Water Governance and Climate Change Issues in Chennai

Samuel Roumeau, Aicha Seifelislam, Shazade Jameson, Loraine Kennedy

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Abstract

Drawing on original research produced in the framework of the FP7 research project "Chance2Sustain" (www.chance2sustain.eu), this Working Paper provides an overview of key water and climate change issues in Chennai, India and analyses on-going challenges for directing governance towards sustainability principles. These issues take on special significance in Chennai, which has the lowest per capita availability of water among India's large cities and where the city's geographical location and groundwater depletion have made it susceptible to flooding and seawater infiltration, respectively. To examine these issues, attention is given to the fragmented institutional arrangements in place for governing water, as well as to the norms that underpin the dominant technoscientific discourse in terms of solutions (e.g., desalination plants, interstate pipelines), which tend to marginalize alternative voices. In order to zoom in on the key water issues, including climate-related water vulnerabilities, research focused in particular on one area, the "IT Corridor" in the city's southern periphery, a mega project built to enhance economic growth by attracting new investments in the IT industry. The state government's special policy for this zone, i.e., 24/7 water supply and efficient sewerage infrastructures, aims to reassure potential investors but meanwhile threatens to deepen already existing social and spatial inequalities in access to basic services. Moreover, the IT Corridor mega project increases risks for the fragile coastal ecosystem, including the Pallikaranai Marshland, which is already under threat from encroachments, garbage disposal and the dumping of untreated sewerage. The research indicates a crucial lack of awareness about the risks related to climate change among decision-makers, planners and residents. It concludes that the fragmented governance structure and lack of integrated analyses of hazards and socioeconomic vulnerabilities are the primary causes of water-related deficiencies in Chennai.

Keywords: Chennai, India, water governance, sustainability, water vulnerabilities, climate change

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The material presented here was originally published as outputs of the Chance2Sustain research programme (mainly the Chennai City Report[2] and the WP4 Thematic Report). Chance2Sustain, also known under its longer title "Urban Chances – City growth and the sustainability challenge - Comparing fast growing cities in growing economies",[3] was funded by the 7th Framework Programme of the European Commission under the Socio-economic Sciences and Humanities theme (Project no. 244828) from April 2010 to July 2014. Isa Baud (University of Amsterdam) was the scientific coordinator of the research network, which included eight partner institutions: the European Association of Development Research and Training (EADI), Germany; Amsterdam Institute of Social Science Research, University of Amsterdam (The Netherlands); French National Centre for Scientific Research (CNRS), France; School of Planning and Architecture (SPA), India; Cities for Life Forum (FORO), Peru; Brazilian Centre for Analysis and Planning (CEBRAP), Brazil; Norwegian Institute for Urban and Regional Research (NIBR), Norway; and the University of KwaZulu-Natal (UKZN), South Africa.

The CNRS research team, coordinated by Loraine Kennedy, was based at the Centre d'Études de l'Inde et l'Asie du Sud (CEIAS) in Paris (UMR CNRS-EHESS). The CEIAS worked in collaboration with the French institutes in India to carry out the research: the Centre de Sciences Humaines in New Delhi (CSH) and the French Institute of Pondicherry (IFP). For the research carried out in Chennai in particular, IFP and the Madras Institute of Development Studies (MIDS) provided critical scientific and material support. Special thanks go to Eric Denis, Aurélie Varrel and S. Janakarajan for research supervision and to G. Venkatasubramanian and Dhanalakshmi Rajappa for assistance with fieldwork and analysis.

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[2] Cf. Kennedy, L. et al., Engaging with Sustainability Issues in Metropolitan Chennai, *Chance2Sustain City Report - Chennai.* Chance2Sustain City Report Series, May 2014, ISSN 2309-8198. Available online: http://chance2sustain.eu/66.0.html

[3] For more information, see the Chance2Sustain website: http://www.chance2sustain.eu

1. Introduction: Discourses, institutionality and configurations in Chennai[4]

The physical geography of Chennai in Southern India makes for a contradictory relationship with water. Laying in the coastal rainshadow of the Western Ghats mountain range, Chennai suffers both from heavy monsoon rains and droughts, despite a higher than average annual rainfall. As a flat, low elevation coastal zone, there is little natural gradient to encourage runoff, causing urban flooding from rain as well as risks from storm surges. How the different urban configurations are positioned in relation to these material realities shape the discourses and institutional arrangements around water governance issues, primarily regarding water scarcity, flooding, or the combination of both.

Whilst the scarcity of water is undeniable, the dominant discourse is about increasing supply to meet the demand as opposed to reducing consumption or redistribution of endowments. The Chennai Metropolitan Water Supply and Sewerage Board, the main parastatal water company (hereafter referred to as Metro Water), turns to large infrastructure projects: Chennai has two large desalination plants (see below), with two more in the planning stages (Lakshmi 2014), as well as a large transboundary pipeline bringing water from the Krishna River basin over 250km away in Andhra Pradesh. Although effective for increasing water availability, these solutions attempt to address the problem primarily from a technological-management perspective; apart from being costly, they do not address related and equally important issues like wasteful consumption patterns, leakages and unjust distribution.

Increasing water supply is a politically sensitive issue. In 2004, the Tamil Nadu state government instituted a Rain Water Harvesting (RWH) Law, making RWH mandatory for all houses. The responsibility for set up and maintenance lies with the individual homeowners, and the only moment the law is enforced is when municipal services are called for maintenance. The distinction between scales here is pronounced: RWH is mandatory for personal homes, but there is no specific harvesting programme in place for public spaces (streets and thoroughfares). Though storm water drains have RWH structures before the opening of the drains, these are often blocked with garbage or debris or overlain when repaving the roads. Hence water megaprojects are construed as simple solutions at the macro scale and water conservation is relegated to the micro individual scale.

The dominant discourse is of technoscientific, civil engineering solutions. Flooding is to be solved by efficient storm water drains, and water supply with megaprojects. The Corporation of Chennai deals with micro level drains, and the PWD deal with the three main macro drains. Together with their private contractors and zonal administrators, these engineers are the primary government coalition around flood management (Jameson 2014). Yet working solely by gravity in a flat coastal plain, they are self-limiting, as well as echoing Metro Water in overlooking socioeconomic vulnerabilities by measuring 'city coverage' as opposed to 'connections'.

There are a few voices contesting dominant framings by emphasizing circular water metabolisms and distributional justice, such as NGOs contesting storm water drains and promoting the revival of traditional RWH because storm water drains are polluted and covered in concrete (preventing groundwater recharge), or the independent Centre for Water Resources conducting excellent

[4] This section draws on Shazade Jameson's Master's research (Jameson 2014).

critical participatory academic research. However, in general these are few, relatively dispersed, and marginalized as being social activists in the realm of technological civil engineering. Trying to circumvent these discursive blockages, the academic activists recourse to cultivating social capital with individual bureaucrats, grabbing the attention of the media, or through international academic arenas for recognition and spreading their message (Jameson 2014). Still, the uptake of holistic conceptions of water is patchy with few feedback loops, and the private water sector has not capitalized on interdependencies between different water providers to strategically improve the system (Roumeau 2012). Meanwhile, demand for water continues to skyrocket, and climate change will only increase the extremity and irregularity of rainfall.

As will be discussed below, the water market in Chennai is largely unregulated; the Ground Water Act of 2003, meant to preserve water sources, has not been enforced. In the meantime the market for private packaged water has boomed. The result has been a downward spiral of over-extraction and the increasing dependency of urban residents on private water sources. The sale of water packed in bubbletops alone is over 5 million litres a day (Roumeau 2012). In this scenario, both low-income urban residents and small farmers upstream from Chennai bear the costs disproportionately.

