10 Rethinking Capacity Building in Water Governance: Factors Influencing Risk Interpretation and Decision-Making in Delhi

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Abstract

The presence of multiple stakeholders, and their varied perceptions and unclear accountability, within the complicated institutional arrangements increase the complexity of water governance in Delhi. In such context, it is highly crucial for stakeholders to well-interpret risks for effective decision-making to tackle water-related hazards. This study aims to understand the interplay of risk interpretation and decision-making in the current water governance system in Delhi by using the Risk Interpretation and Action (RIA) framework. It explores various factors suggested in the RIA framework, such as uncertainty, experience, learning, trust, complexity, scale and social context, and the influence of these factors on risk interpretation and subsequent decision-making. In this study, 30 in-depth interviews were conducted with key stakeholders including members of the private sector, government, non-government, educational, and research organizations. The results highlight a need to rethink capacity building in terms of preparing varied stakeholders for their greater engagements and participation in the development of effective water governance that addresses various implied risks.

Keywords

Capacity Building · Delhi · Risk · Risk Interpretation and Action (RIA) · Water Governance

10.1 Introduction

Water is essential for life! It is an incontestable fact, yet the ignorance towards water in Delhi is not just widespread but threatening. Despite being the capital of India and having a close access to the political and economic power, the city has a weak profile of urban water risks governance. Delhi has been ranked as one of the worst performing metro cities in Asia in terms of providing safe and sufficient water to its residents (ICNP 2001). The maladministration of sewage in Delhi has not only led to the degradation of water quality in the Yamuna but has also claimed it the status of a "dead" river (Sharma and Kansal 2011; Chauhan 2015). Groundwater is overexploited in seven out of nine districts of Delhi (Chatterjee et al. 2009; Shekhar et al. 2009). Besides, the city is exposed to multiple water-related risks, such as water scarcity, flooding, groundwater pollution, and water insecurity in the face of climate change. Despite significant resource investments, a little progress has been achieved in reducing its water-related risks in Delhi. The presence of multiple stakeholders,

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their varied perceptions, and unclear accountability within complicated formal and informal arrangements increase the complexity of the water governance in the city. While the risks related to water are portrayed at different levels, various subtle factors, such as how varied risk interpretations and decision-making are influencing water governance at the local level have not been studied in-depth. In a highly complex system of water governance in Delhi, it is critical that all stakeholders interpret risks accurately for effective decision-making to tackle various water-related hazards. This study aims to understand the interplay of multiple factors governing risk interpretation and decision-making in the current water governance system in Delhi by using the Risk Interpretation and Action (RIA) framework developed by Eiser et al. (2012). Various factors discussed in the model and their implications are discussed to highlight the gap in the capacity building that needs to be addressed for effective water governance at the city scale.

10.2 Conceptual Framework

Water risks in the megacities remain one of the most poorly articulated issues (Vörösmarty et al. 2000). The rising threats in the face of climate change have the potential to destabilize the existing urban water management practices either by creating a need for change or by reinforcing the traditional methods (Keath and Brown 2009). Sustainable Development Goals (2015–2030) point explicitly towards the vulnerability of cities to water disasters that need to be managed in a holistic manner (United Nations 2016). Multiple approaches and discourses applied for water resource management at the city scale continue to fail for various reasons.

Box 10.1 Sustainable Development Goals

Sustainable water governance in India's capital Delhi is crucial given this metropolis is the second largest populated in the world, and water as a resource is scarce. Good water governance is also critical to sustainable development as it is pivotal for economic growth, social inclusion, and environmental sustainability. Water governance in Delhi is challenged by the fact that there is too little and too polluted water to sustain the demand for domestic and industrial water needs and sanitation services. The effects of climate change, urbanization, and growing population among others continue to drive water resources demand, availability, and quality, now and in the future. In this context, the role of water governance for improved water policy design and implementation is now undisputed and will remain key in addressing water challenges. To that end, water runs across all the 17 sustainable development goals (SDGs). The author recognizes water governance challenges in Delhi and identifies "capacity building" across stakeholders, as crucial to address issues of efficiency, effectiveness, and inclusiveness. Using a risk interpretation and action (RIA) framework the author observes that capacity building is still catching up to implementation needs. The research and conclusion drive home the fact that capacity building (including customized training, relevance of auditing for evaluating change over time) will remain crucial for effective to deliver water governance in order to maintain healthy ecosystems, and in the mitigation and adaptation to climate change.

Wong and Brown (2009) note an overhaul of the hydro-social contract that underpins the conventional approaches of water management and associated investments that undermine the proposition of sustainable cities. It is observed that there is a minimal impact on the large-scale infrastructural projects in the face of ongoing sustainability agenda despite their overwhelming impacts on the environment (Crow-Miller et al. 2017). The query for development and addressing the needs of the rising population often keep

the focus away from the sustainable use of resources. Further, watershed management has become an arena for social dilemmas exacerbating the conflicts as well as hazards that are internalized within watershed (Navarro-Navarro et al. 2017). Specific insights derived from an empirical analysis show that water management (WM) is socially embedded in dense networks of family, friends, farmers, and the local government. These stakeholders share varying degrees of information about local water crises. It is found that while irrigation water user representatives (WUR) are connected across communities within their municipalities, but inter-watershed social links with other WUR were virtually nonexistent, despite high levels of awareness of cross-municipality WM problems (Navarro-Navarro et al. 2017).

