Policy exercise: Urban water security under climate uncertainty – Lessons from Singapore and implications for 'smart cities' design in India

Introduction

Cities are hubs of rapid population growth, intensive resource demands, environmental degradation, and greenhouse gas emissions.[1] Changes in key climatic variables such as rainfall and temperature and the occurrence of extreme events such as floods challenge the sustainability of urban systems, massive economic investments, and well-being of urban populations and settlements.[2] Among Asian countries, the most rapid urban growth is envisaged to take place in India, with the total urban population estimated at 590 million by 2030 from about 340 million in 2008. Severe challenges such as overcrowding, lack of basic amenities such as housing, water and power supply; water pollution; and waste mismanagement continue to threaten livability in Indian megacities such as Mumbai. In addition, coastal cities like Mumbai frequently face devastating floods due to changes in rainfall and an increasing risk of adverse effects of sea level rise on the city's water resources,[3] exacerbated by lack of proper city planning and drainage systems.[4]

The Government of India launched the Smart Cities Mission in June 2015 to develop 100 smart cities across India. Smart cities as defined by this initiative offer "good quality but affordable housing, cost efficient physical, social and institutional infrastructure such as adequate and quality water supply, sanitation, 24 x 7 electric supply, clean air, quality education, cost efficient health care, dependable security, entertainment, sports, robust and high speed interconnectivity, fast and efficient urban mobility".[5] Cities such as Singapore are increasingly being considered as a benchmark for smart city projects.[6] Management of the quantity and quality of water resources forms a major part of the desired characteristics of a smart city. One of the long-term challenges facing both Singapore and Mumbai is that of sustainable urban development and water resource management in the face of increasing climate change risks, as well as integrating climate resilience into urban planning. Addressing urban water security is a major challenge for urban policymakers as they need to consider how current and plausible new stressors are likely to change and impact water resources over longer time horizons in the future, and accordingly undertake anticipatory policy planning.[7]

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[1] Leichenko, 2011; Carter et al, 2015
[2] Satterthwaite et al., 2007; Tyler et al, 2010
[3] Mumbai: Climate risk and response. http://sdcenter.org/mumbai-climate-risk-and-response/
[4] Shah, V., 2015. Unlocking India's potential through smart cities. http://www.eco-business.com/news/unlocking-indias-potential-through-smart-cities/
[5] GoI, 2014
[6] Shahzad, O., 2015. Smart Cities: Solving Asia's Urbanization Challenges & Spurring Economic Growth. Singapore Summit, Global- Asia Confluence, 18-19 September 2015, accessible at https://www.singaporesummit.sg/2015/globalasia/articles/smartcities.html
[7] WWAP, 2012; Moore et al, 2014

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1) <u>Background</u>

Cities and Climate Change

Climate change has been recognized as a major challenge for policymakers because there can be multiple perspectives regarding the nature of the phenomenon and its effects, as well as appropriate solutions to address them.[8] Climate change is a global phenomenon with local effects, and there is a time delay between cause and effect.[9] In addition, if the action towards addressing climate change is delayed, it gets even more difficult to solve.[10]

Cities have a role in addressing climate change risk and impact by promoting low carbon development (through the use of renewable energy, energy efficiency, green buildings, and mitigating emissions from urban transport for example) and protecting the urban population and assets through resilient measures.[11] Building resilience in urban systems and populations requires the capacity to respond to a range of anticipated and unanticipated changes in the urban policy environment. Policy efforts in this direction are challenged by mismatch between the timescale over which urban planners operate (years to decades) and the over which the impact of policy decisions related to the urban environment will be observed (ranging from decades to a century) (see **Figure 1**).[12]