2. Major water related issues and vulnerabilities and their spatial distribution

Chennai has the lowest per capita availability of water among large cities in India, i.e., 108 litres per capita per day (lpcd) compared to 270 lpcd in Delhi, 260 lpcd in Mumbai, 250 lpcd in Calcutta, and 140 lpcd in Bangalore.[5] However, this average supply figure says nothing about the wide differentials in access to water supply between geographical zones in the city and between income groups. The poorest and least connected residents suffer most from the water shortage in part because they have less flexibility to find alternative affordable sources of water.

As a poignant example of the increase in socioeconomic vulnerabilities as a result of the multi-scalar privatization of water, our research showed that a wealthy couple with two children in an upscale neighbourhood could get an unlimited quantity of drinkable water for 550 rupees over six months, based on an individual underground storage tank system linked to a main water line, which they also use for grey water purposes. In contrast, a family of four who are not connected to the main line have to purchase about 8 cans of 25L per week, used only for drinking purposes, adding up to at least 3,500 rupees over 6 months. Moreover, poorer districts can have up to twice as many total dissolved solids per cubic metre, indicating a sharp socio-spatial disparity not only in price but also in quality of water (Roumeau 2012).

In order to zoom in on the key water issues facing Chennai, including climate-related water vulnerabilities, a case study was carried out in the IT Corridor, with an aim to benefit from and contribute to the other research being conducted there within the Chance2Sustain project (see map 1).[6]

[5] See Asian Development Bank (2007).

[6] Samuel Roumeau conducted field research in Chennai from 6th October to 15th December 2011 as part of an internship at CEIAS (CNRS-EHESS) in the framework of the Chance2Sustain project and in partial fulfilment of Masters Degree in International Cooperation and Development & Risk Management in Emerging Countries at Institut d'Etudes Politiques de Bordeaux. Cf. Roumeau 2012.

Map 1: Location of case studies in the IT Corridor area of Chennai [Source: fieldwork data Chance2Sustain, Pfeffer 2013]

The IT Corridor is a megaproject that gives expression to Tamil Nadu's economic growth strategy.[7] As such, it requires quality infrastructure and a high level of public services, including water supply and drainage. For this purpose, the Government of Tamil Nadu mandated the water agency in charge of Chennai, Metrowater, to implement a special ad hoc project for providing constant '24/7' water supply and efficient sewerage infrastructures to the IT Corridor. Field surveys in one government-sponsored IT Park along the Corridor confirmed that the government offers uninterrupted quality power supply from dual source and uninterrupted supply of water and other utilities, although this can not be generalised for the entire Corridor (cf. infra). Meanwhile, most households in Chennai are limited to 3-4 hours of water a day, which underscores the severe inequalities of access to water prevailing in the metropolitan area. Even if residents are connected to a network, they are required to diversify their sources of water to ensure sufficient supply.

Given this state of affairs, it is particularly relevant to emphasize water vulnerabilities when examining urban development in Chennai. Relatively little attention has been paid to these vulnerabilities, which progressively aggravate tensions between different categories of water users. The development of the IT Corridor is built on fragile wetlands and water bodies such as Pallikaranai Marshlands and Muttukadu Laguna (cf. image 1).

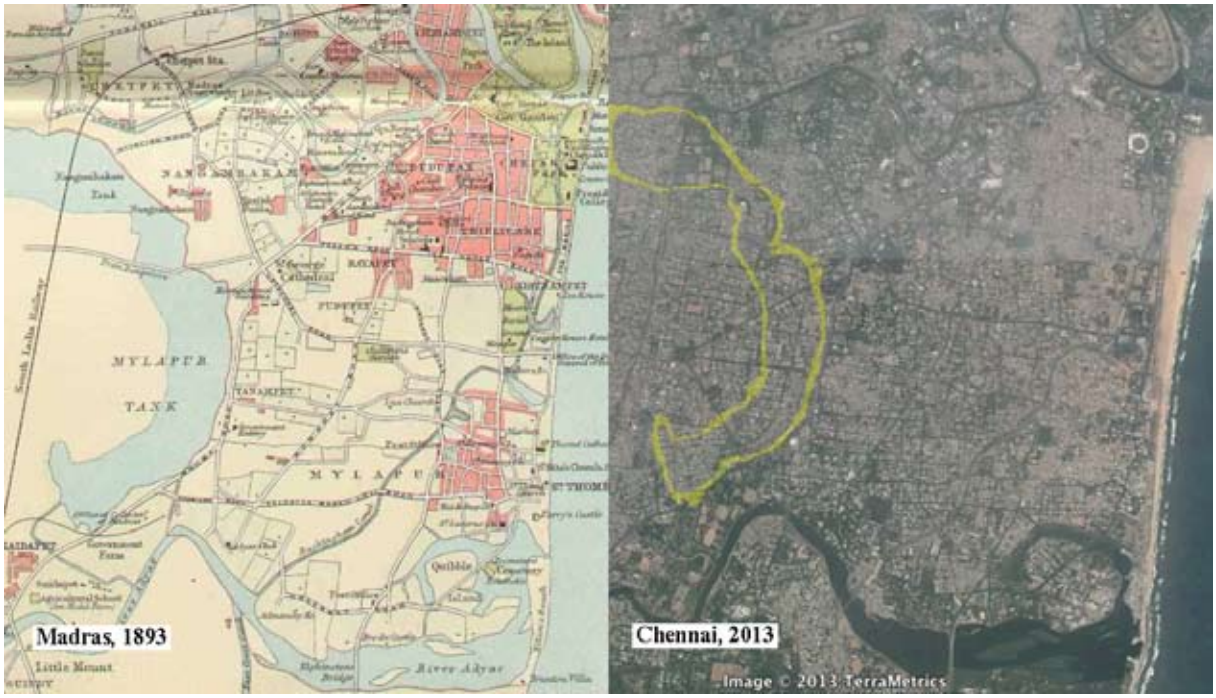
Image 1: Panorama of the rapidly changing residential landscape, south of the toll booth and along Muttukadu Laguna [Source: A. Varrel, Chennai area, March 2012]

[7] For more on this strategy, see section 2 of the Chennai City Report: "Mega projects as an Expression of Economic Growth Strategies" in L. Kennedy et al. 2014.

Due to encroachment on the wetlands and the destruction of the water catchment areas, heavy rainfalls frequently result in flooding on the IT Corridor, especially during the monsoon (cf. image 2). Furthermore, the site is located only a few kilometres away from the Bay of Bengal, a coastal zone vulnerable to the rising sea level and tsunamis. The proximity to the ocean creates another problem: the groundwater depletion is correlated to saline intrusion in water tables. Given these characteristics, water vulnerabilities along the IT Corridor need specific attention in order to ensure that current development of the built environment is sustainable.

Taking the example of flooding, it can be observed today that flooding as a result of heavy rainfall is unequivocally 'naturalised' as being the result of 'naturally low-lying areas'. Though not false, this interpretation ignores the causes of filling in traditional water tanks and their interconnections, which would ultimately lead out to sea (see Map 2) The urban development authority, the CMDA, does recommend the refurbishing of macro tanks in their Master Plan, yet the job is relegated to the Public Works Department (PWD) whose main mandate is drainage and water provision as opposed to the interconnected causes of flooding (Jameson 2014). Particularly, the failure to respect urban tanks and natural flood sinks can be attributed to the lasting influence of the faulty British land use classification system, which

Image 2: Flooding on the link road between Taramani and Kandanchavadi, north of the IT corridor [Source: A. Varrel, Chennai area, November 2011]



Map 2: Much of Nungambakkam district used to be a tank - today, it is a flood risk hotspot [Source : Jameson 2014]

overlooked seasonal land uses (Vencatesan 2006), resulting in rampant encroachment of all water bodies and unclear responsibilities within Metropolitan governance coalitions as to how to stop, prevent and deal with the issue (Jameson 2014).

