspective, it resembles the emergency/disaster management cycle with the four connected factors: preparedness, mitigation, response, recovery, described by King (2007). Therefore, community resilience is required and needs to be built at any time to avoid and confront various types of stresses and shocks.

So how is this community resilience related to urban planning aspects? Aiming to plan for disaster-resilient communities, wider aspects, like the physical, economic, institutional and natural environment, need to be taken into account if sustainable solutions are sought to be found (Tobin, 1999). In an urban area, characterized by pressures due to urbanization, the role of communities as directly affected entities gains elevated

importance in urban planning. However, spatial planning in urban areas, particularly in cities in developing countries, is often conducted in a top-down attitude with little consultation of the public (King, 2008). Thus, the knowledge of communities about local conditions may not be sufficiently reflected in planning decisions. Similarly, emergency management is often handled in a command-and-control manner with little community involvement (King, 2008). As a result, community-based approaches for disaster preparedness (Allen, 2006) are seen as alternative or supportive measures alongside traditional governmental-led planning.

In this paper, the next parts aim at clarifying to what extent communities are expected to play a role in building disaster resilience in Chennai, or whether other stakeholders are given higher priority from the perspective of community leaders (Councillors).

3. From CDRI to AoRA

3.1. Background of Chennai

In this paper, Chennai, located in the state of Tamil Nadu in India, is chosen as an example to undertake an AoRA. The fact that Chennai is a low-lying city (around 1.5 m above sea-level in average) and developed at the coast of the Bay of Bengal where occasional cyclones (e.g. Nisha in 2008 and Jal in 2010) occur make it vulnerable to natural hazards, like floods or storms (Revi, 2008). Moreover, the coastal areas of the city are vulnerable to geo-physical hazards, mostly in form of tsunamis. In combination with the above-mentioned stresses, resulted from the impacts of rapid population growth over the last few decades (Muthiah, 2008), Chennai is challenged by a large number (18.3 per cent of total population or around 820,000 people in 2001) of urban poor who are mostly living in hazard-prone slum settlements along the rivers (CMDA, 2008). Furthermore, unplanned development along the urban fringe and exhausted urban services, such as electricity, water or solid waste (Coelho and Venkat, 2009), demonstrate serious risk drivers. In 2011, the population of Chennai stood at 4.68 million and the average yearly population growth rate over the last decade was 0.75 per cent (GoI, 2011), which was considerably lower compared to the average growth of 1.72 per cent during the period from 1971 to 2001 (CMDA, 2008). Particularly, the inner and older parts become more stable in terms of reduced new migration of people which may enhance the stability of the communities to develop social capital.

3.2. CDRI methodology and application

The CDRI is based on five dimensions (physical, social, economic, institutional and natural) that are further defined each of them by 25 parameters (five parameters per dimension) and another 125 variables (five variables per parameter). The aim of this tool, developed by Joerin and Shaw (2011), is to understand the resilience (see dimensions and parameters of CDRI in Table 1) of communities which is shaped by wider aspects, mentioned above. In a practical approach, the objective of the CDRI assessment in Chennai is to detect discrepancies in different resilience levels between the 10 zones of the city in a quantitative approach, as suggested to be lacking by various authors in this field of science (Bruneau et al., 2003; Rose, 2007; Cutter et al., 2008), rather than in a qualitative type of assessment (Tanner et al., 2009).

Accordingly, the CDRI assessment was undertaken in the ten administrative zones of Chennai from January to February 2010 to understand how resilient these zones are against climate-related disasters (floods, storms, droughts and heat waves). The sources of data for the CDRI consisted of available secondary data from the Corporation of Chennai (Municipality of Chennai) and if not available, zone officers (engineers) entrusted with issues related to environment and disaster management provided responses. The simple structure of the CDRI assessment required to choose a score between 1

TABLE 1 Considered dimensions and parameters of AoRA from Climate Disaster Resilience Index