Many studies look at water management from the economic and efficiency point of view (Briscoe 1997; Briscoe and Malik, 2006; Toteng 2008; Yuling and Lein 2010; Raul et al. 2011). Molle and Berkoff (2007) have documented the history of the idea of "water pricing" and found that there are, in the South, virtually no examples in which pricing does the allocative- and efficiency-enhancing work that mainstream economics want it to do. Privatization of water is also sought for improved services, but it is more closely linked with governance failure rather than better resource management. The social distribution of the cost is highly unequal, and the poor are affected more consistently negatively than the affluent groups. The mainstream perspectives tend to give a commodity status to water by the name of providing value to water, its services, and infrastructure (Obertreis et al. 2016).

Other studies that focus on a closely related issue are the ones looking into the public behaviors of water consumption and its uses in cities (McMohan and Weeks 1973; Maidment et al. 1984; Dube and Zaag 2003; Van Rooijen et al. 2005; Chu et al. 2009; Sohn 2011; Zhi et al. 2015). In this context, the studies focusing on the population water use behavior or consumption model further notify the gaps that administration is forced to fulfill by enhancing access to more water. The focus on distribution, equity, and quality of the water keeps the mind on the need for more water that results in water conflicts, a common feature particularly noted in the cities of developing counties like India (Janakarajan et al. 2006).

One of the most advocated approaches is Integrated Water Resources Management (IWRM). It is defined as a process that promotes coordinated development and management of water, land, and other related resources, for maximizing the subsequent economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP-TEC 2000). It is a step forward towards integrated solutions at the local, regional, national, and transnational scales. Megacities though have specified boundaries and fall within a national boundary, they tend to have very complicated water management systems that defy the general principles of water use applied across the country (Khan 2017). Various hazards relating to the unequal distribution of water, poor water quality, wastewater, leakages, overflow, or cities' overdependence on external resources for their water supply enhance local vulnerability to extreme events. As the increasing struggle to meet the gap between rising water demand and failing resources dominates the focus of urban water governance, the responses to extreme events are frequently ad -hoc and short-term. Cossío and Wilk (2017) note that in contrast to the river basin approach applied in the IWRM framework by the water professional based on a perceived dimension of space for water management, lived dimension of space is more important as they are more flexible, and the local people and organizations relate to them personally for managing water resource than that of the river basin space. The lived spaces also include the local people's perception, experiences, and practices of water use and management.

A shift can be seen in the domain of water management from seeing it as purely a technical domain to one that involves multi-stakeholders for inputs and cooperation (Nguyen and Ross 2017). There is an increasing consensus in the literature which notes that the current water crises are not due to the lack of water supply and technology but due to failure in water governance (Miranda et al. 2011). A surge can also be seen in

the literature focusing on water governance and its various characteristics, including participatory, interactive, or reflexive governance to address the need for democratic decision-making in the scenario of multiple stakeholders (Shove and Walker 2007; Torfing et al. 2012; Pfeffer et al. 2013). Megacities, particularly those in the developing countries with inadequate infrastructure and facilities are served by multiple actors and their networks, including government bodies, non-government organizations, private industries, small water enterprises, and many other units from organized and unorganized sectors (McGranahan et al. 2006). Studies note that diverse interests, rights, and knowledge of multiple actors, stakeholders, and institutions operating at various scales are difficult to reconcile (Sansom 2006), which goes along with the fact that very few studies have attempted to do such a comprehensive analysis. Often the policies adopted at the national or international level fail due to multiple reasons. Studies note that policy measures are weak, particularly in developing countries like India and China due to a lack of robust legal mechanisms to control pollution at different levels, lack of coordination, and gaps in policy implementation (Wang et al. 2016). A part of it can also be attributed to varied perceptions and awareness about the issues relating to water resources and risks that create conflicts in response measures supported or implemented by different stakeholders.

The studies focusing on the perception of water practitioners and decision-makers are rather few and fragmented. Such studies tend to assess perception from the water resource management or policy perspective. Baggett et al. (2006) note that dissonance in the perception of key stakeholders can be useful in building knowledge and participatory planning. Dobbie and Brown (2014) also stressed on the need to acknowledge diversified and subjective risk perception of all stakeholders and water practitioners for a sustainable water future. However, there is a lack of studies focusing on the perception of various water practitioners and stakeholders for their understanding of various water risks and responses in a city, and how they impact sustainability. While the stakeholders' perception of water risks and vulnerabilities in Delhi has been studied (Khan 2014, 2015; Khan et al. 2015), there is no study on the variations in the risk interpretation and decision-making for their influence on water governance.

Eiser et al. (2012) developed the Risk Interpretation and Action [RIA] framework to explain the factors that influence the interpretation of risk and subsequent decision-making and actions. The framework is based on the premise that the judgments underlying risk interpretation and action are not merely personal but interpersonal, which are influenced by several factors, such as uncertainty, experience, learning, trust, heuristics, complexity, scale, and sociocultural contexts. While the RIA framework is developed in the broader context of disaster management, it brings forth multiple factors that influence the response to risks applicable to water as well. Although many studies have addressed these factors in isolation, there is a gap of research focusing on how these multiple factors influence risk interpretation and decision-making for water within an urban context. While RIA framework is not comprehensive in listing all the factors that affect risk interpretation and action, it highlights dominant elements that can be assessed for an overall outlook (Khan et al. 2017). Addressing these factors in the context of water management can highlight gaps in the understanding of the water risks and effective response.

