road to
RESILIENCE

Synergy for Sustainable Cities

An Initiative By
Institute for Smart, Resilient and Future Cities

TARU
LEADING EDGE

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Synergy for Sustainable Cities

Previous book in the series:

road to RESILIENCE – a guide to leading a resilient life
2015
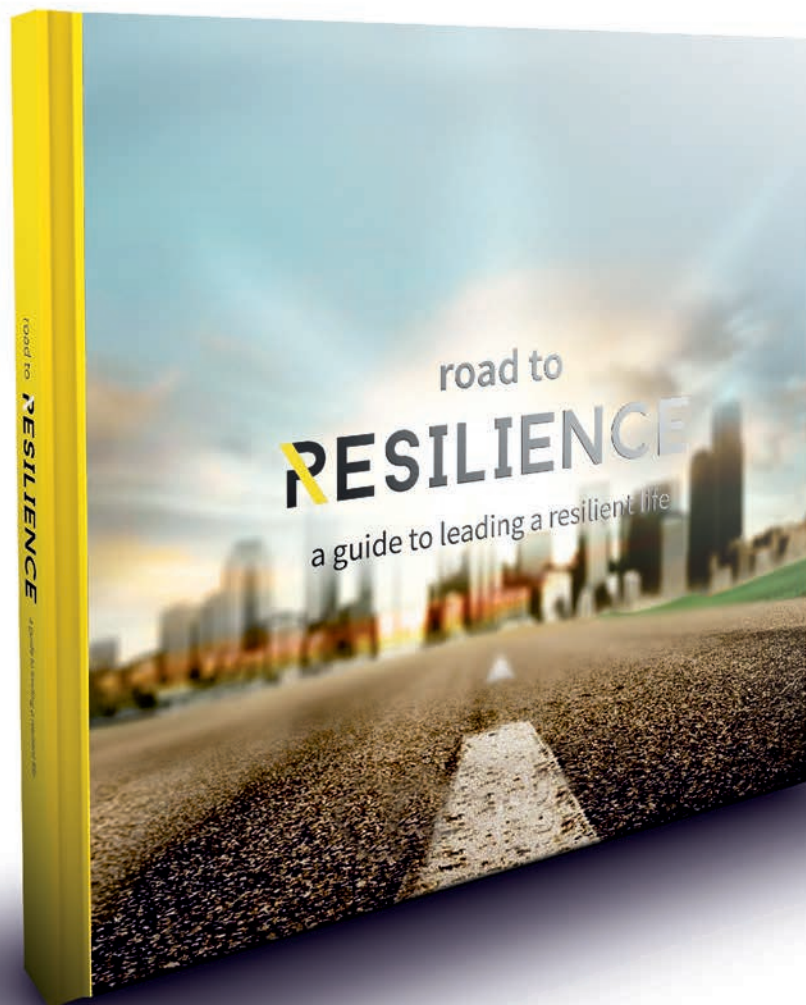
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RESILIENCE

Synergy for Sustainable Cities

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Foreword

The process of urbanization is built on the premise that large populations concentrated in cities can create economies of scale, increase efficiency of production, and foster an environment for greater innovation. While this remains the case, in many contexts we are witnessing a pace and pattern of unplanned growth in which the ecological footprint and resource usage of cities is far from optimal, and in which the benefits of improved infrastructure and services have not reached the poor. Cities have many challenges that cannot be addressed by bureaucratic solutions alone. Indeed, improving the quality of urban life and ultimately building more resilient and inclusive cities, will depend in a large part on the actions of millions of citizens.

We need to utilise a number of emerging opportunities to enable a constructive environment for increasing resilience and ensuring sustainability of our cities:

Changing resource use patterns: The assumption that there are sufficient natural resources to support cities, is increasingly threatened by the pace of growth and uncertainties introduced by climate change. Innovations and increasingly cost-effective technologies in areas such as decentralised solar energy and water recycling can be leveraged to improve resilience and build synergies across scales, while simultaneously reducing the impact on our ecosystems.