The main flood defenses are the Pallikaranai Marshland, the wide beach, the two rivers and Buckingham Canal, which used to be a navigation channel but is now a flood buffer. As disadvantaged economic groups continue to meet their housing needs by building substandard settlements on the banks of the larger rivers in the inner city, upgrading storm water drainage overlaps with the modernization project of 'slum free cities' (Coelho and Raman 2013). In renovating 'their canal', the PWD collaborates with the slum authority to evict encroachers. The urban development authority then paves the banks for traffic flow, beautification and prevention of the return of settlers. Whereas these vulnerabilities underscore the critical need to improve water governance, the field research indicates that the governance structure is complex and highly fragmented, characterised by a large number of stakeholders, both public and private, often working in parallel and non-overlapping epistemic communities with different dominant discourses (Jameson 2014).

2.1 Water Governance in Chennai Metropolitan Area

The fragmented nature of water governance along the IT Corridor can be illustrated by the fact that the public agency in charge of water supply, Metrowater, was not given a clear mandate to service this area. The Second Master Plan prepared by the Chennai Metropolitan Development Authority (CMDA), published in 2008, indicates that 'though Metrowater has jurisdiction over the

CMA as per their Act [1978], their area of operation for piped water is limited presently to the CMC [Chennai Municipal Corporation] area and a few adjoining areas such as Mogappair and the IT Corridor'.[8] However, according to the superintendant engineer of the IT Corridor Water Project (ITCWP),[9] who was evasive on this point, Metrowater was waiting until the entire IT Corridor was included in city limits to supply piped water to the IT Corridor. With the extension of municipal boundaries in 2011, part of the IT Corridor is now included in the Municipal Corporation, i.e., the stretch from Kottivakkam to Semmencheri. However, the stretch from Navallur to Siruseri is still outside Chennai Corporation limits.

The analysis of the various actors, their mandate, influence, and their power relations helps us to understand the decision-making process regarding water related issues. The actors involved in water governance along the IT Corridor are extremely heterogeneous. They include political and public institutions, private companies, farmers, NGOs, academics, scientific experts, socio environmental associations, and key individuals. Not all of these actors are able to participate in a significant way in the management of water and in environmental issues. The Government of Tamil Nadu is the overarching authority that takes all major decisions concerning water management in Chennai, and there is relatively little space for other actors to influence its vision of urban development. However, as the public water authorities do not provide adequate water supply and infrastructures, the private sector also plays a critical role in service delivery. Hence, there is a lack of a holistic vision, encompassing all aspects of water management crucial for a sustainable development. The various actors are briefly presented below:

State actors

The various entities in charge of the decisions over water issues, from the macro to the local scale, include:

1. Government of India, mainly via Ministry of Water Resources, Ministry of Environment and Forests and Ministry of Urban Development.
2. Government of Tamil Nadu (GoTN), Public Work Department – Water resources organisation
3. Chennai Metropolitan Development Authority
4. Chennai Metro Water Supply and Sewage Board (Metrowater)
5. GoTN Department of Municipal Administration and Water Supply
6. GoTN Direction of Town and Country Planning

As indicated above, GoTN is the most powerful actor involved in water governance along the IT Corridor, and has precedence compared to both the Central Government and local governments. The state government has entrusted Metrowater to implement the ITCWP, and it partly funds the project.[10]

[8] See CMDA (2008): chapter XIII ("Infrastructures investments for CMA").

[9] Samuel Roumeau's interview with the Superintendant engineer in charge of ITCWP at Metrowater, Chennai, 28 October 2011.

[10] For some specific entities that intend to draw water from a lake or nearby water body, the authority in-charge of sanctioning approval is the Water Resources Organisation in Public Works Department (PWD). Major supply sources in the IT Corridor are Poondi reservoir, Cholavaram lake and Redhills lake, all of which are under the control of the State PWD (Irrigation); further the PWD (Ground Water Cell) is responsible for the investigation of ground water resources within Chennai Metropolitan Area (CMA) to augment supplies.

Parastatal agencies

Metrowater was formed as an independent institution by an Act of the Legislature of Tamil Nadu in 1978. From this date, the state level utility has taken the task of consolidation and is gradually expanding the water supply and sewerage systems inside the limits of Chennai Corporation. In 2011, Metrowater supplied 774 million litres of water a day (mld) to residents of the city and the suburbs, approximately 87 litres per person.[11] This is more than the previous year when the daily supply was only 575 mld.[12] The State Government directs Metrowater to implement water projects in the Chennai Corporation and some special areas such as the IT Corridor. However, our research indicated that Metrowater appears to be overwhelmed by the magnitude of its jurisdiction, and its supply to the IT Corridor is insufficient to meet the needs of people living and working there.

The Tamil Nadu Water and Drainage Board (TWAD) caters to the area outside the limits of Chennai Corporation, and it would normally be the agency in charge of IT Corridor, except for the fact that Metrowater was assigned this special jurisdiction (including open water drainage, sewerage, extension of water supply and sewerage networks).

The Tamil Nadu Pollution Control Board (TNPCB) is responsible for setting, monitoring and enforcement of environmental regulations and standards. It is in fact a weak body, whose decisions are not always respected.

Apart from these, there are three agencies promoting industrial development in the form of IT parks along the IT Corridor: TIDEL in Taramani, ELCOT in Sholinganallur, and SIPCOT in Siruseri. All of these entities have their own water regulation and management.

Private agencies

The failure of the public utility to supply a sufficient quantity of water to the IT Corridor explains why the private sector has emerged as a critical actor in water governance. Private companies supply water through tankers in Chennai and its surroundings: Tamil Nadu counts 400 licensed companies, *which is 50% of the total in India*, and 220 are operating in and around Chennai. During the severe water crisis in 2003-04, the piped supply for the entire city was virtually shut down for a 12-month period. Consumers became dependent on private tanker suppliers trucking in groundwater from peri-urban areas.[13] Packaged water vendors, selling sachets, PET bottles, and cans, have also multiplied.

[11] This rough calculation uses the 2011 census data for population of metropolitan area, i.e., 8,917,749.

[12] Samuel Roumeau's interview with the Managing Director of Pallippattu distribution station, Chennai, 5 November 2011

[13] See Srinivasan (2008).

Farmers

Farmers are an important group of actors in the distribution of water because they sell groundwater directly to private tankers. Many of them have shifted from agricultural activities to water production, as it yields more money than paddy cultivation.[14] According to a Chennai-based academic following these issues, the water-selling farmers align themselves with the state and urban stakeholders to make a short-term profit. Other farmers perceive the water sellers as enemies, as they are adversely affected; their wells become dry due to round-the-clock pumping. The latter are a voiceless and powerless group, suffering the brunt of water transport and other damages to the local environment.[15] Water sellers associations exist and try to strengthen the relation between farmers groups, but in the end, farmers are not organized and not well informed. Private water suppliers via tankers are better organized and much more influential, which allows them to fix prices collectively for customers.

Civil society

There is a multiplicity of NGOs dealing with water and environmental issues in Chennai. Even though they raise awareness about water governance, their influence on decision-making remains limited. Civil society organizations, activists, researchers and media all play a role in fighting against the depletion and pollution of resources in the peri-urban areas but taken together, this set of stakeholders lacks power and does not represent a clear constituency.[16]

The following non-exhaustive list gives an idea of the NGOs active in Chennai. SUSTAIN, an advocacy and educational organization linked to UN-Habitat works to promote sustainable development by promoting resources efficiency, particularly energy and water, organising conferences and debates, and implementing projects such as Green School, Eco-Campus, Eco-Business. The Rain Centre is the foremost education and resource centre on Rainwater Harvesting techniques; it conducts training for communities, individuals and MetroWater itself. Both ExNoRa International (Chennai branch) and Madras Naturalist Society focus on environmental problems in and around Chennai, and engage debates around environmental issues at community level. Other Media's Corporate Accountability Desk works specifically on environmental health and corporate accountability among pollution-impacted communities. Transparent Chennai defines itself as a non-profit action research think tank whose work aims «to empower residents by providing them useful, easy-to-understand information that can better highlight citizen needs, shed light on government performance, and improve their lives in the city».[17] Water Today is a knowledge-disseminating platform focused on the water and the wastewater industry and organised the international exhibition *Water Expo 2012* in Chennai.