10.3 Methodology

The study was designed to be explorative and qualitative. Both primary and secondary data have been used to reflect on various aspects of water management, hazards, and other related characteristics. Secondary data was collected from the literature, newspaper articles focusing on water issues, websites of different water-related institutions, and published data from the Census of India. For the primary data, scheduled structured interviews were conducted with the key stakeholders. Samples were selected by

using non-probability purposive sampling method. Informed and available interviewees from various government, nongovernment, private, education, research, and local bodies were chosen to understand water issues from different perspectives. In total, 30 in-depth interviews were conducted with varied actors across the city. Eleven interviews conducted for another project chance2sustain on the same issue is also used in this sample, due to the non-availability of many senior officials for the second interview. A larger proportion of interviewees were government officials as water is a state issue in India, which places government as the leading stakeholder in this sector. Out of ten interviews conducted with public institutes, seven were national institutes, one regional, and two were the local governing bodies. This variation helped to understand various complexities in addressing multiple challenges associated with water at different levels. Seven interviews were conducted with nongovernment organizations that deal with water in general and issues relating to water in Delhi in particular. Many of these institutions work closely with government institutions and play a critical role in bringing changes in water management and addressing challenges faced at the local level. Academics and researchers formed the third largest sample. Three universities and three national research institutes were also included in the sample to bring forth different perspectives. Interviews were also conducted with media professionals including one from the leading newspaper of the city and another from a magazine explicitly focusing on water-related issues in India. They helped to bring critical local variations and innovations to address water-related challenges. To include the community perspective, three resident welfare associations were also interviewed. They helped to clarify the details of sustainability challenges faced at the local level. Two private organizations were also interviewed to bring forth their perspective in dealing with water risks.

10.4 Delhi: The Context of Water Governance and Stakeholders

Delhi is the capital of India, and, therefore, is the home of both central and state water governance systems. The responsibilities relating to water in India are spread across multiple ministries and departments that investigate various aspects of water, and they are interlinked through a complex network. At the national level, the Ministry of Water Resource, Government of India is the apex body to formulate water policy and distribution of roles and responsibilities relating to water. It works through a network of organizations some of which have a direct role to play in the water availability, distribution, and quality in India. These include various research departments, river control boards, and major river projects along with public and autonomous bodies of national significance. Other ministries that deal with water include Ministry of Drinking Water and Sanitation, Ministry of Urban Development, Ministry of Environment and Forests, Ministry of Home Affairs, Ministry of Earth Sciences, Ministry of Science and Technology, Ministry of Agriculture, and Ministry of Power. They deal with water for its varied uses, state, hazards, and research.

Apart from ministries, there are several central institutes, which do not fall under any ministry but are formed as critical players through national acts. These include Niti Ayog (earlier Planning Commission), National Disaster Management Authority, and National Institute of Disaster Management. Besides, there are several departments, which work at the national level, but not all of them work in Delhi. Some of the departments that play an essential role in water governance of Delhi, include Central Water Commission, Central Ground Water Authority (CGWA), Central Ground Water Board (CGWB), Central Public Works Department (CPWD), and Water Quality and Assessment Authority. The Central Water Commission is the technical organization attached to the Ministry of Water

Resources. Central Ground Water Board is engaged in research relating to groundwater in India, while the Water Quality and Assessment Authority investigates issues relating to water quality. While these structures are created to have integration at different levels, the multiplicity of organizations and their different focus hinders holistic thinking. Different departments tend to follow diverse approaches as per their mandate, which creates barriers in communication. For example, an engineering approach is found more dominant in the Central Water Commission than the National Institute of Disaster Management, which looks at the ecosystem approach for a sustainable future. Such variations lead to different understanding of the issue, and hence a different response that may or may not be compatible with each other.

Delhi's most important drinking water source is the river Yamuna, which originates from the glaciers of the Mussoorie range of the lower Himalaya near Yamunotri in Uttarakhand state. Before entering the NCT of Delhi at Palla, the Yamuna flows through three riparian states of Uttarakhand, Haryana, and Uttar Pradesh. At this river basin level, the Upper Yamuna River Board (UYRB) is responsible for the water distribution among states, and to maintain optimal flow in the Yamuna River. A member of the Water Planning and Projects Wing of the Central Water Commission chairs the UYRB. In addition to the representatives from the riparian states (irrigation departments of Uttar Pradesh, Uttarakhand, Rajasthan, and Himachal Pradesh, the chief engineer from Yamuna Water Services Haryana, a member of the Delhi Jal Board) the Central Electricity Authority (Ministry of Power), the Central Ground Water Board and the Central Pollution Control Board are members of the UYRB. Despite this arrangement, water at the basin level is subject to frequent interstate conflicts for both quality and quantity. Apart from the usable water, Yamuna is also the source of flooding in Delhi. The Irrigation and Flood Control Department of Delhi is singularly incharge of execution, repair, and maintenance of flood control work on river Yamuna and the Najafgarh drain system. The primary functions of the department are to protect the city of Delhi from floods in the Yamuna River, and planning, execution, and providing support to flood protection and river training works through construction, strengthening, and maintenance of marginal embankments.

Delhi Jal Board (DJB) is the sole government agency responsible for meeting water demands of the city. It was created in April 1998 through an Act of the Delhi Legislative Assembly integrating the Delhi Water Supply and Sewage Disposal Undertaking under one body. Apart from being responsible for the treatment and distribution of drinking water from surface water received from river Yamuna, Bhakra dam, and Ganges along with groundwater, the Delhi Jal Board is also incharge of sewage treatment and disposal of wastewater. The process of water distribution is however not so straightforward. DJB supplies water directly to the households located within the Municipal Corporation of Delhi (MCD), provides water in bulk to the New Delhi Municipal Corporation (NDMC) and the Delhi Cantonment Board (DCB) for further distribution. Besides, the Delhi Development Authority (DDA), MCD, DCB, and NDMC are also engaged in the provision, development, and maintenance of water supply, mainly in newly developed areas. This creates inequity in the amount and quality of water received by different areas. Presently, nearly 83% of households meet their water requirements through piped water supply system (DJB 2016a). The rest depend on tube wells, deep bore wells, hand pumps, public hydrants, and other sources, which are mainly private and informal. The issues of inequity create resentments in the residents. While, at the one hand, some areas receive 24 h of water supply, on the other hand, there are areas that are yet to be connected to piped water supply systems, and others which are connected but receive water for less than an hour in a day.