Leveraging information technology: Decision making needs to be grounded in smart, real-time data in an increasingly complex urban environment where trends and patterns are becoming harder to predict based on historical norms. Disruptive innovations in communication and computational technologies have become affordable and can help in understanding behaviour, unravelling complexity, and addressing legacy challenges. These big data sets can help in developing an anticipatory culture in cities, and transform the awareness of policy makers, citizens, businesses and other stakeholders.

Redefining stakeholder roles: We need multi-stakeholder platforms to enable a much more deliberative process of policy making in order to develop inclusive, resilient and sustainable cities. Complex urban management processes and transformative solutions cannot be guided by governments alone. We increasingly need concerted efforts to engage local communities, the private sector and civil society to create new partnerships to generate resilient urban economies and ecologies.

This book by Taru Leading Edge is the second in a series on the enormous urban challenges we face in the developing world. As with the first, it provides an optimistic vision that can be easily understood by different stakeholders, with a provocative perspective on how actors need to change in order to cooperate in new ways. This volume offers a range of proven, practical actions covering policy, implementation and monitoring systems that can be advanced collectively, and is written for multiple audiences with varying knowledge levels. As such it sets out a framework that can be adapted to diverse urban contexts across developing countries, advocating a blend of technological, institutional and social options to enable transformation towards sustainable cities. Most importantly, it continues in the vital effort of engaging stakeholders in an informed conversation about the future of our cities, and how we can work to increase the well-being of all who reside in them.

Ashvin Dayal
Associate Vice President and Managing Director
The Rockefeller Foundation

DO YOU BELIEVE THAT EVERYONE HAS A RIGHT TO SAFE WATER, CLEAN AIR AND A HEALTHY ENVIRONMENT?
YES _____ NO _____

DO YOU WANT TO REDUCE THE STRESS AND TIME SPENT COMMUTING ON CONGESTED CITY ROUTES?
YES _____ NO _____

DO YOU DESIRE A FRESH VISION AND COLLABORATIVE ACTION FOR A BETTER URBAN FUTURE?
YES _____ NO _____

DO YOU WANT TO BE PART OF THE CHANGE YOU DESIRE?
YES _____ NO _____

If you've answered **"yes"** to any of these questions, this compendium of actions for transforming our cities is where you need to start.

This is a handbook of actions
for those who are willing to
transcend the conventional
urban development models in
the quest to build sustainable
and resilient cities.

List of Abbreviations

AMC	*Annual Maintenance Contract*
BEE	*Bureau of Energy Efficiency*
BMS	*Behaviour Management System*
CPHEEO	*Central Public Health and Environmental Engineering Organisation*
CSR	*Corporate Social Responsibility*
EIA	*Environmental Impact Assessment*
GDP	*Gross Domestic Product*
GHG	*Green House Gases*
GIS	*Geographical Information System*
IEC	*Information Education and Communication*
IOT	*Internet of Things*
MIS	*Management Information System*
NMT	*Non-Motorised Transport*
PPTS	*Public and Para Transit Systems*
RE	*Renewable Energy*
SME	*Small & Medium Enterprise*
SOP	*Standard Operating Procedure*
STP	*Sewage Treatment Plant*
UHI	*Urban Heat Island*
WLTSC	*Ward Level Technology Support Center*

How to Use the Book

Title of the action.

Urban problems addressed by the action.

Quotes for the particular action.

About the action.

Broad actions that need to be performed.

Collaborating stakeholders for the action.

How the action relates to other sectors.