Dimensions	Physical	Social	Economic	Institutional	Natural
Parameters considered for AoRA	■ Electricity ■ Water ■ Sanitation and solid waste disposal ■ Accessibility of roads ■ Housing and land use	■ Population ■ Health ■ Education and awareness ■ Social capital ■ Community preparedness during a disaster	■ Employment ■ Finance and savings ■ Budget and subsidy	■ Mainstreaming of DRR and CCA ■ Effectiveness of zone's crisis management framework ■ Knowledge dissemination and management ■ Institutional collaboration with other organizations and stakeholders ■ Good governance	■ Ecosystem services ■ Land-use in natural terms ■ Environmental policies
Remaining parameters not considered in AoRA			■ Income ■ Household assets		■ Intensity/severity of natural hazards ■ Frequency of natural hazards

$$\frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} = \frac{w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 + w_5x_5}{w_1 + w_2 + w_3 + w_4 + w_5}$$

FIGURE 1 Formula – weighted mean for calculating a score of a parameter

(low) and 5 (high) for each variable to determine whether this aspect is functioning well in a particular zone. For example, if all (100 per cent) the residents of a zone have access to electricity at their home a score of 5 would have resulted. Furthermore, each variable was attributed with a weight (between 1 and 5) determining its importance to shape the resilience of a particular parameter and dimension.

Weighted mean (Figure 1):

In order to calculate the resilience scores for each parameter and formula, a simple formula named weighted mean was adopted (see Figure 1). Thereby, *w* stands for the weight attributed to the score of a certain variable *x*. In an aggregated calculation, the final resilience scores (1, low resilience; 5, high resilience) for each zone and dimension shown in Figure 2 were derived. The following key findings summarize the result of this assessment presented in Parvin et al. (2011):

- Northern areas (zones 1, 2 and 3; economically weaker and higher social problems) of Chennai are less resilient compared with the inner and southern parts of the city where economic growth and new development activities (housing and industries) are higher.
- The older areas (zones 2, 3, 6 and 7), which are the most densely populated (more than 30,000 people per square kilometre) parts of the city, but with low population growth rates, show lower physical (provision of