[14] See Ruet, Saravanan and Zérah (2002).

[15] Information collected during Samuel Roumeau's interview with Professor S. Janakarajan, Madras Institue of Development Studies, Chennai, 2 December 2011.

[16] See Janakarajan et al. (2007).

[17] http://www.transparentchennai.com/about/, last consulted 2 April 2015

Academics

CPR Environmental Educational Centre is a centre of excellence of the Ministry of Environment and Forests that strives to increase awareness and knowledge about the environment among key target groups (school children, local communities, and women). Similarly, the Conservation Authority of the Pallikaranai Marshland (CAPML), which although not directly mandated with water governance, is a collective of different state and civil society representatives charged with managing the forest reserve on the marshland, who also have an education centre in the marsh about the habitat and the migratory birds. By carving out a specific geographical space over which CAPML has the sole authority, governance is simplified and effective (Jameson 2014). In this way it plays a large role by managing the city's largest flood sink, which recharges the southern coastal aquifer.

Compared to NGOs, research and academic centres appear to have more credibility. The Indian Institute of Technology Madras (IITM) is conducting a research program on Public Private Partnerships (PPP) in Urban Infrastructures with a focus on water and sanitation, and the Institute of Remote Sensing at Anna University is the main research consortium for flood risk mapping in the city. However, social scientist academics who are critical of dominant discourses and strive for more integrated water governance, such as researchers at the Madras Institute of Development Studies (MIDS) and the Centre for Water Studies at Anna University, are often disregarded beyond cursory seminars (Jameson 2014).

2.2 Limited perspectives for inclusive scenario building

Theories on water governance indicate that in many cases actors operate collectively (organizations and institutions), but in other cases participation occurs in a more individual fashion. That is the case of 'Opinion Leaders' who count on recognition, credibility and citizen support to 'provoke learning and changes in attitudes and practices among people and institutions, in order to encourage processes of reaching agreements around sustainable development'.[18] What is striking in Chennai is the relative absence of such opinion leaders. Even though some actors could play this role, they are presently not organized and do not constitute 'networks or competency groups'.[19] Such networks can be understood as a change in the political structure of a society more than as a new analytical approach, representing new forms of social organization in response to political problems of coordination. In Chennai – and a fortiori along the IT Corridor – this change has not occurred. The other alternative for opinion change is through media channels, if the issue can be politically charged enough to draw the attention of political leaders. In this sense, the ambition of building a scenario based on public participation seems to be seriously undermined. It is nonetheless important to note that organizations such as Transparent Chennai or SUSTAIN contribute to more informed public debates and strengthen cooperation in favour of research. That said, as a result of the tensions between epistemic communities of civil engineers and critical social scientists, the recognition and integration of socioeconomic and biophysical water-related vulnerabilities depends largely on the predisposition of different actor coalitions. Either they recognize the holistic, cyclical

[18] Miranda, Hordijk, and Torres Molina (2011).
[19] Braun and Whatmore (2010).

nature of water, or they do not; the latter view is dominant, reinforced by technical hazard mapping and the increasing multi-scalar privatization of drinking water (Jameson 2014).

There are examples of initiatives for recognizing local forms of knowledge about flood risks and socioeconomic vulnerabilities. One notable initiative was the interactive mental mapping exercise of vulnerabilities around the marshland, built up from the personal relationships between the local NGO CareEarth and the University of Freiburg. They combined PRA methods to visualise community tacit and contextual knowledges about coping with geospatial data. The outcomes followed different strands: freely publishing a flood risk map online (University of Freiburg 2012), releasing an interactive participatory mapping tool online, then publishing an academic paper (Pfeiffer et al. 2008). This particular initiative was taken up by the CMDA and incorporated into the Master Plan of the city as a no-development zone around the marshland, hailed as an enormous success.

Whilst the interactive mental mapping tool is incredibly innovative, it is also vulnerable; currently (2014) it is no longer available, for lack of funding, lack of technical capacities in other NGOs, and the individual concerned could no longer take it on board. This reinforces the fact that when the individual champion behind an initiative is for whatever reason no longer there, then the initiative falters. Relying on initiatives driven by individuals thus depends very strongly on their social networking, and the extent to which they have access to decision makers (Jameson 2014), pointing to the limitations of this method as a means for transforming dominant narratives.

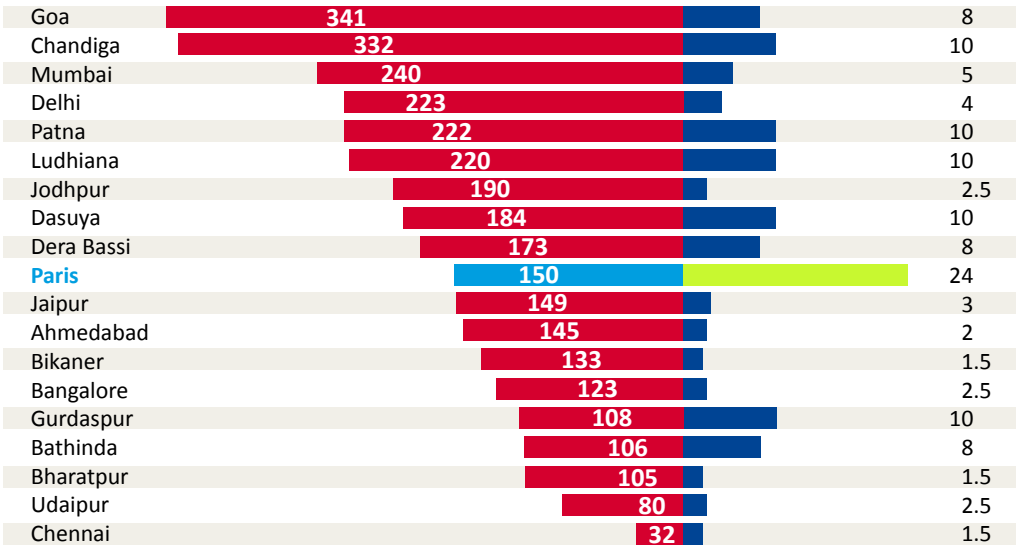
3. Policy and specific projects for water supply

It can be recalled, from a global perspective, that world water requirements are projected to grow from 4,500 billion m^3 today to 6,900 billion m^3 by 2030. This is a full 40% above current accessible, reliable supply. One-third of the world's population, concentrated in developing countries, will live in river basins where this deficit is larger than 50% (Water resources group 2009). According to a recent study, the demand-supply gap is expected to be around 300 mld for the city of Chennai in the year 2026.[20]

As mentioned above, Chennai's piped water supply is one of the worst of all Municipal corporations in India with less than 2 hours of supply per day, on average (see Graph 1). Not surprisingly, the poorest and most marginalised populations of Chennai Metropolitan Area suffer the most from the shortage of water. The wide range of water prices, depending on the type of supply, reinforces inequalities. As far as piped supply is concerned, the government fixes prices for water sold by Metrowater. The prices are determined through a tax of 7% of the annual rental value collected by Metrowater for water supply and sewerage. To encourage

[20] The study is based on the following consumption of water: 150 lpcd for Chennai Corporation, 125 lpcd for Municipalities in Chennai Municipal Area (CMA), 100 for Town Panchayats, and 80 for village Panchayats. It would appear that the rates of water consumption used in this study are over-evaluated compared to many testimonials from residents. For an alternative perspective, see also the 2007 figures for India cities available here http://www.globalwaterintel.com/pinsent-masons-yearbook/2012-2013/part-ii/15/