What individual stakeholders can do.
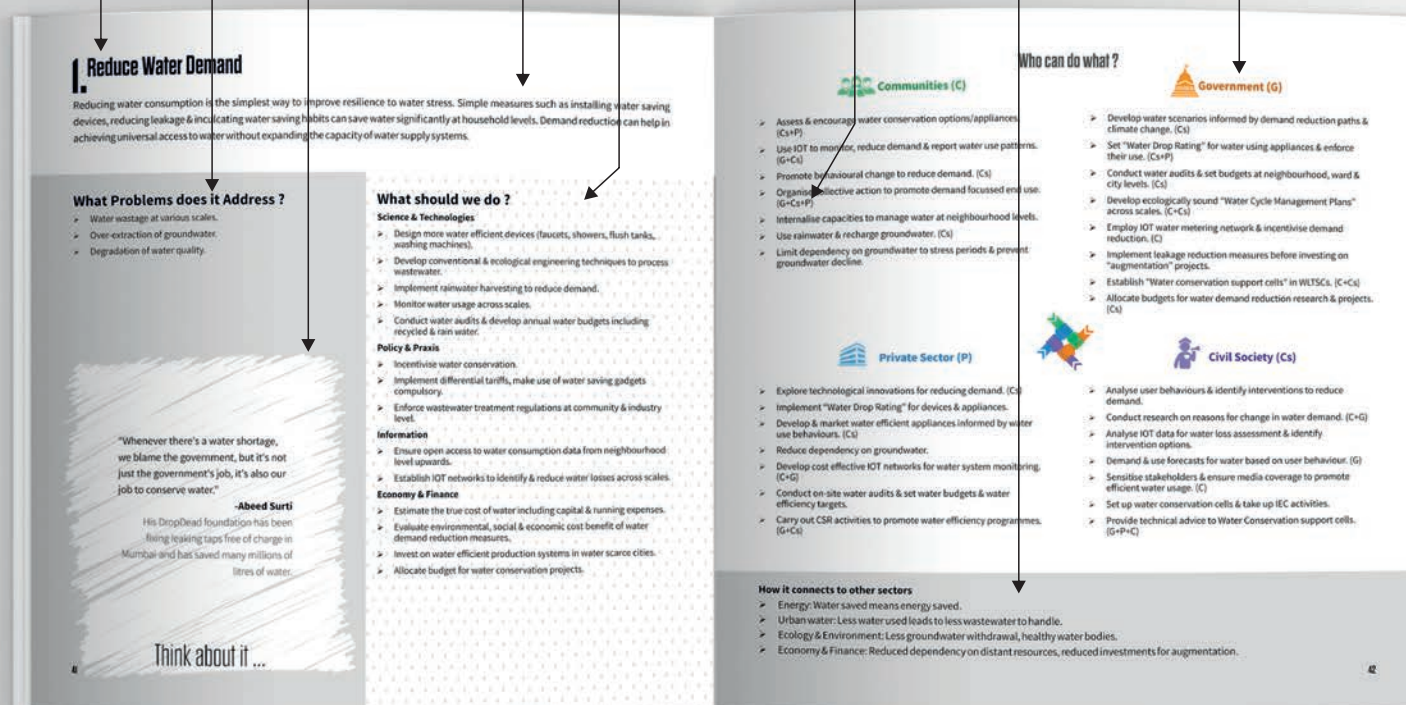
The real wealth of the Nation lies in the
resources of the earth soil, water, forests,
minerals, and wildlife. To utilize them for
present needs while insuring their
preservation for future generations requires a
delicately balanced and continuing program,
based on the most extensive research. Their
administration is not properly, and cannot be,
a matter of politics.

- Rachel Carson

Preface

India is a land, water and energy hungry country. Over the last one century, we believed in unlimited natural resources despite facing a growing population and shrinking per capita land, water and energy availability. Without understanding these limits, 24x7 water and energy supply and universal access will remain a pipe dream.

We need to first define sustainability, smartness and future readiness of cities in Indian contexts. For being sustainable and smart, we need to learn how to live with what we have, without damaging our ecosystems and environment, by restoring and conserving natural resources and learning to recycle and reuse.

Climate change and urbanisation lead to uncertainties, and increasing extreme events impacting our lives, as evidenced by Surat, Chennai, Srinagar and Kedarnath floods and also one of the worst droughts of central India in 2015-16. We need to anticipate these uncertainties and build resilience by incorporating these lessons in urban development and management strategy.