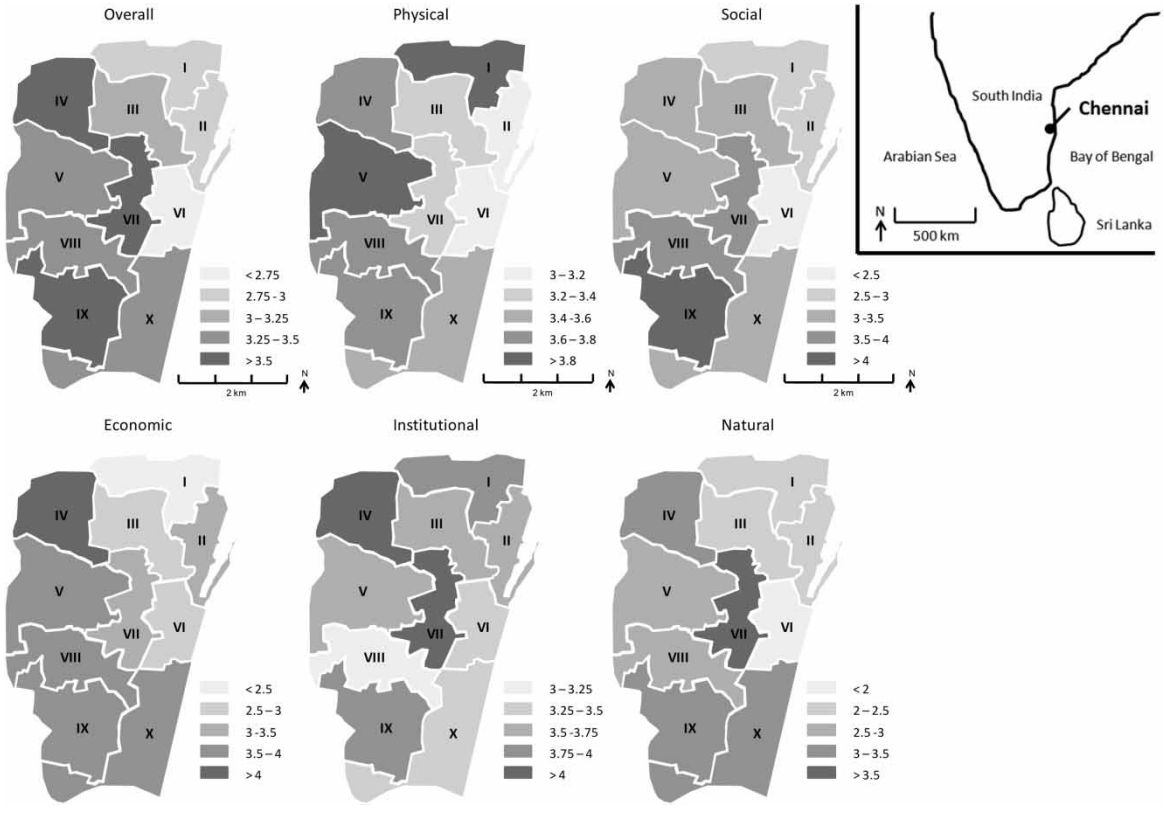

FIGURE 2 Results from CDRI assessment and location of Chennai (low (1) to high (5) resilience)

electricity and water, solid waste disposal, condition of roads, housing quality, etc.) resilience compared with areas along the urban fringe and areas which are recently being developed. The statistical correlation between the physical dimension and average yearly population growth rates during the period from 1971 to 2001 among the 10 zones of Chennai is $R^2 = 0.92$.

- The social and natural dimensions also have a statistically high correlation of $R^2 = 0.71$, indicating that socially related aspects show a relationship with the condition of the natural environment (ecosystem, loss of urban green space and implementation of environmental policies).

The mapping of climate-related disaster resilience at different zones in Chennai pointed out that issues related to livelihood aspects of individuals result in lower resilience levels. For example, lower economic opportunities and social conditions in the north of Chennai combined with a deteriorating natural environment have a dampening effect on the ability of communities to respond to a potential climate-related hazard. In other words, the northern areas have lower capacity to absorb such a disturbance that can ultimately lead to a disaster if no action is undertaken to build resilience. In contrast, the prospering southern areas benefit from the economic growth which leads to the development of new physical infrastructures, but also strengthens the social cohesion of communities. Furthermore, the greater availability of urban green space (e.g. Guindy Park) and lower population density (leads to less densely built areas) has positive effects on climate-related disaster resilience.

The results from the CDRI assessment further highlight that action measures are needed, sector-wise, to enhance the climate-related disaster resilience in Chennai. Thus, in close collaboration with the Corporation of Chennai a climate action plan (CAP) has been drafted which proposes defined actions (focus on soft adaptation measures) to be implemented either in the short (within 2 years), medium (up to 5 years) or long term (more than 5 years). This CAP shall support the planning decision-making process of the city to address potential impacts of climate change and urbanization in the form of disaster risk reduction (DRR) measures to fulfil expectations from the Hyogo Framework for Action. Finally, the aim is to trigger sustainable land-use and development which take into account pressures from climate change and urban migration movements. The developed CAP is currently in consultation to be adopted in the form of a policy by the legislative body of the Chennai Corporation.

3.3. AoRA methodology

The previous part emphasized on Chennai's climate-related disaster resilience and need for action planning based on the CDRI methodology. The subsequent proposed tool, the AoRA, adopts the same 5 dimensions and 21 of the 25 parameters from the CDRI (see Table 1). According to the findings from the initial CDRI assessment, three action measures for each parameter are defined to understand the current level of implementation of these selected actions and how important the roles are of the involved key identified stakeholders (local government, communities, academia, private organizations and NGOs) in this process. Thus, the objective of the AoRA is to reveal the importance of different actors in the implementation of selected action measures which have the potential to enhance the disaster resilience of communities (wards). Although the level of responsibility for the defined actions in the AoRA is likely perceived differently among the five actors, this tool concentrates on the perceptions of councillors to represent the views of their constituencies. The practical approach of this assessment aims to find out to what extent different actions require multi-stakeholder engagement or if a top-down, governmental-led planning is sufficient.

A total of 63 actions (equally divided into 21 parameters) were identified based on results from the previously conducted CDRI and

literature review on how resilient communities are understood. In addition to the results from this initial assessment (Parvin et al., 2011), the actions formulated in the AoRA are derived from various on-site visits, extensive desktop studies focusing on lessons learned from previous disasters and other guidance (UNISDR, 2007).