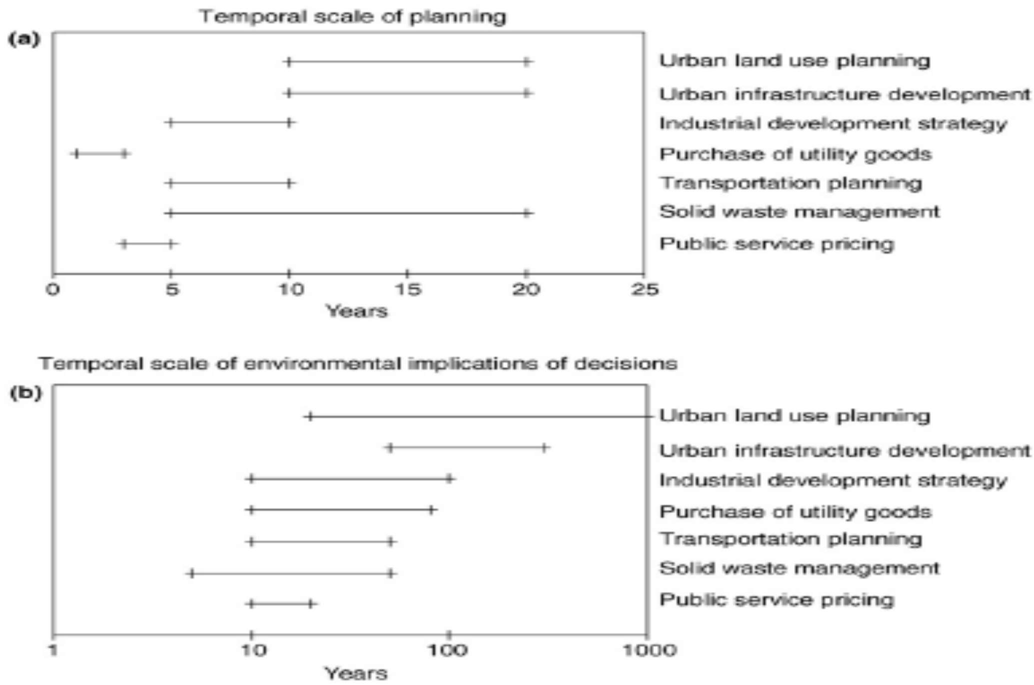

Figure 1: Timescales of urban decision making (a) temporal scale of urban planning and (b) temporal scale of environmental implications of policy decisions (Bai et al, 2010)

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[8] Rittel and Weber, 1973
[9] Schneider and Kuntz-Duriseti, 2002
[10] Levin et al, 2012
[11] DfID, 2010
[12] Bai et al., 2010

At the core of achieving sustainability in cities lies the health and well-being of the urban population. This in turn is dependent on environmental factors and phenomena such as climate change and quality of air, land, and water that are further influenced by subsystems such as urban functions, energy, waste, water, and institutional factors governing them, including urban governance, land management, legislation, financing, and public-private cooperation among others (see **Figure 2**).[13]

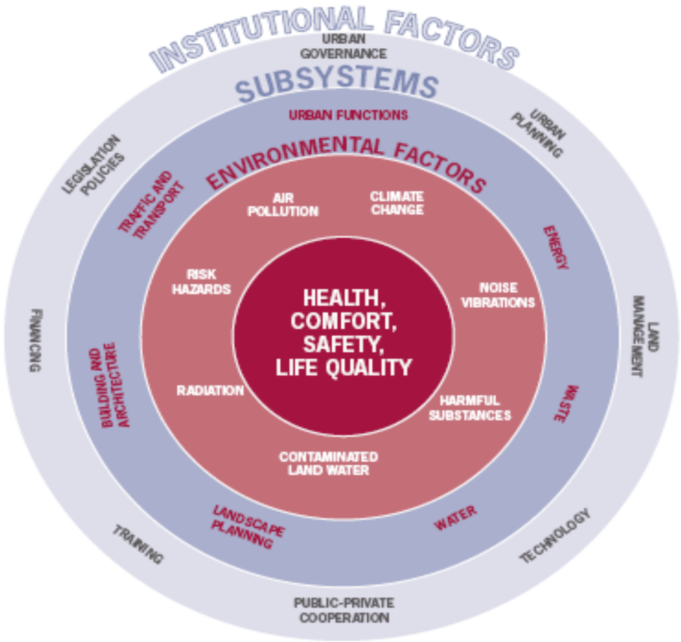

Figure 2: Factors that influence sustainability in a city (SIDA, 2007)

[13] SIDA, 2007

Changes in key climatic variables such as temperature and rainfall over the short- and long-term can give rise to urban hazards. **Table 1** summarizes the primary and secondary order impact on cities due to short- and long-term changes in climatic variables.

Changes in climatic variables	**Primary and secondary impacts**
Temperature extremes Rise in average temperatures of a region may lead to warm spells and heat waves	• Heat-related mortality - at high risk being the aged, those with pre-existing ailments such as cardiovascular and respiratory diseases and those with poor housing structures. • Increase in demand for water and impacts on air and water quality, and increased demand for cooling etc.
Heavy precipitation events (sometimes associated with cyclones and storm surges)	• Deterioration of the quality of surface and groundwater • Mortality, injury, water-borne and food-borne diseases • Flooding and water-logging • Disruption of mobility • Displacement of settlements • Damages to industry and infrastructure (including drainage, sewerage etc.)
Sea Level Rise	• Land inundation • Salt-water intrusion into groundwater aquifers • Impacts on coastal agriculture and livelihoods etc. • Displacement of coastal settlements • Damage to industry and infrastructure
Climate change may increase the frequency and intensity of **extreme events** such as floods and cyclones	• Mortality and morbidity • Damage to infrastructure, including communication channels, power supply etc. • Spread of water- and food borne diseases etc.