It is necessary to stop demanding that the government provide subsidised services, instead we must take active roles in managing our basic lifeline services and managing our wastes. The governments themselves should learn to stop taking more responsibility than what they can deliver, and instead create spaces for other stakeholders to contribute to make our cities better places to live.

Sustainability is no more the domain of the city administration alone, but everyone's business. As we enter the age of miniaturisation and intelligent devices, it is now increasingly possible to ensure that our water, energy and food production systems and our urban management strategies are realigned to actively engage citizens, civil society and the private sector. We should develop an anticipatory culture in this age of disruptive innovation and avoid getting enamoured by new technologies, without understanding their pros and cons.

Increasing symmetry of information and evidence based decision making must be given space to make our cities more liveable and sustainable. The sensor and big data layers needed can only be built above a rugged city infrastructure and services layer. The city infrastructure layer must respect the natural rules of land, climate and ecosystems. As Chanakya said, the person building his house in the floodplain or one who has a snake in his house cannot sleep in peace.

We do not have a large burden of retrofitting a legacy infrastructure, as there is much more to be designed and built. We require an innovative mindset and the willingness to engage all stakeholders in building an inclusive and sustainable future.

Glimpses of Gadbadganj

Gadbadganj grew from a laid-back town to a sizzling metropolis in a matter of years. Rural folk from villages were either lured to it by the promise of opportunities or driven there by their shrinking of livelihood options. Escaping the fragmentation of land ownership and the alternating sequence of droughts and heavy downpours, most of them were unable to afford formal houses and were forced to stay in risk prone areas of city, increasing the slum population by about 5 percent over the last decade. With joint families, no longer in vogue and each nuclear unit wanting their own space, the well-heeled too spread out, resulting in more houses, and larger houses. But all these citizens are affected by the maladies that affect Gadbadganj, diseases and climate extremes do not respect boundary walls, however expensive those may be.

one end and expenses on the other. A plethora of problems, including apathy and vested interests ensures that the water metering system is dysfunctional. While the water is insufficient, it is also every now and then polluted by untreated sewage. The residents of Gadbadganj live a low quality but expensive life frequently disrupted by water and vector-borne diseases.

The Gadbadganj citizens don't want to soil their shoes with mud, so they have ended up covering nearly every square inch of their colonies with cement and concrete. The municipality has pitched in, building impervious roads, cutting trees and eliminating verges to expand roads. With no natural drainage, the roads of Gadbadganj transform into canals every time it rains. Outstation relatives plan their visits during the drier seasons to avoid wading through waterlogged streets. As the land prices increased, it was profitable to fill lakes and extend the city into the flood plains. When the area stolen from the rivers faced inevitable floods, the government built embankments to protect the risk prone areas from the river water. Gadbadganj has effectively jacketed the river. The city now gets more intense floods even when there is less water flowing into the river.

As the demand for water exploded, more reservoirs were created and longer pipelines were built to carry in water from increasingly distant sources, yet every summer Gadbadganj finds the spectre of water scarcity looming ahead. Those who have a piped water supply get intermittent water and the benefit of subsidies, others get nothing except the promises that are handed out before elections. Some businesses and homes depend on tankers to meet their needs. Others rely on borewells that go dry in few years. There are some who need to line up for hours for a pot of water. Maintenance and expansion of the pipeline network suffers as the cash strapped urban local bodies (ULBs) find it difficult to strike a balance between the subsidies on

A few dams were originally built for irrigation and power, but now Gadbadganj cannot live without them. Climate variability is a new gorilla in the boardroom, and nobody knows how to deal with it; the dam managers are in a dilemma, they must choose between storing water for summers, or releasing it to avoid dam breaks. Often, they end up creating floods in good rainfall years and need to curtail water to the city in summers. The original concept of protective irrigation is lost and farmers in the command area happily grow water intensive crops such as sugarcane and demand more water depleting scarce reserves.