Graph 1: Per capita litres per day vs. hours of supply per day

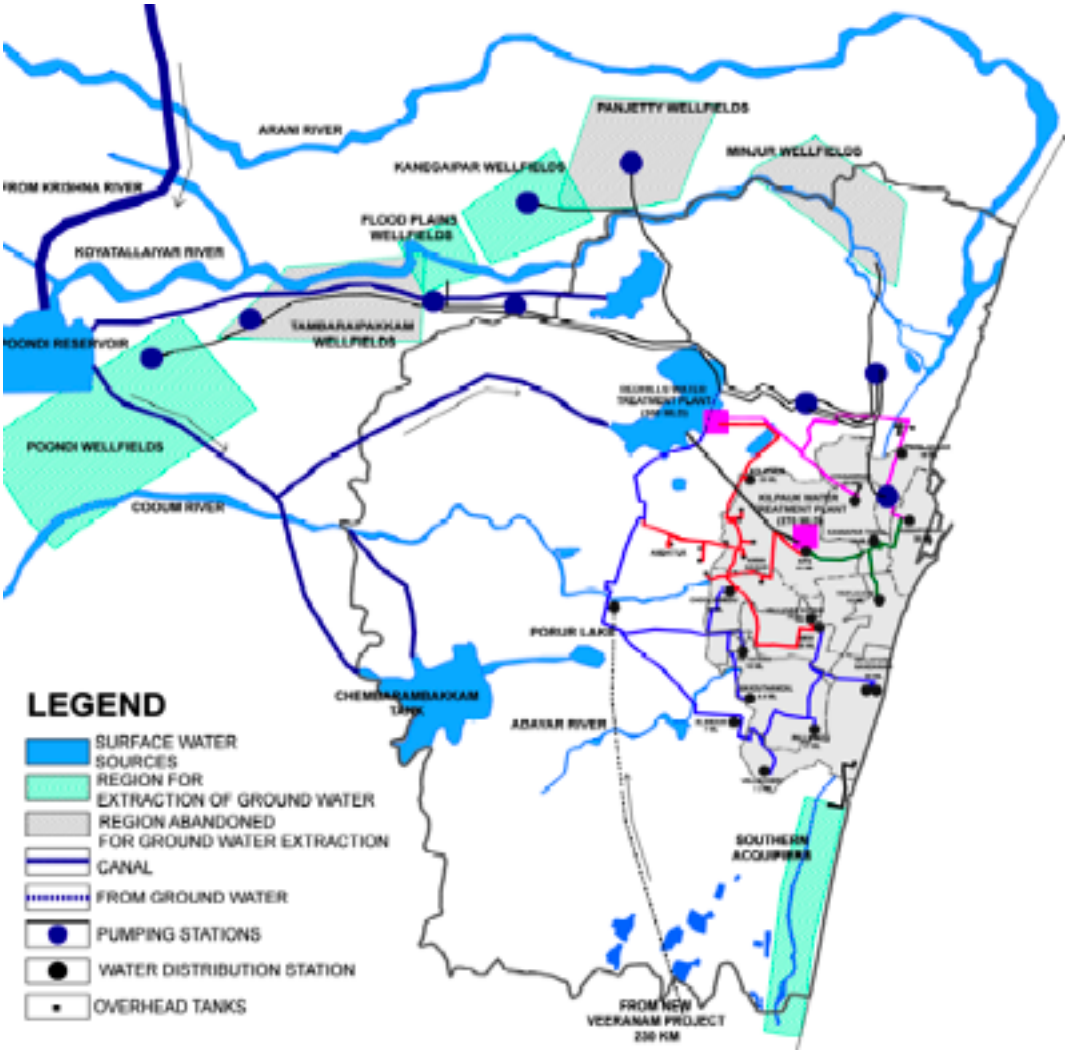


Source: Data collected from the water boards or utilities; A. Amiraly 2009

water savings, the marginal cost of water increases with the level of consumption. Prices are thus proportionally lower for people who use smaller amounts of water, and there are higher tax rates for industries because of their higher water consumption (and greater capacity to pay). Regarding water carried to unconnected households by tankers, 9000 litres cost an average of 600 rupees for domestic use and 765 rupees for commercial or industrial use. Residents organise themselves to share on an equal basis the costs of using the collective sources of supply. In late 2011, the 25 litres bubbletops cost 25 rupees on the burgeoning market of packaged drinking water. One of the findings of this research is that the lowest income groups consume the lowest quantities of water, at the highest price per litre.

A total of 1954 million litres of water are consumed everyday in Chennai. According to the Centre of Water Resources at Anna University, the three main sources of water supply to Chennai are surface water, ground water, and 'other minor sources' (See Map 3).[21] In addition, the recently built desalination plants at Minjur and Nemmeli transform large amounts of seawater into drinkable water. This controversial source will be further developed in the next section.

[21] For surface water, the main sources are the following: the reservoirs located at Pondi, Cholavaram, Red Hills and Chebarambakkam lakes (227 million litres per day - Mld); Krishna water through Kandaleru reservoir in Andhra Pradesh under Telugu Ganga project from 1996 (837 Mld); Veeranam lake located 228km South of Chennai, from September 2004 (180 Mld); and local sources including Palar river (32 Mld). For ground water: six well fields located in Araniyar & Koratalaiyar river basin adjoining the reservoirs around Chennai (68 Mld). Extractable quantity of local groundwater in the city for other purpose than drinking and cooking; and multiple wells, both owned and hired (240 Mld). For other small sources: Porur Eri, Madhavaram Rethai Eri, Southern coastal aquifer, and Brackish water treatment plants (5Mld).



Map 3: Sources of water in Chennai [Source: Metrowater, 2010]

3.1 Desalination plants

Following the first desalination plant built at Minjur (25 km north of central Chennai), the State Government decided to construct a second plant at Nemmeli, to the South of the IT Corridor (45 km south of central Chennai). The project was financed partly through a central government grant and partly through the Metrowater budget. VA Tech Wabag executed the project on a Design Build Operate basis in partnership with IDE technologies, from Israel. The plant comprises disc filters, ultra filtration membranes and reverse osmosis membranes.[22] This 100 Mld plant, which cost 1,000 crore rupees (approximately $1.6 million), was inaugurated

[22] Reverse osmosis is considered the most convenient and effective method of water filtration. It filters water by squeezing water through a semi-permeable membrane, which is rated at 0.0001 micron. It is also the only technology capable of desalinating seawater, making it into drinking water. Non-RO water filters are much less effective, and the pore size of these filter media are much bigger, generally 0,5-10 micron. As a result, water is far less clean and safe compared to reverse osmosis filtration.

in February 2013.[23] According to official sources, it will consume around 16Mw of power per day, which will be supplied from a sub-station that the Tamil Nadu Electricity Board will set up. Officially there would be no sludge generated, as no chemicals will be used during the desalination process. The water with heavy concentration of salt will be discharged into the sea as per the specified norms.[24]

The desalination plant in Nemmeli has the following advantages: it is located near the sea on a flat area, and there is adequate availability of electricity for pumping. However, critics from environmental networks and academics highlight three drawbacks of such a project. First, the drinking water produced will be expensive; this source of supply is estimated to be twice more expensive than the current rate for Metrowater supply. This goes against the objective of introducing affordable standards and targeting subsidies to the poor. Second, it is environmentally unsustainable because (i) the desalination plant requires a lot of energy to produce water (every litre of water produced demands 7,5 Kw/h of energy); (ii) the plant will reject 17 kilolitres per day of extremely salty water in the sea; (iii) it is socially destructive because the activity of the plant will deeply affect the livelihoods of local fisherfolk who will have to go further out to sea to catch fish. As critics point out, it may make sense to opt for desalination plants in countries such as South Africa, Singapore and especially Qatar or United Arab Emirates where rainfall is far less than 1200 mm a year. However in Chennai, rainwater harvesting and measures based on the dual quality of water would appear to be better, more sustainable options.