Equipped with the powers of the capital city, the Delhi Government, mainly through the Delhi Jal Board, has been able to shape the discourse in such a way that Delhi's water crisis is predominantly understood as a demand-supply gap. Today, besides the Yamuna water, Delhi gets its

water through inter-basin transfers from the Beas River and the Ganges. Therefore, Delhi's water hinterland exceeds far beyond its local watershed and has a substantial impact on the water governance of distant regions and communities. It has brought a greater emphasis on the raw water supply augmentation through the construction of new dams in the Himalayas, and yet the shortage continues (Rohilla, 2012; DJB 2016b). There is enough data to prove the water scarcity in the city.

In 2010, Delhi's installed capacity for water treatment was about 745 million gallons per day (MGD) from the surface water. With an additional groundwater augmentation of approximately 100 MGD, the Delhi Jal Board supplies about 845 MGD water to the residents of the city. This supply is more than 100 MGD short of the actual demand (DDA 2010). This gap increases further during the summer season. Besides, as per the Delhi Master Plan 2021, the demand for water increases by approximately 20 MGD per year that add to the existing gap (ibid). Wastage of water is another primary cause of the shortage of water in Delhi. The unaccounted water losses in transmission and distribution of the water supply are noted to be about 42%, indicating further deficiency (Department of Urban Development 2006). Besides, nearly 40% (90 lpcd) of the treated water supplied by the DJB is used for domestic chores, flushing of toilets, and not for drinking purpose. This further reduces the quantity of clean water available for drinking purpose, and, therefore, people depend on sources other than DJB for water. Interestingly, the Delhi urban area has the highest per capita supply of water in India, which indicates further worse situation in other cities.

Consistently rising demand causes a greater dependence on groundwater, which results in groundwater depletion and pollution that affect both human health and environmental carrying capacity. Groundwater is a significant source of water in Delhi, particularly in unplanned or newly developed areas with inadequate water supply. A few studies suggest that in contrast to the official figure of 11% of Delhi's total water use, nearly 50% of Delhi's water comes from groundwater (Ruet et al. 2002). According to the Central Ground Water Board, the total groundwater potential for Delhi has declined from 428.07 million m^3 in 1983 to 292 million m^3 in 2003 (DDA 2010). Groundwater is confined to semi-confined state at the depth varying from 1 to 10 m below ground level in alluvial terrain and up to 70 m in sandy aquifers (DDA 2010). The maximum decline was noted in the Najafgarh and Mehrauli blocks, i.e., areas experiencing rapid urbanization and population growth (DDA 2010).

Although Delhi uses minimum water from the Yamuna, it discharges nearly 80% of the total pollution load in the river (CPCB 2006). As a result, the 22 km stretch of the Yamuna in Delhi is the most polluted stretch of the entire river. Yamuna is comparatively clean in the upstream of Delhi, despite a deterioration noted in the water quality from 1999 to 2005 due to an increasing number of coliform bacteria and concentration of ammonia (CPCB 2006). However, a threat exists with increasing population and industrial development in the cities upstream, e.g., Yamuna Nagar, Karnal, Sonipat, and Panipat, for a rise in pollution levels if treatment capacities for domestic and industrial wastewater continue to be inadequate. Due to the abrupt release of high qualities of wastewater from industries (e.g., distilleries), incidents of higher pollution levels have led to massive problems and the temporary shutdown of water treatment plants in Delhi. The Delhi Jal Board is now facing major difficulties in demanding unpolluted freshwater from Haryana when it is responsible for the same problem for downstream states, which receive polluted water generated by Delhi. Unable to resolve Delhi's discrepancy of sewage generation (about 700 MGD) and existing sewage treatment capacity (about 514 MGD), Delhi is responsible for the severe pollution of the river Yamuna. The situation gets further complex since the neighboring states Haryana and Uttar Pradesh represent the interests of both upstream and downstream water simultaneously. In such case of upstream-downstream relationship, the role of state governments in the regional water governance setup of UYRB is crucial.

In Delhi's water supply, the private sector also plays a significant role. A substantial number of private tanker companies are employed in Delhi to supply water to areas facing water shortage. The DJB has awarded contracts to three private companies to run 385 water tankers. It is in conjunction with the Delhi Government's plans to privatize essential water services in the wake of DJB's inability to successfully supply water to the unserved or underserved areas throughout Delhi. In July 2012, three companies—City Lifeline Travel, VSK Technologies, and Ramkey Enviro Engineers were awarded contracts for 10 years to run the 385 water tankers in five zones. Besides, the private sector also plays a dominant role in water purification either through supplying the bottled water or through reverse osmosis systems in Delhi.

The local and national non-governmental organizations (NGOs) working on water, sanitation, and environment are other essential stakeholders in the region. Environmental NGOs play an important role in improving public access to the proper information about the local problems, including drinking water quality and the water-related risks for human health. Many of these NGOs organize seminars and workshops on water problems for the communities and local authorities, multi-stakeholders' debates on water supply development, technical solutions, public hearings, and sanitation plans at the local and national levels. They also publish and disseminate many educational and information materials on different water and health problems.