Gadbadganj remains chronically short of electricity despite the increase in generation capacity. Those who have access get the intermittent power and benefit of subsidies, while the poor must invest on coping strategies, pay fines for informally tapping the lines but receive no subsidies. In summers the urban heat islands amplify increasing temperatures, those who can afford it remain in air-conditioned cocoons drawing more and more power, and install large generators for back up. When the monsoons are delayed, there is a surge in power demand as farmers resort to pumps for sowing crops, resulting in regional power breakdowns, impacting railways, hospitals and lifeline services equally.

Every day people in the city travel increasingly greater distances to earn their bread, not unlike hunter gatherers of the desert facing impacts of climate change. As the public transport in Gadbadganj is unsatisfactory, increasing numbers of private vehicles are inevitable. Many create two "houses" for their cars, one at home & another at work. Others end up parking on the roads, obstructing others. People buy bigger and more comfortable cars with music to help them maintain their cool in the growing traffic jams.

When the population of Gadbadganj reached 1 million, flyovers became necessary and when the population doubled, there were regular traffic jams on the flyovers. The city's public transport planning was unable to catch up with the change, and Gadbadganj's long-delayed metro service was overcrowded from the very first day it opened.

In the 1970's Gadbadganj's urban planning was based on low rise, high density settlements and single use zoning. The neighbourhoods built in that era had no car parking spaces, but now the lanes of Gadbadganj are tightly packed with cars staying overnight. The earlier middle class neighbourhoods have deteriorated with few trees and narrow lanes. The new paradigm of transit oriented development cannot be retrofitted to these core city areas, without serious "reconstructive" surgery requiring land acquisition from many residents. Adding to the city's woes, real estate companies have made a killing buying up houses and converting them into multi-storied flats with total disregard to the lack of sufficient access roads and the decrepit water and sewerage infrastructure which were built for much lower demands.

The pursuit for increased consumption has led to an increasing problem of solid waste accumulating on stinking street corners before it is eventually cleared by contractors. The growing mountains of garbage occasionally catch fire and the lungs of Gadbadganj accumulate the sins of a consumerist society. When air quality deteriorates, the municipality issues orders to shut down generators. When there is no improvement, they look around to pass the buck to neighbouring states for adding to the air pollution, but none know how to really deal with the polluted air.

The urban risk calendar here is already full. The famed city of dreams is a merely myth for the poor and migrants burdened by heat, beleaguered by power cuts and mosquito bites. The media eagerly waits for monsoons to catch the breaking news of floods, Dengue, Chikungunya and Malaria. Long acrimonious media debates are often not informed by sufficient evidence or knowledge about the sources and scales.
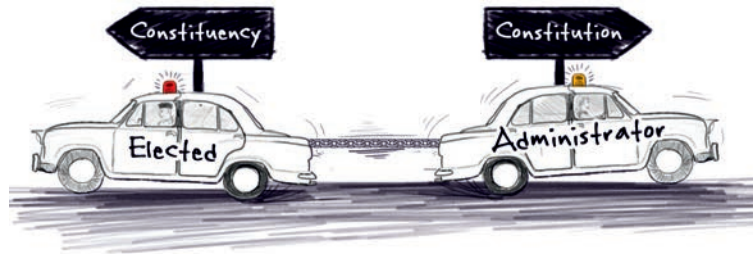
The Gadbadganj municipality is torn between two managers, the administrative system and the elected body. The masterplans are too often violated. The flyover designs are manipulated to suit the interests of influential people, resulting in traffic bottlenecks. Celebrated green belts are only seen on legacy maps shut away in inaccessible cupboards. The municipality has numerous responsibilities, but too few managers and must rely on their mostly unskilled and semiskilled workforce. It faces major capacity constraints to plan and manage, leave alone anticipate demand growth and take preventive measures. Despite the 74th Amendment, Gadbadganj still does not have full control of funds, functions and functionaries. Core functions in new areas have been shelved off to parastatals such as the Gadbadganj Urban Development Authority (GUDA) and water supply & sewerage board. The municipality has been left saddled with drainage and

other non-paying services. The new peri-urban areas developed by GUDA was transferred back after the real estate was sold and the unsatisfactory systems became a new burden for the Gadbadganj municipality. Fragmentation and overlapping roles are a rule. Asymmetry of information between the municipality & real estate on one side and the citizens on other side sustains and strengthens the parallel economy.