Instead of entering into a discussion on how each of the 63 actions is defined, the following key points, for each dimension, emphasize on the importance of the selected 21 parameters to be available and functioning in a disaster resilient urban community:

- *Physical*: Studies (Cannon et al., 2003; Twigg, 2007; Gaillard et al., 2008) on post-disaster livelihood assessments emphasize, for example, on the need for people to have secure electricity and water supply to recover quickly from a disaster. In other words, a solid physical infrastructure is crucial for urban areas to absorb a disaster and thus, apart from functioning urban services the built environment (e.g. houses) need to meet highest building and engineering standards.
- *Social*: Various scholars (Cannon et al., 2003; Paton, 2003; Murphy, 2007) stress the beneficial support of strong social capital, social networks, disaster awareness among communities to not only withstand a disaster, but also to better respond to it. Furthermore, Tobin and Whiteford (2002) point out that intact and well-functioning health capacities (facilities, networks) during situations of disaster are imminent to reduce avoidable losses of human lives.
- *Economic*: Rose (2004, 2007) emphasizes on the adequate allocation of financial resources and effective organization of the economic sector to support and develop incentives to reduce losses from disasters. Available insurance schemes and financial systems would have the potential to provide pre-disaster and after disaster funding (public and private), which are beneficial to sustain a disaster from the economic perspective.
- *Institutional*: The mainstreaming of climate change adaptation (CCA) (Trohanis et al., 2009) alongside effective emergency management (McEntire, 2001) are two aspects which require a strong institutional set-up to ensure their implementation before, respectively, their functioning during a disaster.
- *Natural*: The protection of the natural environment (ecosystems, urban green space) is crucial to reduce the probability of disasters to occur and to uphold its coping capacity during times of disasters.

This short summary shall reveal that the application of the term resilience in the field of disaster risk management is extremely multi-disciplinary. Hence, the AoRA proposes a set of actions for all the five dimensions and identified key parameters (Table 1) to understand the perceptions from community leaders about who are the key stakeholders to enhance or build resilience in their community. The selection of actions aims to correspond to the needs of a particular urban area in relation to enhancing its resilience to climate-related disasters. The detailed description of the actions is shown in the results from the applied case study in Chennai. Four parameters (income, household assets, the severity and frequency of climate-related hazards) from the CDRI are not considered to be attributed with actions, due to their complex nature, for example, the amount of available household assets depends on the available income a household has (Parvin et al., 2011) and also on their members' employment situation. Thus, specific actions to increase income depend on the availability and quality of employment. Equally difficult to take action is to limit the severity and frequency of climate-related hazards, as their occurrence and strength depend on processes which are only indirectly related to human activities and yet still difficult to exactly predict (IPCC, 2007).

To conclude briefly, the AoRA has the key aim to understand the role of different stakeholders in implementing actions which enhance an urban community's resilience to climate-related

disasters. Knowing about who are the key stakeholders for different resilience-enhancing actions has the potential to ease their actual implementation and potentially offers more participatory-led development. Accordingly, processes aiming to enhance the resilience of an urban area are expected to become more widely accepted among communities.

4. AoRA applied in Chennai

In this study, the councillors (members of the legislative body of the Chennai Corporation [Municipality]) of Chennai's 155 wards are identified as community representatives and target group to give their perception on a proposed set of 63 actions defined in the AoRA. Although the councillors may not represent all the different views of different community groups in their wards, they are the democratically elected representatives of their constituency. Thus, a majority of people in each ward is expected to be represented by them. However, difficulties in holding free and fair elections in Chennai in the past may limit the legitimacy of some councillors to represent their constituency. Nevertheless, they are functioning as community and political leaders of Chennai's wards, and also have the opportunity to exert a considerable amount of political power in the legislative body of the Chennai Corporation which ultimately becomes relevant in governmental-led planning decisions.

4.1. Limitations of approach

The AoRA is a semi-qualitative approach to enhance actions at the city level. This may not be directly applicable in other cities if a CDRI assessment is not undertaken beforehand, as the selection of actions depends on the needs of improvement which are distinct between different cities. However, the participatory process of involving local decision makers and stakeholders in selecting and identifying the priority actions can be useful for any city. The identification of actions is based on the interpretation of existing literature aiming to enhance climate-related disaster resilience and does not provide actions to all other existing types of natural hazards. Furthermore, the AoRA may not include each and every required action that would be needed to cover all aspects of building climate-related disaster resilience.

The AoRA in Chennai focuses only on the perceptions of councillors to determine the responsibility levels of the proposed actions; therefore, the findings are limited to views of one group of stakeholders. Accordingly, the results do not reflect the views of the local government, academia, private organizations and NGOs, but solely reveal how local community leaders and/or political representatives would like to see actions related to building climate-related disaster resilience to be implemented.