The Supreme Court and the High Court also emerge as key stakeholders in case of state government failure and public cry for water. Based on a Public Interest Litigation filed by the environmentalists in 1992, the Supreme Court of India forced the riparian states to maintain a minimum flow of 10 cumecs (353 cusecs) of water downstream of Tajewalla to Okhla for ecological reasons. Again, in February 1996, the Supreme Court of India by giving priority to drinking water supply also forced Haryana to maintain the required pond level at the Wazirabad Barrage to ensure uninterrupted functioning of Delhi's water treatment plants. The Supreme Court thereby suspended the existing MoU in favor of drinking water supply in Delhi. Besides, the CPCB has been given the mandate of monitoring the river water quality by the Supreme Court. Apart from the Supreme Court, the High Court has also passed a few orders to Delhi Jal Board to supply regular water to the residents of Delhi.

Another important water stakeholders in Delhi include media and press. Apart from the multiple water problems of Delhi, the social and physiological impacts of policymaking interest the media groups. Journalists and reporters cover the water supply and management sector extensively. Media groups help to understand how politics, demand, supply, and other factors affect the actual availability of the resource for the public. Several print and electronic media reports have extensively covered the water supply and management situation across the city. The role of print and electronic media is vital in generating awareness among the general population. They also help to create a link between the government and the people by proving information on policy and their implications to society.

Besides, Delhi has a population of over 16.75 million, a key stakeholder that manages water at the very local level (Census of India 2011). The State of The World's Cities 2012–2013 suggests that the Delhi urban agglomeration is likely to have a population of 28.6 million by 2025. Its increasing population contributes to the rising demands and additional pressure on the limited water resource of the city. Due to the regular demand-supply gap, incomplete coverage, unreliable supply, the residents of Delhi make their own private water provisions. The residents are paying a high price to augment water and the poor suffer most from such a situation. These informal and alternative arrangements of water in Delhi are (1) private-owned bore wells and tube wells, (2) private small-scale piped water provision, (3) private water tanker, (4) private packaged water or bottled water, (5) informal reselling of water through pushcarts and bicycle operations, (6) DJBs' water tanker, and (7) DJBs' packaged water (Biswas 2011). The willingness-to-pay survey carried out under a study project estimates that around 23% of the households use

such sources for at least part of their water requirement (Economic Survey of Delhi 2005–2006). Most of these alternatives are grossly unsustainable and available to people at high environmental, economic, and health costs. Illegal private water tankers and packaged water vendors charge a very high price, which is unaffordable to the poor, but they are flourishing due to poor water governance in the city.

10.5 RIA Framework: Influences on Decision-Making and Response to Water Risks

This section assesses various factors discussed in the Risk Interpretation and Action framework to identify their influences on decision-making and response to water risks by multiple stakeholders in Delhi.

10.5.1 Uncertainty

Risk emerges from uncertainty, but the meaning of uncertainty would differ from people to people, from the one which is associated with the likelihood of the event to the one related to the value of the consequences which may vary further both objectively and subjectively (Eiser et al. 2012). The studies on urban water management have modeled uncertainty about water demand and supply along with associated hazards, i.e., of scarcity, flooding, desalinization, and so on (Zelazinski 1998; Singh et al. 2010; Ray and Shaw 2015). Some studies have also explored the influences of uncertainty on decision-making (Bender and Simonovic 2000; Zelazinski 1998). However, less attention has been paid to the qualitative differences in the meaning of uncertainty to which people respond. In case of Delhi, uncertainty did not emerge as a leading factor in water management. The respondents however noted various sources of uncertainty that threaten water supply throughout the city, i.e., of erratic rainfall, lack of infrastructure, inadequate capacity to manage existing water demands, changing climate, and the complexity of water management systems. While most respondents admitted uncertainty in the water supply, only a few noted it to be an essential factor that influences decision-making, mainly the respondents from the government and research organizations. They found that varied uncertainty of hazards determines their priority for management. For example, a hazard of high frequency and spatial certainty receives higher priority as compared to a rare event with diffused locus and undefined spatial boundaries. These respondents also found themselves to be well equipped to deal with uncertainties because of their access to both science and technology. They mentioned that uncertainty has also played a key role in driving investments, e.g., towards prediction methods, early warning systems, or developing new seeds with a greater threshold of drought and flood resistance. Contrary to this, uncertainty is found to be less useful by the respondents from the non-government organizations and resident welfare associations. These respondents resolve conflicts based on evidence, and do not necessarily deal with uncertainty. They noted that their decision-making depends on the culture of responsibility where they must act despite having varying degrees of uncertainties being attached to a hazard. It causes continuation of various practices and unsustainable designs that are built to manage the current environmental challenges without necessarily focusing on sustainability in the face of future risks.

10.5.2 Trust

RIA Framework identifies trust in others as of central importance to any hazard response. It notes that trust is ingrained in the prior belief systems which vary individually as well as socially (Eiser et al. 2012). The role of trust has been studied mainly on the periphery of water management practices. There are some theoretical accounts of how trust can enhance cooperation between multiple stakeholders engaged in the process of water management (Richter et al. 2003; Ogden and Watson 1999; Wade 1988). However, the evidence of its influences on decision-making associated with water risks and