3.2 Special project for the IT Corridor

In order to cater to fast urban development linked to the economic activities of the IT Corridor, the State government entrusted Metrowater to implement the special project 'Providing water supply and sewerage infrastructures along the IT Corridor and the Rajiv Gandhi Salai'. This policy can be seen to give special treatment to the southern part of Chennai, with an aim to offer guarantees (or at least reassurance) to potential investors in terms of basic infrastructures. It is characteristic of the incentives put in place by the State Government to spur economic growth. At the same time, it deepens already existing social and spatial inequalities, since it targets selected geographical spaces and specific economic actors. The inability of the authorities to achieve an efficient and sustainable water infrastructure system has led to the emergence of adaptive practices that are outside the control of the public sphere. Both companies and residents have become very dependent on private sources of drinking water.[25]

Metrowater has been mandated to supply water and sewerage facilities to the IT Corridor area at the cost of 417.7 million rupees (approximately 5.4 million euros). The work commenced

[23] See "Nemmeli plant: The desalination dilemma", Live Mint & The Wall Street Journal, 23 May 2013. URL: http://www.livemint.com/Politics/FvpXSl7v5JClJIPjyDLejO/The-desalination-dilemma.html, last accessed 20 January 2014.

[24] "Israel IDE seeks partners to tap Indian desal market" India Water Review, 23 February 2012. URL: http://www.indiawaterreview.in/Story/News/israels-ide-seeks-partners-to-tap-indian-desal-market/546/1 last accessed 20 January 2014.

[25] A newspaper article evokes the importance of private water suppliers along the IT Corridor: "Recently, some of the offices had to shut down for a day when tanker owners went on a flash strike, protesting against the seizure of vehicles by revenue for illegal extraction of groundwater for commercial use." See 'Stalin vows nonstop water for OMR', *Times of India*, April 24th 2010.

Image 3: Tanker inside Ascendas Tech Park [Source: A. Varrel, Chennai, November 2011]

in April 2007 and was almost complete at the time of this study in late 2011 (about 90%). This project focuses on both sewerage and water supply works. It mainly consists in building sewerage treatment plants to improve the wastewater management and laying mains to provide piped supply to this area. This strong state support in favour of a very limited space while the entire city suffers from water scarcity and poor sewerage system reveals the particular commitment of the authorities to make the IT Corridor an exceptional space with 'world-class' infrastructure aimed at attracting foreign investment. However, 24/7 supply remains on paper only and many residents remain unconnected to sewerage and supply networks.

An estimated 60% of the water that Chennai's public uses come from sources other than Metrowater.[26] The table below presents the average litre per capita per day by type of source for a person living along the IT Corridor. These estimated figures were compiled on the basis of a survey conducted with residents of villages located on the IT Corridor. They are an average for the whole sample and should be interpreted accordingly.

[26] Transparent Chennai data: http://www.transparentchennai.com/research/water/background/. Last accessed 17 February 2012.

Table 1: Water consumption by sources on the IT Corridor

Year 2011	**Lpcd per source**
Public sources	
Metrowater piped supply	5
Metrowater individual hand pumps	20
Public taps	2
Metrowater lorries	2
Private sources	
Own well	25
Private lorries	18
Packaged water	2
Total	74

Source: S. Roumeau (2012), adapted from V. Srinivasan (2008).

4. Vulnerability to climate change impacts

The IT Corridor is a compelling case study to illustrate how the particular natural hydrological topography of this area has been almost completely erased by the artificial landscape of water infrastructure, 'urbanized' to synchronize with the mega-infrastructure project as well as private-led property development. Environmental Impact Assessments are not required for IT development although those projects are not as green or non-polluting as often claimed. Climate change impacts add to the pressure exerted on water resources. Environmental vulnerabilities along the IT Corridor in Chennai are characterised by groundwater depletion, destruction of water bodies, extreme weather events, and the proximity of the sea. Finally, beyond such real and verifiable vulnerabilities, the biased perception and lack of awareness among actors about these vulnerabilities constitute a major factor of risk.

Groundwater depletion and the induced saline intrusion in groundwater tables may be the major source of concern in the IT Corridor area. The overexploitation of groundwater resources correlated to the new development of this area is accelerating the depletion of aquifers and leading to saline intrusion of seawater, making the water unfit for consumption. To regulate and control the extraction, use or transport of ground water and to conserve ground water, the Chennai Metropolitan Area Ground Water (Regulation) Act, 1987 was enacted. The Tamil Nadu Groundwater Act improved this legislation in 2003.[27] Even if the Groundwater Department is monitoring the general status of the aquifers, exploitation is not managed in a sustainable way. According to a leading specialist of water in Chennai, the legislation on groundwater is not respected and practically anyone can extract water from groundwater without punishment. This observation was corroborated by fieldwork, for instance, for agencies that manage IT parks, for some towns and villages along the IT Corridor such as Sholinganallur[28], and also at the individual level.

[27] See description of this Act in the part 1.2.1.

[28] See case study on Sholinganallur in Roumeau (2012).

The State government has plans to address issues of water quality and availability in Chennai Metropolitan area by constituting a comprehensive groundwater regulatory authority. The objective is to wean the city's residents away from an unsustainable dependence on groundwater and impose strict controls on the use of sub-surface water. According to the engineer in chief at the Water Resources Organisation,[29], 'a bill on groundwater is under the consideration of the government, and a decision will be taken shortly. The practice of digging a hole anywhere and drawing water must stop'.[30] Some of the measures proposed for curtailing the overexploitation of groundwater include: clarifying property rights, introducing extraction charges and limitations, and promoting water conservation policies. At a technological level, mapping and planning optimal use of natural resources through GIS can pave the way to a more sustainable conservation of groundwater.

The development of IT industries and residential properties along the IT Corridor is threatening two large water bodies: the Pallikaranai Marshland and the Muttukadu Laguna.

Image 4: Aerial view of Perungudi: on the left smoke from the dumpsite encroaching on the Pallikaranai Marshland [Source: A . Varrel, March 2012]

[29] S. Kumaresan is engineer in chief at Water Resources Organisation, Public Works Department. His testimonial was reported in the press. See "Groundwater regulatory authority soon", *The Hindu*, 2 May 2011.

[30] Some borewells operating without a license reach 100 to 200 metres depth.

In addition to water and waste issues, the Pallikaranai Marshland is being affected and its biodiversity harmfully disturbed.[31] It is being used for garbage disposal, sewage treatment, as well as for drainage (cf. images 5 & 6). The Perungudi dumpsite, (see image 4) has existed in the Marshland since 1987 (see image 5 for dumpsite location in the Marsh).