Although there is bias in selecting only councillors (politicians) as a target group for the AoRA, they have considerable power to influence the actual implementation of actions at the city level and therefore, their views are expected to have significant weight for building a climate-related disaster resilient city. Nevertheless, it is acknowledged that the AoRA could be further conducted with other stakeholders that would provide more diverse or different perceptions on this issue.

4.2. AoRA: Process and results

The AoRA was conducted from September to November 2010, in form of a questionnaire survey, and targeted all the 155 councillors of Chennai's wards. After the latest election in 2006, the legislative body of the Chennai Corporation is represented by 56 women (36.1 per cent) and 99 men (63.9 per cent). The questionnaire requested the councillors to first tick whether an action is already fully implemented/available/functioning in their ward, or not. In a second step, if an action was not yet fully implemented, the respondents had to decide on the responsibility of all the five stakeholders about their role in

the implementation process of a particular action. A range beginning from 1 (very low), 2 (low), 3 (high) and 4 (very high) defined the level of responsibility and had to be decided for each stakeholder. If an action was perceived to be already fully implemented, the second step of deciding on the role of different stakeholders was not required.

The response rate of this survey was 83.2 per cent (total 129: women 49 [38 per cent], men 80 [62 per cent]), or 129 councillors fully responded. In Figure 3, the implementation level for each of the 63 actions shows that councillors perceive that all actions are not yet fully implemented in their ward. The fact that more than a qualified majority (66.67 per cent) responded that none of the actions are yet fully implemented points out that taking action for building climate-related disaster resilience is needed in Chennai. Therefore, the key question of this paper about the role of different stakeholders in implementing disaster resilience enhancing actions becomes much more relevant. In case the results from Figure 3 would have shown that most actions are already implemented this second part of the survey would have become obsolete. The results from Figure 3 underpin that Chennai has large potential to build resilience in all dimensions and sectors.

As the overwhelming majority of councillors perceive that the proposed actions in the AoRA are not yet fully implemented, the responsibility of the identified five key stakeholders in the implementation process is investigated. Therefore, Figure 4 shows the very high (4) responsibility level of each stakeholder to be involved in each of the 63 actions and emphasises which stakeholders are given highest priority to implement a particular action.

The results in Figure 4, point out that the responsibility of the local government is highest in 62 of 63 actions. The roles of communities, academia, private organizations and NGOs are in general not perceived as very high important in the implementation process of actions. However, going into more detail, actions related to enhancing awareness to disasters, water and energy use and environmental protection are