His bid was the lowest Sahab.
Also, he is a reputed builder here.

The glittering multi-storeyed buildings hide the poverty of the municipality, which is forced to rely on funds from national flagship programs. These programs come with attached generic policies and guidelines, which often do not address the context of Gadbadganj. Somehow it seems no new national program is informed by the bitter lessons learnt from the previous. The city has ended up as proud owner of buses, which mostly stay in the garages due to lack of funds for maintenance. One much-loved and publicised housing project for the poor, is mostly unoccupied, another has ended up as multi-storeyed slums far away from the city. Since the residents must come to the central city to earn their livelihood they spend must spend

precious time and money on the long commute. The city managers visited Brazil recently and say that the Favelas have better urban services than the Gadbadganj's middle class colonies. The expected outcomes last only up to the program closure. The experts design and launch rehashed national government once again, which also face the same fate of the previous ones.

Market players offer "amazing items" that they claim have transformed many cities in another half of the world. Gadbadganj has bought many a new software and hardware, it is the proud owner of many generations of GIS, MIS and BMS[1] software, hydraulic road and sewer cleaning machines. But while the sellers are laughing their way to the bank, the costly purchases are locked up safely in rooms and garages and the software is unused. The municipality has neither skilled staff nor money to maintain or update them. The growing scale and complexity of the challenge is such that problems cannot be fixed with packaged solutions.
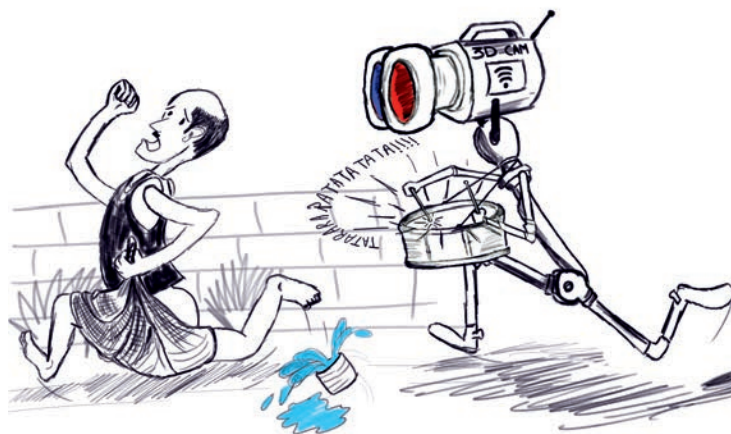
The most recent program to pass through Gadbadganj was called "Informed City", and promised to manage the city's lifeline services (and people's behaviour) from a centralised control room. A component of this programme was to stop open defecation by using a system with integrated video cameras, full body recognition software and automatic drums. This much-touted system was supposed to recognise the squatting people from a 3D full body database of ID cards, respond by beating the drums, and send a notice for paying a fine through a mobile phone app. This initiative

[1]Behaviour Management Systems based on artificial intelligence and mind plasticity

did not bring any benefit, and a small article tucked away in the paper said that even if the system actually worked, there was no database for most of the migrant people. When the city flooded in the monsoons many CCTV cameras became dysfunctional and the city continues to be as dirty as it was before.

The literati are discussing the introduction of autonomous cars. But some wonder what kind of traffic jams will occur when people, cows and dogs can quickly learn they can confidently cross roads anywhere, secure in the knowledge that the "intelligent situation awareness" software will stop the car when it notices any obstruction.

Experts continue to visit the Gadbadganj to hawk their esoteric next generation solutions, Gadbadganj grasps at them, more out of a desire to be seen to be acting rather than out of hope of success. Surprisingly simpler solutions such as collaborations and community level initiatives are not much in favour as signing a cheque is probably easier. It looks like a physician applying an improved version of expensive bandages on a cancer patient who hopes for a permanent cure.