Table 1: Impact on urban systems due to changes in climatic variables (compiled from IPCC, 2007 and Prasad et al, 2009)

Megacities and addressing climatic risks: the case of Mumbai

Mumbai is the largest city in India with a population of over 22 million and a population density of over 20,000 persons per square kilometer. The city is made of seven islands separated from the mainland by the Thane Creek, Mahim River, and Harbor Bay. Mumbai houses Asia's second largest slum settlement, Dharavi, with an estimated one million dwellers.[14] Emergence of such informal settlements on public and private lands was the result of extreme land scarcity within the city.[15]

Coastal cities often expand by clearing natural buffer systems such as mangrove forests (that help protect the inland areas from saltwater ingress) and creeks (that form natural drainage channels for rainfall and storm water). Mumbai's urban expansion has similarly proceeded in this way, replacing natural cover with urban impermeable surfaces that impede percolation of

[14] Mumbai Population 2016. Accessible at: http://worldpopulationreview.com/world-cities/mumbai-population/
[15] Shaw, 2009

rainwater into the soil and drainage of storm water into the sea.[16] Coupled with its topography and a decrepit, century-old drainage infrastructure, Mumbai risks flooding every year during the monsoon period, and will be threatened by rising sea-levels. Large areas of Mumbai are reclaimed and situated just slightly above mean sea level. It is estimated that urbanisation alone has contributed to increased runoff in the city. Inadequate drainage systems are further impeded by urban encroachment and channel blockages.[17] Devastating floods in July 2005 brought Mumbai, which is also India's financial capital, to a standstill when there was 944 mm of rainfall within a 24-hour period. Over 1,000 lives were lost and the incident served as a warning for the local urban development and disaster management agencies to reassess the city's urban planning.[18]

The 2005 Mumbai floods witnessed the prominent role of civil society in initiating flood rescue operations (even before official rescue and relief operations could respond). Several innovative local solutions emerged, with groups of small-scale industry workers, scrap dealers, sanitary workers, and slum dwellers participating in many of the local rescue operations.[19] The strength of this informal sector included their resourcefulness, access to local networks in facilitating recovery (including familiarity with the alternative routes and lanes in densely populated slums), and deployment of quick low-cost options for public safety during the floods (for example, local automobile repair shops provided tyres to save people trapped in flood waters). Local groups were activated to distribute free food and provide temporary shelter for stranded kids and elderly in hotel ballrooms and bank offices. The urban government agencies also relied heavily on the informal sector for cleaning up, repair, restoration, and reconstruction of infrastructure, shelters, and other amenities following the floods.[20]

In the aftermath of the 2005 floods, structural changes were initiated at the city level to reduce the impact of future flood events. A network of 30 automated rainfall-radar-stations was set up to quickly identify high flood-risk locations in the city, along with a Doppler radar station for rainfall prediction and other technical infrastructure such as flood walls and emergency shelters. Regular cleaning of the drainage channels was initiated to increase their discharge capacities. The risk governance and disaster management procedures were reorganized to reduce the response times and enable effective resource management in case of extreme events. Use of information and communication technology (such as mobile phones for communication of weather aberrations, flood-risk zones, and related updates) in disaster risk management became an important part of local and city level disaster planning. Area-based approaches through local area management committees (earlier used for waste management) were deployed to create an information database and public awareness about extreme events at the municipality level by combining community-level information from local groups and informal sector as well as scientific information such as area-wise prediction of flood prone zones using Geographic Information Systems.[21]

Cities in India including Mumbai have also been part of large national urban development and renewal schemes such as the Jawaharlal Nehru National Urban Renewal Mission

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[16] Satterthwaite et al, 2007
[17] Ranger et al, 2011
[18] Mumbai climate risk and response. Accessible at http://sdcenter.org/mumbai-climate-risk-and-response/
[19] Butsch et al, 2016
[20] Parthasarthy, 2015
[21] Butsch et al, 2016

(JNNURM)[22] launched in 2005. Though JNNURM emphasized urban governance and decentralization of power to local governments, major urban governance challenges in Indian cities remain in terms of coordination of urban local bodies with state and national level urban agencies.[23] India's recent Smart Cities Mission is a major programme for urban development launched by the Ministry of Urban Development that aims to enable cities to apply information technologies to improve infrastructure and urban services. Key areas of focus include e-Governance and urban services, management of waste, water, energy, and urban mobility.[24] The development of the cities under this programme will involve a city-wide approach to improve the liveability of its residents through three area-based development measures, to be applied alone or in combination. This includes retrofitting of existing built space, redevelopment in areas with poor urban infrastructure, and 'greenfield' programmes, under which vacant spaces in the city will be innovatively developed.[25]

Despite additional water and flood-risk management measures being initiated, Mumbai continues to face future risk of severe flood damage, largely owing to persistent infrastructural and urban governance challenges.[26, 27, 28] Cities such as Singapore are increasingly being considered by megacities such as Mumbai as a benchmark for smart cities.[29] Management of the quantity and quality of water resources forms a major part of the desired characteristics of a smart city. One of the long-term challenges facing both Singapore and Mumbai is that of sustainable urban development coupled with water resource management while addressing climate risks and integrating climate resilience into urban planning.