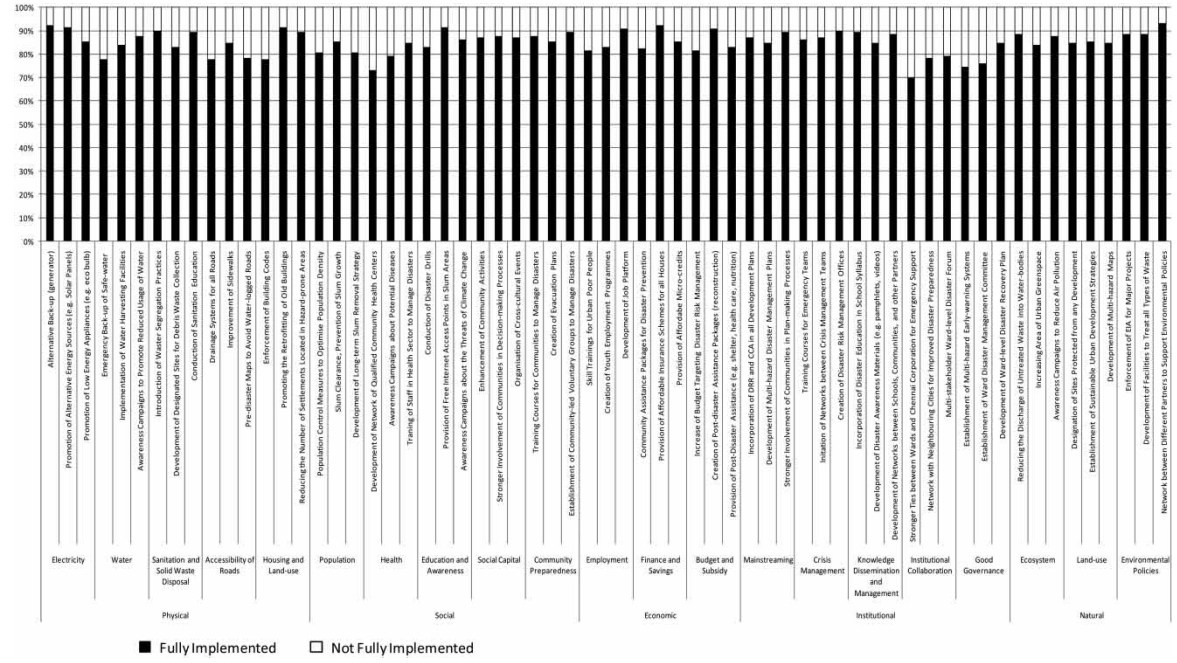

FIGURE 3 Implementation level of AoRA actions

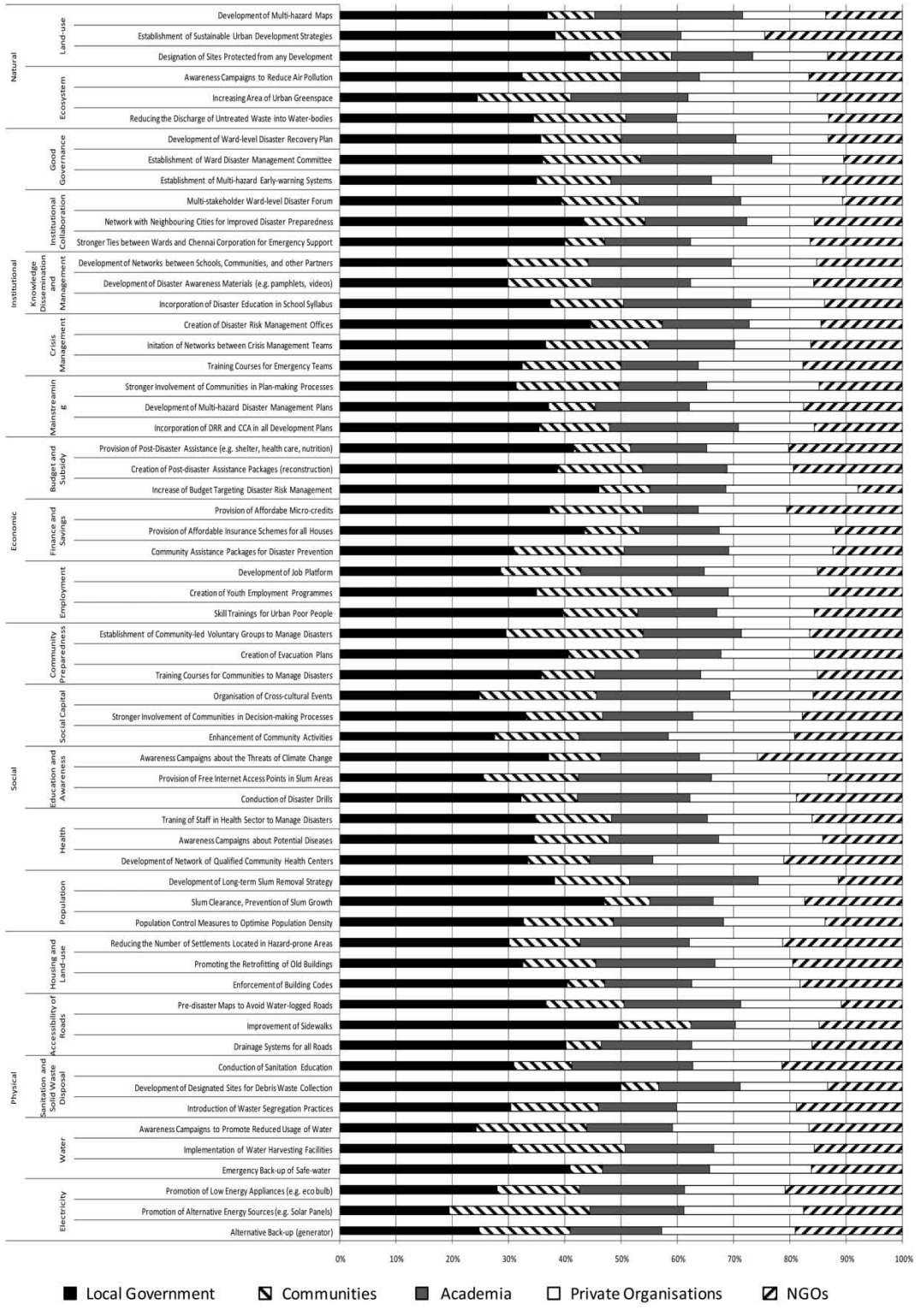

FIGURE 4 Very high role in the implementation of AoRA actions, stakeholder-wise

perceived to be implemented in a multi-stakeholder approach rather than only led by the local government. In contrast, actions which involve enforcement of laws and rules (e.g. building codes for houses, slum clearance), as well as actions that are traditionally undertaken by governmental bodies, for example, the designation of sites for debris waste collection and protection of development, improvement of sidewalks, budget for disaster risk management, as well as actions related to disaster prevention in the form of developing plans and early-warning systems against disasters are perceived to be undertaken by the local government as the key stakeholder.

Overall, communities are not given a very high responsibility to lead the implementation of actions, except in one (promotion of alternative energy sources) out of the 63 actions. In particular, communities are administered with little responsibility to carry out actions related to construction, for example, development of drainage systems or emergency back-up of safe water. However, not surprisingly, actions directed to enhancing awareness to disaster and measures protecting the environment are regarded to involve communities more into their implementation processes.

The academia is seen as an important partner in actions where knowledge is needed, for instance, development of slum removal strategies, a job platform, or hazard maps. Furthermore, the academia is recognized as a crucial partner in mainstreaming disaster education and DRR in development plans.

The involvement of private organizations is comparatively high in actions in the physical and natural dimension, for example, reducing the discharge of untreated water into water bodies or the provision of alternative energy back-up systems. Furthermore, actions where the private sector can directly provide solutions, such as alternative back-up energy provisions, awareness campaigns to reduce the usage of water, or establishment of free internet access points in slum areas, emphasize the expectation of the community leaders to give responsibilities to other stakeholders than the local government. They also perceive that the provision of funds for disaster risk management should receive contributions from the private sector.