security is limited. Most of the respondents in Delhi were found to be divided over the influence of trust in their risk perception and response. While respondents from the government organizations found that trust has little to do with their work as they follow the intent, procedure, and guidelines of the organization, it was noted to be a dominant factor by the respondents from the non-government organizations, education sector, and research institutes. Lack of trust between different stakeholders was evident in interviews. There is a lack of trust among communities in getting any assistance from the state authorities. It thus made it difficult to bring both people and members of the Delhi Jal Board on one platform as noted in Dwarka. One respondent from Shahadra stated that while one department plans by trusting other, but different departments do not respond as expected, which creates a discrepancy in response. Respondents also found a need for the government to start conversations to make people aware of risks as well as new knowledge and technologies. They note that government should provide subsidies, insurance, and required knowledge to gain farmers' trust, who are critical stakeholders in Delhi's water. Low trust in the system affects the type of solutions one chooses to deal with water-related issues, e.g., political, technological, or expressing grievances with municipal authorities. One respondent also mentioned that foreign organizations are trusted more for the local solutions as noted in the case of Public-Private Partnerships [PPP]. Another respondent from a non-government organization found that the government cannot be trusted for the pro-poor solutions, and, therefore, they must intervene and promote local interests. While all stakeholders are essentially working towards solving water issues for the state, such discontinuities in trust, not only could hamper the success of existing policies but may also affect future response in case of a major hazard.

10.5.3 Experience

Past experiences not only influence risk interpretation regarding severity and magnitude of the potential consequences, but also the perception of one's ability to deal with the uncertainty and other implications (Eiser et al. 2012). Experience has rather been studied more frequently in the domain of water management than any other factor (Lange 1998; Mitchell 2006; Woltjer and Al 2007; Domenech and Sauri 2011). Experiences tend to affect the decision-making in this sector directly. The success and failures of different approaches, methodologies, and technologies are of particular interest in this field, and their applications are regularly shared so that the acquired knowledge can be readily applied with slight or no modifications. In case of Delhi, most of the respondents had experienced water hazards including scarcity, contamination, flooding mainly in the form of waterlogging, pollution, and land subsidence. The role of experience was not easy to articulate in research but was clearer in practice. Most of the respondents from the organizations which directly respond to hazard such as government, non-government, or Resident Welfare Associations found that their past experiences immensely affected their decision-making. They found that experience helped them to prepare better for the contingencies. On the other hand, those engaged in the works that address hazards on the periphery found it less significant regarding its influence on decision-making. In general, researchers found that personal experience should not affect their writings on larger issues that affect a wider population. On the other hand, those engaged in practices of water management explained that experience adds to their knowledge but does not affect their decision-making. It is also found that in some cases, despite having a personal experience of a negative outcome, respondents continue to do what is asked of them. For example, one engineer mentioned that "by my experience, I wouldn't make rainwater harvesting structure on floodplain but because it is a government mandate, I have to make it," and in such case, experience has a little or no role to play in decision-making.

10.5.4 Learning

Learning plays an essential role in risk interpretation and action as it has the power to transform existing social belief. RIA finds that all learning is dynamic (Eiser et al. 2012). In the domain of

water resource management and sustainability, there is a growing emphasis on learning, particularly, social and policy learning (Pahl-Wostl et al. 2007; Pahl-Wostl et al. 2008; Huntjens et al. 2011). In Delhi, learning emerged as a leading factor, and it is found to be extremely important in government, non-government, and research organizations. Here, learning has been mainly associated with water management, hazard characterization, and mitigation techniques. The most frequent source of learning is found to be research, literature, personal experience, newspapers, and other media channels. Various national government and research organizations mentioned pursuing research and expert opinion for making guidelines and suggestions, while the non-governmental organizations used their learning for advocacy and policy recommendations. The agencies which did not find learning to be important were those either dealing with a particular aspect of risks, such as running campaigns, writing magazine articles, or were Resident Welfare Associations, who must deal with water challenges on a day-to-day basis, and they address it accordingly.

10.5.5 Complexity

The complexity in risk interpretation and action emerges from various reasons ranging from that of a scale of hazard to its understanding, multiple interactions, learning, and sometimes diverse and opposing interests of varied stakeholders (Eiser et al. 2012). The complexity is widely recognized in water governance and boundary issues along with its multiple uses and users (Berger et al. 2007; Bressers and Lulofs 2010). In Delhi, while complexities prevail at different levels and scales of water management, not every respondent could relate to it, and, therefore, they found it less important. The respondents from the government, non-government organizations, and universities could clearly see the penetrative role of complexities in water management. However, the agencies involved in practice of hazard management and Resident Welfare Associations found it to be of low value in affecting their decisions because they deal with the issues at hand, and not necessarily have to work on the complexities associated with them. The sources of complexities in the water management in the city are found to be varied and dispersed ranging from a lack of knowledge and awareness to poor political will, social structure, lack of sectoral coordination, and uncertainty. Respondents noted that people tend to order water tankers in case of shortages and do not realize that a tanker also gets its water from the same aquifer. "Out-sourcing" the extraction of groundwater to another geographical location though solves the immediate water requirement; it creates deficiency with long-term negative environmental impacts. Similarly, the construction on the riverbed affects the ability of soil to absorb water, which leads to the problem of waterlogging as seen in Budh Vihar. Lack of coordination and communication between different departments is also a source of complexity in Delhi. A respondent noted that dealing with urban flooding should be the responsibility of the Ministry of Urban Development, but this is not the case. A multitude of civic bodies is interfering with water; the vastness of the network system along with the new trend of concealment is the major source of complexity. Earlier buildings had exposed water systems with uncovered pipes, open drains, canals for the supply of water, and as they were visible, people had a greater sense of belonging and responsibility for the water system. Now, since most pipes are hidden either behind walls or underground, it is difficult to detect any leakage, break or collapse instantly. As people must wait for external agencies to spot the fault and restore the system, it causes greater loss at times depending on the nature of the problem and complexities involved.