Singapore's urban planning and water resource management experience
Recognizing its vulnerability to water scarcity and pollution threat to existing water resources, Singapore made massive long-term investments in Research and Development (R&D) to address these issues following its independence in 1965. Although Singapore received plenty of rainfall annually, the city-state had high water scarcity risk owing to limited land area for rainwater collection and storage.[30] The Public Utilities Board (PUB), a statutory board under the Ministry of Environment and Water Resources (MEWR), is in charge of water resource management issues in Singapore. R&D related to water resources in Singapore are managed through the Environment and Water Industry Programme Office which includes several agencies such as Singapore's Economic Development Board (EDB), other enterprise development agencies, and research institutes. A characteristic feature Singaporean government agencies is the adoption of a 'whole-of-government' (WOG) approach to policymaking whereby policy design and implementation are done in a collaborative mode across different agencies.[31] In the case of water resource management,

[22] https://mmrda.maharashtra.gov.in/jnnurm
[23] Hoelscher and Aijaz, 2016
[24] Beerman et al 2016
[25] WEF, 2016
[26] http://www.livemint.com/Politics/WwQ2
Pdc1FHU1POveJsWE0M/Why-are-our-cities-struggling-to-deal-with-water.html
[27] http://indianexpress.com/article/cities/mumbai/bmc-proposes-ways-to-manage-floods-flood-control-not-included-say-activists-2828151/
[28] http://indianexpress.com/article/india/india-news-india/a-tale-of-two-cities-4/
[29] Shahzad, O., 2015. Smart Cities: Solving Asia's Urbanization Challenges & Spurring Economic Growth. Singapore Summit, Global- Asia Confluence, 18-19 September 2015, accessible at https://www.singaporesummit.sg/2015/globalasia/articles/smartcities.html
[30] NEA, 2014
[31] PUB, 2012

this approach ensured that the development of all buildings and land area was integrated with the public water piping and drainage systems.[32]

Meteorological projections indicate that Singapore is at risk of adverse events with climate change, largely in the form of higher temperatures, increase in the frequency and intensity of heavy rainfall, and sea level rises.[33] To accommodate and address such risks to water resources, the PUB launched several innovative initiatives in water resource conservation and management. For example, in 2004 PUB adopted a 3 P (People, Public and Private) approach towards water management to encourage citizens to own and conserve water.[34] In 2006, the Active, Beautiful and Clean (ABC) Waters Programme was initiated as a long-term commitment to integrate Singapore's drains, canals, and reservoirs with public parks to create new green spaces for community use and recreation.[35, 36]

Singapore aims to achieve self-sufficiency in water resources by diversifying its sources of water. This diversified portfolio includes locally harvested rainwater, desalination, wastewater reclamation (locally branded as NEWater), and imported water. While imported water and rainwater harvesting may face supply uncertainties, NEWater and desalinated water offer more supply certainty.[37] The fifth NEWater factory is scheduled to be completed in 2016. Two more desalination plants will be added in the next four years. Investments in NEWater and desalination technology and infrastructure are aimed at buttressing Singapore's water supply from alternative sources to 85% by 2060.[38]

In addition, investments of about $2 billion have been made over the past three decades for developing and upgrading Singapore's drainage infrastructure. These efforts have resulted in a reduction in flood-prone areas from 3,200 ha in the 1970s to just 36 ha in 2013. Drainage infrastructure is designed to provide flood protection not just along pathways (i.e. drains and canals) but also at source (i.e. in areas generating storm water runoff) and receptors.[39]

Possible policy approaches in addressing long-term climate uncertainty

Urban governments have been continually developing policies to deal with likely impacts of changes in the climate on urban infrastructure and populations. While most government policies have been crafted in anticipation of events that are 'reasonably predictable', policy events can also be, 1) unpredictable, 'unforeseen' and 'unprojectable'; 2) catastrophic; or 3) impossible to anticipate because of associated moral and social issues.[40] While some