NGOs are expected to take particular responsibility in actions about developing sustainable urban development strategies and awareness campaigns about the threats of climate change. They should also play a role in provisions which are traditionally not or only partially delivered by the local government, such as affordable micro-credits, development of community health centres or post-disaster support.

4.3. AoRA: Key summary results

The key findings from the AoRA are as follows:

1. No less than at least 70 per cent of all councillors responded that the proposed 63 actions in the AoRA are not yet fully implemented (Figure 3).
2. The local government of Chennai has highest responsibility to implement 62 of 63 actions (Figure 4). In the remaining action (promotion of alternative energy sources) communities are regarded as the main stakeholder.
3. There is no action which is expected to be carried out by only one stakeholder (more than 50 per cent responsibility) for both, very high and high implementation levels.

5. Discussion

The allocation of the highest responsibility is overwhelmingly given to the local government which highlights a command-and-control view of community leaders where initiatives (actions) are coordinated by an administrative authority (local government) rather than by other potential stakeholders. The example from Chennai represents King's (2008) observations on how traditionally emergency management and urban planning is often handled in developing countries. The comparatively little responsibility

given to the communities underpins that their role is to carry out actions rather than being involved in the process of designing or shaping them.

These findings are not surprising as they largely reflect the organizational structure of the local government and the planning agency in Chennai; whereby, the latter is conducting little or no consultation with the public on how future planning scenarios of the city ought to look like. Thus, there are limited opportunities for communities to actively get involved in the decision-making process and implementation of actions and as a result, they are highly dependent on other stakeholders, particularly the local government, to look after their needs. The consequences of this dependency is that communities may not receive sufficient support before, during and after disasters in case the local government fails to act appropriately and thus, additional risk is created, making communities less resilient to such events.