Just like the municipality, the media and civil society, pulverised by twin stones of daily routines and financial targets, appear incapable of evolving the long-term vision required to ferret out answers to current challenges. Admittedly, many initiatives were taken, but they never got much further than initial feeble attempts. Thus, the man on the street in Gadbadganj has developed a fatalistic mindset that may be in tune with the doctrine of karma but it hardly helps make his city more liveable.

As soon as he starts earning, he buys health insurance, hoping to be protected from hospitalisation expenses. Insurance companies prey on his fears to lighten his pockets. There are smart solutions to healthy living galore, with advertisements for gym memberships, supplements, purer water, and air purifiers offering promises to a healthier life. Yet the urban diseases will still probably rob him of a decade of his effective life.

There are more effective ways of tackling environmental problems including global warming, proliferation of plastics, urban sprawl, and the loss of biodiversity than by treaties, top-down regulations, and other approaches offered by big governments and their dependents.
- Preston Manning
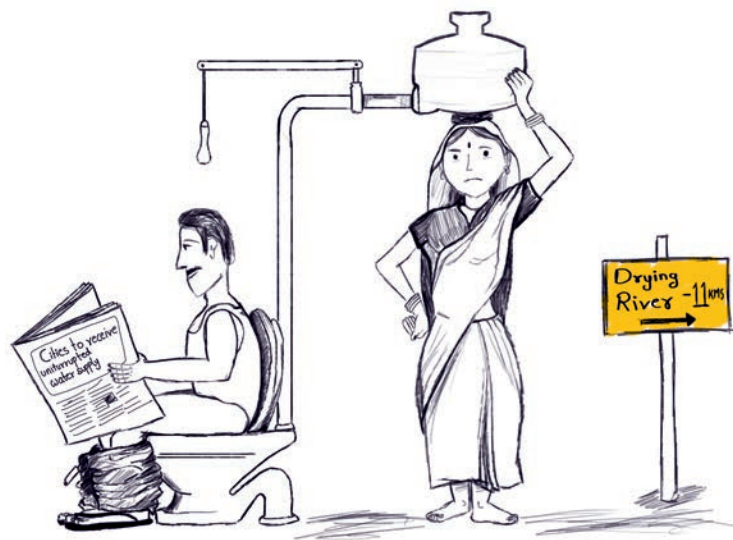
With a large gap between demand and supply, no short-term measures seem to work. Countless person-hours are wasted each day for managing water, energy and mobility needs. Those who can afford to pay, continue to enjoy better services through ad-hoc arrangements, creating mini-utilities for water and energy in gated communities and houses, while the majority copes with scarcities. Self-serving, individualistic behaviour and solutions lead to neglect and collapse of the city services. There is mistrust between different groups and within the groups, so no collaborative actions can be undertaken. The muted suffering of the majority is broken by occasional protests that clog the roads for few hours, and when the sun sets, the protestors disperse, the cause is soon forgotten. Gadbadganj continues the same downward spiral of deteriorating quality of life, as the challenges spin out of control.

This story is a synthesis of two decades of a common man's observations in cities across India. No single city may have faced all the misfortunes described here, but many readers will acknowledge that they have seen and experienced these miseries in their own city. The stresses and shocks described in the imaginary city of Gadbadganj are stark reality for millions of urban citizens. This book tries to explore steps towards working together and creating a new paradigm for the cities we would like to live in.

2. Paths to Transformation

Life in the Time of Urbanisation

Over the last one century, the average human lifespan has increased and quality of life has improved due to major advances in medical technologies. Drudgery in primary activities such as food production has reduced significantly. The need for labour in agriculture and related activities has decreased at the cost of increased use of energy. The shift from primary towards secondary and tertiary activities has led to large-scale urbanisation. As the global population increased from about 1.6 billion in 1900 to 6 billion by 2000, the per capita availability of renewable land and water resources reduced proportionately. The urban population has increased from 1 billion in 1960 to 4 billion now and it is expected to exceed 6 billion by 2050.