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[32] Ong, 2010

[33] Speech by President Tony Tan at the Opening Ceremony and Welcome Reception of the World Cities Summit, Singapore International Water Week and Cleanenviro Summit on 10 July 2016 at Sands Expo and Convention Centre. Accessible at https://www.nccs.gov.sg/news/speech-president-tony-tan-opening-ceremony-and-welcome-reception-world-cities-summit-singapore

[34] Tortajada and Joshi, 2013

[35] PUB's Active, Beautiful, Clean Waters (ABC Waters) Programme wins at Global Water Awards 2013. Accessed 18 July 2016, http://www.siww.com.sg/media/pub%E2%80%99s-active-beautiful-clean-waters-abc-waters-programme-wins-global-water-awards-2013

[36] 20 more ABC Waters projects to be completed in next 5 years. Accessed 18 July, 2016, http://www.channelnewsasia.com/news/singapore/20-more-abc-waters/2619600.html

[37] NEA, 2014

[38] Speech by President Tony Tan at the Opening Ceremony and Welcome Reception of the World Cities Summit, Singapore International Water Week and Cleanenviro Summit on 10 July 2016 at Sands Expo and Convention Centre. Accessible at https://www.nccs.gov.sg/news/speech-president-tony-tan-opening-ceremony-and-welcome-reception-world-cities-summit-singapore

[39] MEWR, 2015

[40] Day and Klein, 1989

projections about medium- to long-term future climate change are available, these are probabilistic in nature and not deterministic.

Under such uncertainty, how do urban planners and policymakers decide what plan of action to take or invest in today, given multiple plausible scenarios of climate change and also socio-economic conditions that can influence (and be influenced by) climate change?

One of the ways to classify policy approaches under conditions of uncertainty is based on the *nature* of the decisions being made (one-time/static or dynamic) and the type of actions being taken to address uncertainty.[41] This broad classification can generate five policy approaches:

1. **Do-nothing**: There is no policy until the impending uncertainty is resolved.
2. **Delay**: Maintain status quo while efforts are made to reduce or better characterize uncertainty by gaining more knowledge.
3. **Optimise**: Policymakers use 'best estimate' models to choose an 'optimal' policy.
4. **Static robust**: A robust policy or one that performs 'reasonably well' across most likely plausible future scenarios is chosen.
5. **Adaptive**: involves adapting the policy over time as conditions change and learning takes place.[42]

	Static policy		Dynamic policy
Change in the system	('optimal' policy approach) • Predict the future and implement 'optimal' policy for that future	(static robust policy approach) • Identify plausible futures and find policy that works acceptably well across most of them • Hedge against vulnerabilities/ contingencies	(adaptive policy approach) • Adapt policy over time as conditions change and learning takes place
No change in the system	(do-nothing policy approach) • No policy until the uncertainty is resolved		(delay policy approach) • Do more research • Negotiate with other parties for a consensus or compromise

Figure 3: Policy approaches under uncertainty (Augusdinata, 2008)

Under high future uncertainty, policymakers should also consider the likelihood of worst-case scenario, and factor in strategies that enable quick recovery or even radical reforms in current policy designs.[43] Under conditions of high uncertainty such as that associated with climate change and its effects, defining a single best solution may either be difficult or impractical. A 'suite of solutions' for different contexts may work better.[44] Policy-makers must learn to recognize early warnings or changes in the environment, especially as new information is discovered. Considering only 'no-regret' or safe policy choices in the short-term can delay timely preventive actions that could have avoided long-term adverse effects.[45]

[41] Augusdinata, 2008
[42] Swanson et al 2010
[43] Walker et al 2010
[44] Hallegatte et al, 2012; Pelling, 2010; Smith et al, 2010
[45] European Environment Agency, 2001

2) <u>The policy exercise</u>

The Government of India has been in dialogue with the Singapore government over the past year on technical cooperation and support for development of smart cities in India.[46] In this context, a policy brief needs to be prepared for the Ministry of Urban Development, Government of India, highlighting aspects of urban water security under climate change and its implications for megacities such as Mumbai and capturing lessons from Singapore's urban development experience and water resource management practices.

Similar to Mumbai, Singapore was built by reclaiming land from the sea. Mumbai is also a major hub of investments, has a high and rapidly increasing population density, scarce land area, is threatened by sea level rise, and its water availability and supply is under threat from climate change. A key challenge facing the Ministry of Urban Development, Government of India is to integrate climate resilient measures in megacities such as Mumbai, intended to become future 'smart cities' while enabling economic growth and sustainable resource management including water resources.[47] Mumbai faces challenges similar to those Singapore faced at independence in 1965. This includes the need to address basic urban infrastructural issues of sewage and drainage systems to prevent water logging and flooding. In addition, the federal structure of urban governance in India necessitates alignment of action between national, state, and local governments. Another issue relates to inclusion of the informal sector and marginalized communities residing in urban slums, and who are at high risk of flooding and who lack access to the basic urban services.