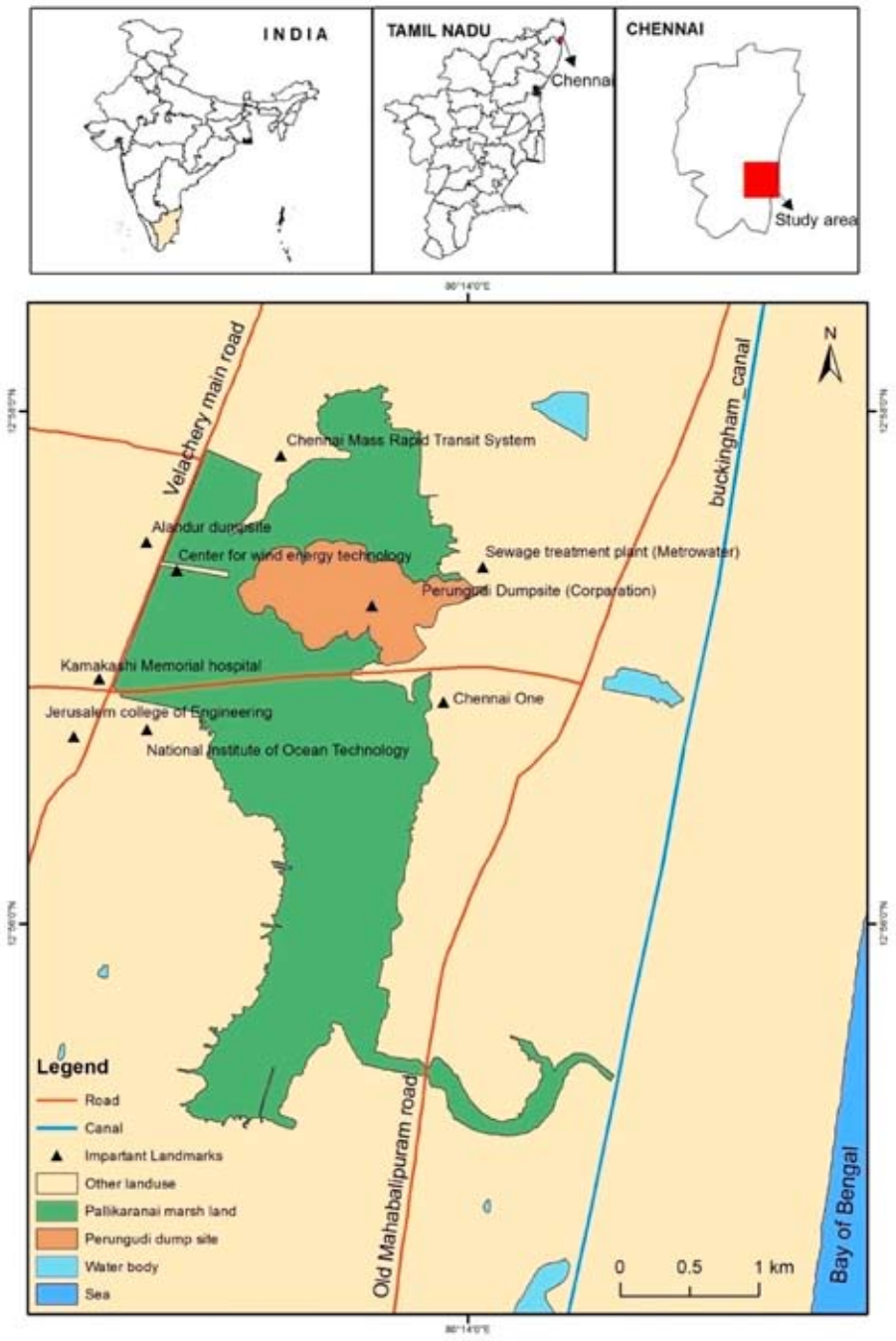


Image 5: Pallikaranai Location in south Chennai [Source: A.Seifelislam, 2013]

[31] The data and analysis of the Pallikaranai Marshland draws primarily on a study by Aicha Seifelislam. Cf. Seifelislam 2013.

According to a recent study, the dumping started with 20 ha in 1995 and increased to 44.75 ha in 2002. At present the dumping site has an area of 78ha with a current waste dumping of 2,450 tons per day (Seifelislam 2013: 14). Because the Perungudi dumpsite is poorly drained, lacks sanitary design, and has direct contact with the underground (Parameswari et al 2012), it very probably contributes to groundwater contamination.

Moreover, treated and untreated sewerage pours into the marshland. According to one source, Metrowater has been letting out 32 million litres of untreated sewage water every year directly into the marshland and a sewage treatment station located next to the Pallikaranai releases treated sludge into the marshland (Seifelislam 2013: 19).[32] Some localities on the periphery of the wetland such as Mylai Balaji Nagar directly release untreated sewerage (see Images 6 and 7).

Naturally these pollution sources have adversely affected the ecological balance of the marshland. Until a few years ago, the Pallikaranai Marshland was a functioning percolation system, a key environment for the recharge of underground water: taking the flow of rainwater from the upper catchment areas like St. Thomas Mount and the Pallavaram Hills. Now, the quality of the recharge is threatened because the marshland has been polluted and can no longer be tapped for drinking water. Field interviews and the local press indicate that as recent as 20 years ago, surface water could be consumed without treatment (Seifelislam 2013: 11). Today, various studies of water quality confirm that it has high concentration of TDS (Total Dissolved Solids). A study from the University of Madras indicated that the concentration of the TDS in the Pallikaranai Marshland is generally higher than the desirable limit of 500mg/L for safe drinking, and that in more than 50% of the samples the a concentration is even higher than 2000mg/L, the amount permissible for agricultural use (Vijayakumar, 2011) (cited by Seifelislam 2013: 17).

One explanation for the waste dumping and raw sewerage inflow, as well as the unhindered property development in the area, is that marshland was classified until recently as 'wasteland' by the government (Vencatesan 2006). Various groups, including the 'Save Pallikaranai Marshland Forum' have been fighting to maintain and protect it. In 2007, the southern part of the marshland was declared, as a Reserved Land under the Forest (Conservation) Act of 1980 and brought under the jurisdiction of the District Forest Officer through CAPML (Seifelislam 2013: 27). The forest department is now responsible for the marshland and a request to upgrade it into a highly protected area is on the table of the Chief Minister of Tamil Nadu.[33]

The IT Corridor is a flood prone area.[34] On the basis of discussions with various stakeholders, there appear to be five main causes of floods. First, in addition to monsoons twice a year (June and November), there are extreme rainfall events, which may be correlated with climate change. Second, the increasing level of urbanisation is often correlated with a decrease in forest

[32] This was contested by the Metrowater officer working in the Pallikaranai sewage treatment plant who asserted that the treated water does not flow into the Marshland but into the Buckingham canal (Seifelislam 2013: 19).

[33] One proposal, reported by the press, consists in converting the existing dumping yard into an ecopark. Cf. "A giant step towards preserving Pallikaranai marshland", *The Hindu*, 10 Sept 2013, cited by Seifelislam (2013).

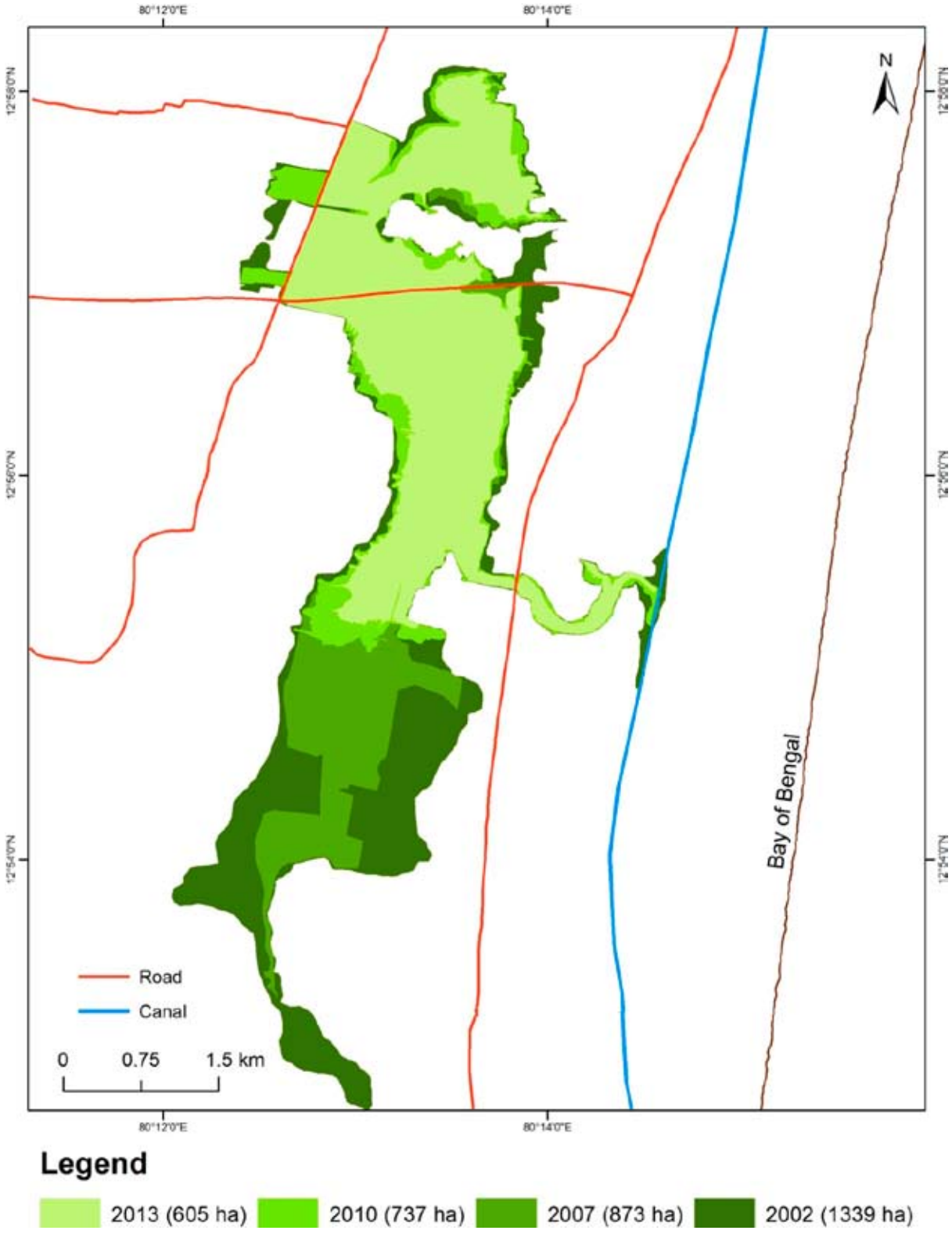
[34] Although major flood events occur only every five years on average, annual floods kill people every year: for instance, over 170 persons died in 2010 in Chennai.