The limited power of communities in the political context of India's cities is emphasized by Baud and Nainan (2008) who assessed the opportunities of advanced locality management (ALM) groups, established in Mumbai, as a successful approach to let communities take part in DRR activities. These community groups, established in the 1990s mostly by middle class people, were supportive, for instance, in overcoming the devastating floods in Mumbai in 2005, as they provided relief and rescue operations. Their role is to facilitate a government–community partnership and advocate the interests from their neighbourhoods in order to enhance the quality of life in these areas (Surjan and Shaw, 2009). Accordingly, Surjan and Shaw (2009) emphasize on the potential benefit of making use of the collective power of large number of people (e.g. community groups) in carrying out effectively specific DRR activities which require rather human resources than financial needs. The activities undertaken by the ALM groups are, for example, the collection of solid waste or cleaning of streets which reduce the risk of blocked drainage systems during intense rainfall events. However, Baud and Nainan (2008) conclude that little 'space' is given to these ALM groups to exert political power or get involved in decision-making processes due to the hierarchical institutional set-up of Mumbai. Nevertheless, they gather people and carry out community-based activities fostering DRR and thus, enhancing the resilience of communities to disasters.

Another similar example of a government–community partnership emphasizing on DRR activities is established in Kobe (Japan) where voluntary-based disaster prevention groups were formed in all the 191 school districts of the city following the Great-Hanshin Awaji Earthquake in 1995 (JICA, 2010). Initially, the objective was purely on conducting activities related to earthquakes, such as disaster drills and awareness campaigns in schools, but gradually these so-called BOKOMIs (Bosai Fukusai Komyunithi) expand their scope of action beyond these activities and receive greater support from the local government (Matsuoka et al. 2012).

Both examples from Mumbai and Kobe aim to provide examples how communities can gain greater influence in the implementation of DRR-related actions at the neighbourhood level in a hierarchical institutional system. The benefit of these efforts is their enhanced social capital and thus, stronger resilience to potential disasters.

Although the Chennai Corporation (local government) is regarded as the key actor to implement most of the proposed actions in the AoRA applied in Chennai, purely command-and-control-driven politics may not enhance the resilience of communities to disasters. Instead, sustainable forms of development require multi-stakeholder approaches, for example, actions related to raising awareness to disasters and environmental protection require the involvement not only of the Chennai Corporation, but also communities, academia and NGOs. Accordingly, the AoRA has the potential to precisely determine the roles of different actors in implementing specific actions. For example, a scheme funded by the Government of India named 'Basic Services for the Urban Poor Scheme (BSUP)' launched in 2009 aimed to

improve the living conditions of the slum population in Chennai. Although this is a scheme put in place by the local government, it cannot only be successfully implemented through the support of communities and NGOs as actors who are involved in the implementation process. Another example where the AoRA can support the city planning is through the promotion of rain water harvesting facilities. Although the Chennai Metropolitan Water Supply and Sewerage Board promotes such installations, little has been undertaken to increase the number of rain water harvesting facilities in Chennai so far. Thus, the AoRA may give emphasis on how councillors, in this case, perceive who and what level of responsibility different stakeholders have in facilitating such installations.

Although the AoRA, in this case, is undertaken by choosing only councillors or local representatives, it could be further expanded to select other stakeholders' views regarding the determination of level of responsibilities of different actors in the implementation of resilience enhancing actions.

As mentioned earlier, there are several risk-assessment tools, which mainly focus on hazard and vulnerability analysis. The key of the AoRA and CDRI approach is its participatory nature, and link to the community leaders and city managers perceptions and priorities in identifying the key actions. This process has raised significant awareness at the city government level, which is exemplified in the high level of commitment of the Corporation of Chennai in implementing climate-related actions. Thus, one of the key emphasis of this methodology is it emphasis on the process-oriented approach, which is often neglected in many other risk-assessment methodology. Shaw and Sharma (2011) have provided the results of CDRI applied in 36 cities in the Asia Pacific region. AoRA method can be applied to these cities based on the nature of the local community leaders and elected representatives. When combined this process-based approach with other risk-assessment methodologies, it can serve as a useful tool to enhance actions at the city level.

To conclude, through the AoRA an attempt was made to understand the responsibilities of five key stakeholders in building resilience to climate-related disasters in place-bound communities (wards) in Chennai. The results from the proposed resilience-enhancing actions show that the local government is seen as the most important actor to implement actions that are related to disaster prevention and risk reduction. However, communities, academia, private organizations and NGOs depend on the type of action increasingly encouraged to take responsibility.

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