Please identify city-level options that can form part of an appropriate path towards urban water security and climate resilience in Mumbai. Also consider how policymakers might respond to long-term climate uncertainty, and what lessons they could draw from previous and ongoing efforts in Singapore to address climate uncertainty and water resource management.

Build a justification for the choices based on selected criteria and available information in the case and design strategies for the short-term (5-10 years), medium-term (15-25 years) and long-term (25- 50 years). Though a direct one-to-one replication of successful practices from Singapore's water and flood-risk management into Mumbai might be challenging, this policy brief should highlight what can be learnt about planning for climate uncertainty in Mumbai by studying the Singapore example given the risk profiles and urban governance structures in the two cities.

[46] Singapore in talks with India to help build new cities. Retrieved from https://www.mfa.gov.sg/content/mfa/media_centre/singapore_headlines/2015/201501/headlines_20150112.html
[47] http://www.dailypioneer.com/columnists/oped/smart-cities-are-climate-resilient.html

Key questions that the policy brief should address include:

1. What are the key similarities and differences in the risk profile and governance of water resources and flood risk management in Singapore and Mumbai?
2. What are the opportunities and challenges for transfer of practices and lessons from Singapore's experience with water resource and flood-risk management (both excess and lack of quality water resources for the urban population)?
3. What strategies can be adopted for water resource management and flood risk management in Mumbai?

Glossary

- Climate is described in terms of the mean and variability of temperature, precipitation and wind over a period of time, ranging from months to millions of years
- Climate variability refers to variations in the mean state and other statistics (standard deviations, occurrence of extremes, etc.) of climate on all spatial and temporal scales beyond that of individual weather events
- Climate change refers to a "change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

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Policy exercise: Urban water security under climate uncertainty – Lessons from Singapore and implications for 'smart cities' design in India (Teaching Note)

Teaching objectives and target audience

The target audience for this case is students of public policy and planning, including policy planners, practitioners and researchers, especially those working on urban issues. This public policy case has been developed to illuminate the challenges faced by policymakers while operating under risk and uncertainty i.e. formulating policies when the future is partly or completely unknown. The risk and uncertainty in this case refers to the current and future impacts of climate change on urban systems and populations.

The specific teaching objectives of this case are:

1. To give the students an opportunity to co-examine urban development and climate resilience policies in cities (with similar risk profiles) in a developing and developed country context.
2. To study and compare the risk management and policy planning approaches in the case cities while factoring various anticipated and unanticipated changes in the urban policy environment into the urban policy design.
3. To help the students gain an appreciation of the variety of risks and uncertainties that urban policy planners grapple with while designing long-term policies for economic growth, development and sustainability of the urban systems and populations.

Method for using the case

Introduction to risk and uncertainty

This case falls under the broad theme of risk and uncertainty management in policymaking. The instructor can start with a 5-minute introduction on risk and uncertainty to orient the class for the policy issue they are going to discuss. The idea is to encourage the students to appreciate the concept of risk and uncertainty in policymaking.

The introduction can include remarks on what risk and uncertainty means. A seminal paper by Knight (1921)[1] distinguished the uncertain future into that which is reasonably quantifiable and represented by probability distributions (risk) and that which cannot, as their distributions are unknown (uncertainty). In addition, while uncertainty often arises due to imperfect information, which includes wrong information or complete lack of any information to base the decision, the available information is also prone to multiple interpretations and diverse perspectives i.e. ambiguous[2]. Especially for environmental issues, uncertainties surrounding the choice of policy options, their consequences, confidence on available information and values of multiple stakeholders including decision-makers are not well characterized[3]. The instructor can elicit responses from the class by asking questions such as what is risk and uncertainty, how does it affect policymaking?

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[1] Knight, F.H., 1921. Risk, Uncertainty, and Profit. Boston, MA: Hart, Schaffner & Marx; Houghton Mifflin Company.
[2] Jones, B. D and Baumgartner, F. R., 2005. The Politics of Attention. Chicago: University of Chicago Press.
[3] Hansson, S. O., 1996. Decision Making under Great Uncertainty. Philosophy of the Social Sciences 1996 26: 369.

Introduction to the case

This can be followed by a brief explanation of the case problem as described in the Introduction section of the case study. In this case, the context is that of building 'smart cities' wherein the aim is to balance urban economic growth and development along with protection of the urban population and ecosystems from climate risks.