10.5.6 Scale

The importance of scale is recognized widely and applied in the water management sector in different domains be it water supply or issues relating to water use or users (Kurian 2004; Faysse 2004). In Delhi, respondents found water hazards at all levels, starting from the local neighborhood to

sub zonal, zonal, city, and regional levels. Water scarcity is found to be spread around the city mainly in slums and unauthorized areas along with some planned areas, particularly during summers, while flooding is found concentrated in the Yamuna floodplain. Groundwater depletion and pollution are found across the city whereas surface water pollution is found in the river Yamuna and along the major drains that carry sewage. Respondents also noted that not just the character of hazards, but also the vulnerability varies across scales. Some sections of society are affected by many hazards. Apart from the poor sections of the society, the areas of very high density of population are also affected greatly due to water scarcity. Although the risk of water-related hazards, such as scarcity, groundwater depletion, pollution, and related health hazards exist at the city level, it is often not perceived like that. It is mainly because it is addressed at the local level. Resource conflict is also a major concern for the related government bodies. Scale of an issue directly influences decision-making. The scale of hazards determines its priority and the level of resource mobilization along with institutional and political attention that can be pulled for certain hazards. Also, the nature of response changes at different scales as noted by the research organization. For example, at the urban scale response include the introduction of water recharge methods and interactions with policymakers and government bodies, while at the social scale, it is important to speak with residents, use rainwater harvesting, and engage in greywater recycling, and at an individual scale, talking to individuals including children and residents through workshops to bring down water consumption gains prominence.

10.5.7 Social Context

The role of communities is found to be very important in the RIA Framework as they communicate and create the social system to deal with any risks. The water uses and associated practices not only emerge from social and cultural contexts but also impact them in multiple ways (Kley and Reijerkerk 2009; Donahue and Johnston 1998). In Delhi, the social context is found to be relevant by most respondents. They explicitly noted that rich people can adapt to hazards, while the poor are highly vulnerable and lack adaptive capacity. Slum population lacks a voice on the policy front. Delhi as a city is attracting migrants from different states with varied cultural backgrounds, which means that the people perceive risks differently. Most of the respondents engaged in research, teaching, and non-government organizations found the social context to be a significant factor behind decision-making, while government organizations and reporting agencies found it less important as they tend to respond to all groups. Non-government agencies mentioned that they respond to the needs of the society, so the social context is more important for them than hazards. Equity, poverty, affordability, access, and awareness of water rights are essential criteria for this. Also, what kind of solutions are suggested to a community is primarily dependent on the social context. It is noted by a respondent that the better aware public is likely to take better decisions, and it can also influence political will for specific issues and the type of solutions to be adopted.

10.6 Discussion

Water management stands as a distinct field with its explicit theories and specific practices for managing this vital resource as well as its risks. RIA framework was developed to understand human decision-making and actions in the face of disaster risks. Integrating the theory and practices from these two fields was though not obvious, the results of this exploratory study brought forth some interesting findings that need attention. While many of the factors identified in the RIA framework have been studied in the water management sector, they have not been assessed for their influences on decision-making at various levels. In the case study of Delhi, all respondents were asked to rank multiple factors of RIA framework for their influences on decision-making,

which showed some interesting trends when averaged at the city scale (Fig. 10.1).

Among various RIA factors that influence decision-making, learning and experience turned out to be the leading factors, while complexity and occurrence of hazards had minimum influences on the decision-making. A significant finding is that the importance of the selected factors varied for different stakeholders. Various stakeholders were divided over the influences of trust and socio-cultural context. It is evident from the results that not only the understanding of different factors varied among various stakeholders but also their inclusion in the process of decision-making. However, most stakeholders could see some influence of most factors suggested in the RIA framework on water management, even though there were very few factors for which all agreed to be of high importance.

The importance given to a factor for its influence on decision-making also depended on the role of the respondents and their respective sphere of influence in decision-making. Trust is found to have minimal impact in the environment of protocols followed by the government sector. It is important to note that many civil authorities were aware of the lack of trust in public for them, but less effort has been put on the ground to bridge this gap. Trust is rather found significant by the non-government sector in dealing with water risks, as they must engage people in various activities. Such deviations are often not planned. Similarly, the variations in the significance given to complexity in decision-making often go unnoticed and unaddressed.

It is also interesting to note that there is a poor understanding of many factors mentioned in RIA and how they influence decision-making by different stakeholders. Many participants found it difficult to understand the influence of heuristics. The use of heuristics in the water sector is limited to the engineering and technical domain (Yang et al. 2012; Cabrera and Cabrera Jr 2003). In this context, heuristics refers to the process of learning from past anecdotes in contrast to experience that refers to enhanced professional knowledge concerning water management practices. The lack of its clear understanding and application in the Delhi water management highlights a gap that can be addressed for a better response.

The participants could also identify other factors that were not included in the RIA Framework, but they influence the way decision-makers perceive and interpret water risks, such as the political will or lack of coordination. Political will is found to be an important factor for its influence on water management decisions, which affects the way water issues are addressed. The solutions to enhance the quality and quantity of water along with reforms in decision-making often fail to be applied or produce the result in Delhi attributed to ideological contestation, fear of price hike, unequal access, and politics (Janakarajan et al. 2006).