Image 6: Sewage canal in Mylai Balji Nagar: Outflow from the living area [Source: Seifelislam, A. 2013]

Image 7: Sewage water inflow to the Pallikaranai Marshland [Source: A.Seifelislam, 2013]

cover and water catchment areas[35] (cf. Map 4 representing the shrinking of the Pallikaranai Marshland, resulting in reduced catchment and groundwater recharge). Third, the existing storm water drain system is inadequate and inefficient. Fourth, the dumping of waste and

[35] According to calculations realized by Aicha Seifelislam, the Pallikarnaai Marshland has diminished from 1339 ha in 2002 to 873 in 2007, and further to737 in 2010 and 605 in 2013 (represented in Map 7). The catchment area over the years was calculated using googlemaps pictures and the ARC Gis Program (See Map 7). For the missing years an average amount, based on a constant shrinkage over the time, was used. Cf. Seifelislam (2013).



Map 4: The changes in catchment area of the Pallikaranai Marshland in the past years [Source: Seifelislam, A. 2013]

garbage restrains the flow of water. Fifth, people's habits such as parking vehicles on road contribute to floods as well.

At the same time, the city of Chennai is also hit by droughts. In 2003, the North Eastern monsoon failed: in the recorded history of 54 years for which data is available, never had Chennai experienced such an acute drought. In the year following the drought, 2005, unprecedented flooding took place during the monsoons. These swinging cycles of flood and drought complicate the water management scenario in a city like Chennai as state institutions prepare for extreme scenarios year after year.[36]

The sea level has been steadily rising, up to about 1.3mm/year on average on the eastern coast.[37] This higher ocean level is directly linked to salt water intrusion in ground water supplies, threatening the quality and quantity of freshwater access to large sections of the population. The Department of Oceanography at Anna University asserts that the sea level has risen by one meter in the past 70 years along the coast of Chennai. Moreover, Chennai city is prone to huge waves. For instance, the tsunami in 2004 reached the shore of the Bay of Bengal killing dozens of people.

5. Producing vulnerability analyses and scenarios; spatial perspectives and participation

In the course of discussions with residents, it became evident that there is a crucial lack of awareness regarding the dangers related to climate change. It remains an abstract concept without any concrete application or consequences in the minds of the residents. Awareness among city planners is not necessarily much better. It became evident from interviews on that specific topic that most planners do not realize the very concrete impacts that climate change may have on their lives and on the environment. They perceive it as a vague and distant threat. According to the former chief planner, an IAS officer, 'In Chennai, no one of us, including experts, was conscious of the potential threats of climate change for our city before 2008, date of the Second Master Plan. The process of awareness is very new and evolving slowly'.[38] Two small paragraphs were dedicated to climate change in the chapter on the Environment in the Second Master Plan of Chennai.[39]

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[36] See Arabindoo (2011).

[37] Cf. India Network for Climate Change Assessment (2010).

[38] Quote from the speech made at the Seminar on « Cities and Climate Change » organised in Chennai by the Madras Chamber of Commerce in collaboration with SUSTAIN and UN-Habitat, 9th November 2011.

[39] 'It is recognized now that climate change due to global warming is going to be an important threat to safety of millions of people not only living near the coastline but also in the interior because of its impact on changing rainfall patterns and cyclones. Chennai is a flat coastal city subject to regular cyclonic storms and extensive inundation during the northeast monsoon period. Hence it is necessary to take into account ways and means of tackling the effects of climate change in a planned manner. Knowledge on this subject is only gaining ground in recent times. We need to absorb latest information and technology in this discipline not only to cut down green house gas emissions from urban activities but also anticipate the effects of climate change on the economy and life of people to take timely remedial measures'. (CMDA 2008:105-106).

The conference on 'Cities and climate change', organised in November 2011 by the Madras Chamber of Commerce & Industry in collaboration with the Citizens Alliance for Sustainable Living (SUSTAIN), was the first of its kind in the city. It took place on World Habitat Day, and attracted experts from academics, as well as participants from the administration, civil society and business groups. The launching of 'Sustainable Chennai Forum' that occurred the same day also illustrates a shift towards the inclusion of climate change aspects in the debate on sustainability. It is meant to be a platform for enhanced dialogue and information.

During meetings with members of SUSTAIN and Transparent Chennai, the idea of organizing debates on findings from the Chance2Sustain project emerged, within the broader framework of climate-related water vulnerabilities. This proves that scenario building processes are not merely a pipedream but are taken seriously by NGOs and other environmentally committed people.

To summarize, this study has shown the clear commitment from the Government to provide water-related infrastructures along the IT Corridor, in its objective to meet world-class standards. In this sense, water infrastructures form part of the global incentive structure intended to satisfy the expectations of foreign investors. However, this special treatment is not as efficient as expected. Thus far the 24/7 supply remains on paper and in the meantime both firms and ordinary residents have to deal with a limited and unreliable access to water. This requires them to vary their sources of supply from both the public utility and the private sector. Inequalities are strong within the IT Corridor and have also increased in comparison to the rest of the city, where most areas are still limited to 3-4 hours daily supply and poor level of sewerage infrastructures. The question of social justice in access to water remains largely ignored in the debate around water issues in Chennai.

This analysis supports the idea that the alarming water situation in Chennai is not primarily due to insufficient technical or financial means. Funds can be raised and Chennai is the city that counts the most engineering schools in India, so there are sources of knowledge available locally. The fragmented governance structure and lack of integrated analyses of hazards and socioeconomic vulnerabilities is the primary cause of water-related deficiencies. Among the various stakeholders, the Government of Tamil Nadu takes all major decisions regarding urban development and water infrastructures, and gives directions to all parastatal agencies to execute the projects in the specified area. At the same time, the influence of private sector actors has increased quickly to compensate for deficient water networks: the system of tankers is one of the main water sources for residents.

Meanwhile the role of NGOs and users associations in advocacy remains limited, and the empowerment of civil society would be required to favour more participatory governance practices. The effective participation of residents in decision-making would also require broader awareness with regard to climate and water related issues.

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