The instructor can set the tone for the case by discussing **Figure 1 & Figure 2** presented in the case. While **Figure 1** highlights an important challenge facing all policymakers, the mismatch between the timescale considered by planners and the actual timescale over which impacts of these policies will be felt in the urban environment (further impacting urban populations). The point to be emphasized here is that policymakers have to design these long-term policies with extreme caution as introducing a wrong policy or plan of action can have long-term repercussions which may not be reversible, may put the urban systems at high risk, and/or may be too costly to rectify in the future. Additionally, Governments may find it tough to invest in climate change mitigation measures because the returns are in the future and uncertain (whether climate change will be as bad as predicted; whether the mitigation measures will work as intended?), while the costs are incurred in the present and definite.

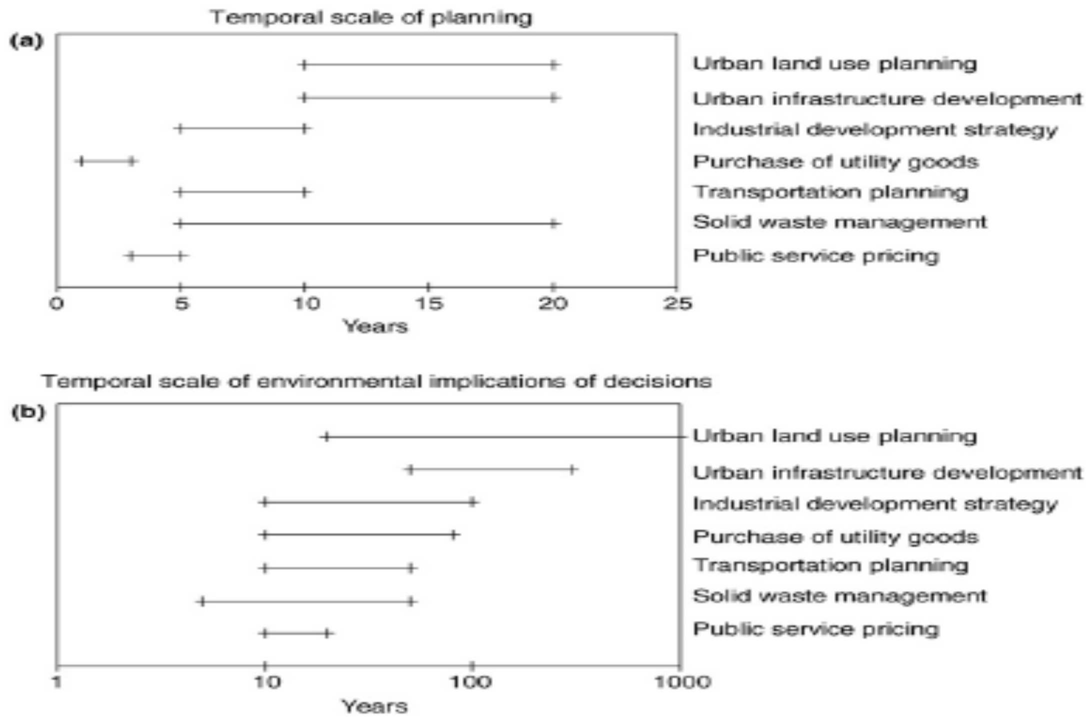

Figure 1: Timescales of urban decision making (a) temporal scale of urban planning and (b) temporal scale of environmental implications of policy decisions (Bai et al, 2010)

A brief discussion of Figure 2 is essential to help the students appreciate the components of a sustainable urban environment and their interconnections. An urban planner operates in this complex context and essentially needs to consider various environmental and socio-economic factors, subsystems and institutional factors while designing their policies.

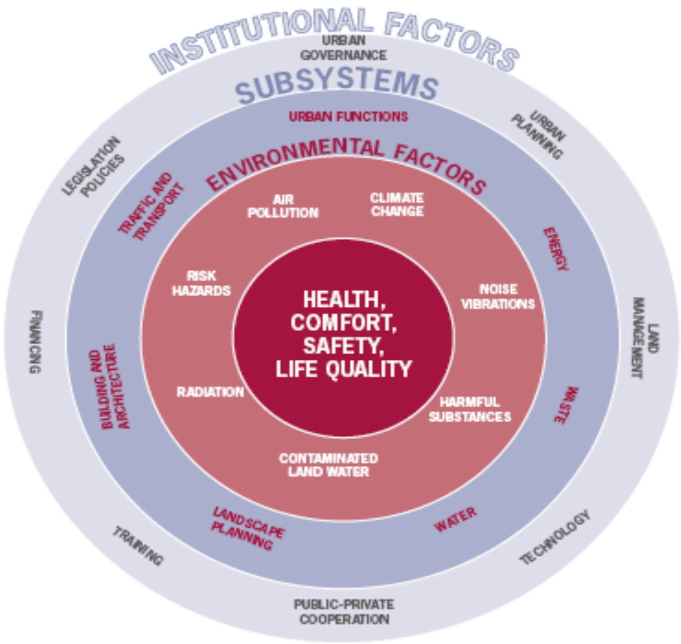

Figure 2: Factors that influence sustainability in a city (SIDA, 2007)

Class discussion and break-out group discussion

The case study can be discussed in two parts:

1. Firstly a class discussion is conducted wherein the instructor helps students assess the multiple options that governments might consider while responding to uncertainties in the policy context.