Water in Delhi is mainly found to be a management issue, where there are too many stakeholders with minimum coordination. Delhi Jal Board is the nodal agency for the water management within the city however multiple stakeholders are making decisions around water every day

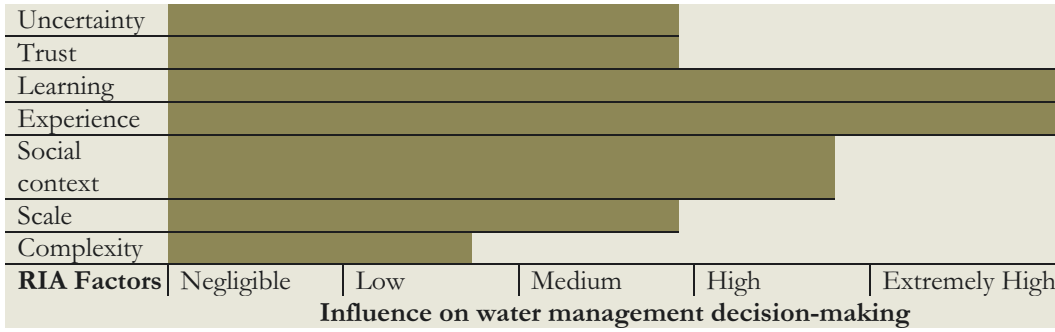

Fig. 10.1 Influence of RIA Factors on the Water Management Decision-Making in Delhi

at different levels with a completely different set of criteria, and at times with opposing interests. The conflicts of interest and power create more of water mismanagement than management. It is found that frequently, the cause of conflict is not resource scarcity but a human-made and entangled with ideology (Janakarajan et al. 2006). Lack of coordination, contestation, and political conflicts noted in the water management situation in Delhi, that often render the existing services less successful.

The existing capacity building programs revolve around the components of technical performance, economic efficiency, management issues, and policy applications, which fail to deal with the local conflicts based on varied risk interpretations and actions taken by the multiple stakeholders. According to Frantzeskaki and Loorbach (2012, p. 21), dealing with complex risks and uncertainties requires "a different set of guiding principles in the context of sustainability transitions. Transitions cannot be governed linearly by simple objectives and targets following regular implementations models." Within a centralized water management system, the participatory or reflexive water governance fails to be applied. Besides, it is essential that water-related risk management must find at the place within currently institutionalized practices of governing water (Conca 2015). Currently, drought and floods are managed by separate departments, which have little to do with the water governance system of the city.

Werbeloff and Brown (2011) highlight the vulnerability associated with the centralized institutional infrastructure and propose "security through diversity" as a strategy for urban water management. The current water management practices are based on engineering, economic, and ecological principles, and there are no distinctive variations based on the heterogeneity present within the community. It can also be attributed to the absence of traditional water management practices within cities. However, as noted in this case study, the decision-making by different stakeholders is influenced by varied factors, it is important to consider variations in risk interpretation and action. It can be particularly significant in managing major risks associated with water including, scarcity, flooding, or water insecurity.

It is noted that in a situation of a diverse group of stakeholders, dialog is an effective tool for better resource management than implementing more laws or policy reforms (Janakarajan 2003). The current water governance system puts a little emphasis on the complexity of multi-stakeholders dealing with the issues. While the aspirations of IWRM also include making it more participatory, knowledge-driven, and rational in economic, ecological, and hydrological terms, there are documented cases of IWRM-inspired "reforms" that create institutional rigidity without the benefit of better participatory decision-making (Conca 2015). Rules and guidelines are so rigid that despite having a pertinent knowledge, the officers and experts prefer to follow the rules than making a request for change or introducing flexibility to meet the changing situation.

This is further critical in the face of climate change. Mall et al. (2006) find that climate change brings uncertain future at the global, national, regional boundary conditions along with technology, law, socioeconomic development, politics, value judgments, and consumer habits that are likely to affect the water demand and supply in the Indian context. Climate change though addressed at the national level within the national water policy, it is found missing as an important factor for decision-making and planning response. Climate change adaptation in Indian cities finds little priority as most municipal authorities are challenged with a significant deficit in infrastructure and services (Sharma and Tomar 2010). In such a situation, recurrent messages of integrating climate change adaptation with that of disaster management and resource planning fail to impact the local reality due to a lack of coordination and support across the departments (Aromar 2008; Sharma and Tomar 2010). It is however not merely because of the differentiated decision-making power but also because of varied understandings of uncertainty, risks, and services that go unnoticed.

Disconnect between people and administration continues to exist despite several efforts on

the political front in case of Delhi. This is primarily due to the lack of training of various engineers or officers who perceive water management as their job and people as the receivers. Less emphasis is being paid to social learning in the existing water governance. In the era of rapid technological change and public awareness, the dependence of people is likely to decline further creating an even more significant gap between the people and administration causing more water misuse and ecological degradation than planning and preparing for a sustainable future. It is crucial that capacity building is not just limited to the training of a few officials, but it also focuses on building responsible communities by promoting participatory water governance.

10.7 Conclusion

Water management and associated hazards are assessed and responded by different departments than that of the general disaster management. While it does bring specialized attention to water, it also creates some gaps due to a lack of communication across these departments. RIA model although developed in the context of disaster management, it highlights many critical aspects of decision-making, which are not understood and strategically used in water management practices. The gaps in understanding and knowledge of these factors result in a fragmented and ad-hoc response to water hazards and other management issues. These differences can be minimised by meaningful engagements of different stakeholders to bring a common understanding for sustainable water management practices. Water problems in Delhi are not merely the result of inadequate water provision, but emerge from a complex water governance system where stakeholders are aware of different realities of water and associated issues that they addresses in their own way. It is essential that all the stakeholders realize the risk that the city faces and respond accordingly within their domain of understanding and power. More officials found it better to follow guidelines than understanding the risk context. It implies that existing practices and capacity building at the city scale need a rethinking and research for a more holistic water risks management.

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