   In the case of climate change, delaying necessary policy response and adopting a wait-and-watch approach is not always a preferred or useful option, owing to the large-scale risks and impacts due to climatic change. The key questions around which the case discussion can develop include the following:
   - How does climate change create additional risk in urban areas?
   - Why do 'smart cities' need to consider climate resilience?
     - To avoid endangering large-scale economic investments
     - Timescale mismatch issue (Figure 1)
   - What are the differences and similarities between Mumbai and Singapore's risk profile and urban governance structure?
     - Whole of Government (Singapore) approach vs. federal governance
     - Civil society vs. Government driven action

- Choice and balance between technical solutions vs. Community-based action (lead onto discussion into aspects of how to engage the informal sector into responding to water security issues, citing the Mumbai 2005 floods example)
- Differences in response capacities of urban local bodies

2. After a class discussion, the students can be divided into two groups that discuss options that will work and not work for Mumbai while trying to emulate the Singapore model (in case the class size is quite large, multiple break-out groups discussing these two aspects can be formed). It would be good if each group can have at least one student from India and Singapore
    a. The students are also asked to select a group representative and given 20 minutes to discuss the options from their perspective and 10 minutes to present points in support or against each of these options.

Group1: What aspects of Singapore's urban water planning might work for Mumbai?

- What would be the design requirements and timeline for implementation?
- Preserve mangroves
- Issue flood advisories
- Improve drainage
- Introduce variation in options (Example of four water supply options in Singapore)
- Engage private sector, grassroots organizations and citizens?

In which categories do these options fall (No-regrets, worse case etc). One may notice that some options may be considered as doable and not-doable by different groups (discuss the evaluation criteria using an illustrative table given below):

Evaluation criteria		**Policy Options**			
		Continue business as usual	**A**	**B**	**C**
Cost					
Resourcing					
Stakeholder engagement					
Type of governance					
Intended consequences					
Unintended consequences					
Affected parties	**Winners**				
	Losers				

Table 1: Illustrative table with evaluation criteria for selected policy strategies (adapted from Nair et al, 2013)

A sample timeline for implementation of policy options may look like this.

Policy option	**Timeline**
Plug gaps in existing infrastructure/policies	Up to 5 years
Creation of new infrastructure	5 – 10 years
Community based measures	5 – 20 years
Radical changes in current policies and strategies	Up to 50 years or more

Table 2: Proposed timeline for implementation of policy options

Group 2: What aspects of Singapore's urban planning are unlikely to work in Mumbai?

- No slum areas in Singapore- how to include the informal settlements and marginalized population into decision-making?
- Urban governance approach different in both cities- what to learn from Singapore's whole-of- government approach?
- Unplanned urban planning in Mumbai, how easy is it to retrofit?

In the end the instructor should help students balance both perspectives. Debate can be facilitated by encouraging students to challenge and defend specific statements and choices.

Suggested courses for this case

1. MPA: This case would be very interesting to be discussed in an MPA course as the class largely comprises of officials with several years of experience in public administration and representing different countries in Asia. The general class discussion would be very insightful in this case as different students can present examples and experiences from cities in their own countries regarding the challenges and opportunities for urban planning and climate resilience. The class discussion is more relevant here and the break-out group session may not be as useful if most of the students are government officials.
2. MPP: The breakout group discussions, presentation and debate is highly encouraged in this class as the MPP students come from diverse backgrounds, and the group can bring out different perspectives to look at the same policy issue.
3. Urban policy/ risk management courses: This case can form a part of any of the electives that cover urban policy or risk management in policymaking.

Discussion Questions and Analysis

Take-home assignment

The students can present a broad analysis of any urban planning document in relation to climate risks and resilience in a city of their original residence or country, while considering the outline provided ahead. Students from Singapore or Mumbai can choose another Asian city.

Outline for Analysis

- What are the projected urban development and climate change scenarios for your city?
- Does your city integrate climate resilience into its urban planning? If yes, how?
- Present pros and cons of options considered in urban planning to address uncertainties in an urban environment.
    - What criteria govern the choice of these options?

Additional readings/references

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