We are Guzzling Resources

Urbanisation results in huge demands for water, energy, food and materials to support the people concentrated in thousands of cities across the globe. The environmental footprint of cities expands as they increase resource extraction from distant regions and produce large amounts of waste, impacting the land, rivers, oceans and atmosphere.

We require about 0.4 million sq.km (or 12% of India's geographical area) to house the world's urban population considering a density of 100 people per hectare. It will require 5 countries of the size of India (or the geographical area of Russia) with 1,000 mm of precipitation to provide the 4,000 cum/year of water necessary to support the population excluding the ecological flows necessary to maintain our hydrological systems. Once-through water, energy, carbon and mineral systems (without reuse) are not only unsustainable, but also threaten our water, air and land on an unprecedented scale.

Birth of the Anthropocene Age

It was a sad day when the Earth's atmosphere crossed 400 ppm of carbon dioxide and unfortunately neither we nor our children are going to see the world below 400 ppm again. The impact of increased greenhouse gases is evidenced by increasing global temperatures, uncertainties in precipitation patterns, and rising sea levels. The rapidly increasing signature of human activity on earth systems has led scientists to define an "Anthropocene Age" starting from the year 1950.

The driving human forces responsible for many of the anthropogenic signatures are a product of the three linked force multipliers: accelerated technological development, rapid growth of the human population, and increased consumption of resources[2].

As the global temperatures and rainfall patterns are becoming increasingly unpredictable, we have no option except to get ready for an uncertain world. It has become imperative that all of us work together to minimize our environmental footprints and adverse impacts of climate change.

The Times they are Changing

Today's urban planning still relies on the old paradigms of availability of abundant resources and land, whereas we need to learn to live with increasingly less per capita resources in an age of growing aspirations and fast changing livelihoods. As the cities are increasingly becoming dependent on complex physical and virtual networks, the conventional land use centered planning is unable to integrate these networks in modern cities. Simultaneously the centralised grid based utilities are increasingly challenged by decentralised production and recycling systems.

As the cities grow they need increasingly complex networks to manage adequate resource and information flow. As the complexity increases, the municipality led conventional planning and management is increasingly challenged. As city utilities are unable to cope with the demand, those who can afford install mini utilities at house and colony levels to convert intermittent supplies to 24x7 systems. Inability to fulfill increasing demands and manage the treatment of wastes has created growing inequity and "poverty of lifeline services" for many.

Several major disruptions such as cars, computers and cell phones have radically changed the ways we can manage our urban systems. Towards the end of the 20th century, miniaturisation of

[2]*Water et al 2016: The Anthropocene is functionally and stratigraphically distinct from the Holocene. Science Vol 351 Issue 6269*

devices has made it possible to manage water and energy more efficiently at the household and the neighbourhood levels if they are connected to the grid. The next generation of innovations will enable the consumers to become "Prosumers" (both producer and consumer), as decreasing capital costs can make decentralised solar energy and water recycling systems accessible. Cities such as Singapore have proved the feasibility of managing limited resources without sacrificing the quality of life.

Disruptions in information and communication technologies increased our ability to model and manage complex systems, global supply chains and less cash intensive financial systems. They also reduced the turnaround times of processing and communications. These technologies have enabled aggregation of manpower, infrastructure, and resources as exemplified by taxi aggregators. Advances in biotechnology, electronics and artificial intelligence are causing major disruptions in diverse sectors such as agriculture, health, waste recycling and mobility. For example, autonomous cars can make disruptive changes in mobility through a shift to buying "serviced kilometres" instead of buying private cars, thereby reducing the total number of vehicles needed in cities. The disruptions are also causing snowballing impacts across sectors such as urban planning, lifeline service utilities and even insurance. As human functions shift to increasingly intelligent machines, capital and technology is poised to replace labor on a large scale. Consequently, an increasing number of people will face unemployment and concepts such as "universal basic income" are being floated by governments.

Social networking technologies are influencing public opinions as well as political and administrative systems. The concepts of "right to information" and e-governance have been taking root in urban management systems. The information asymmetry between the public and the governance structures is rapidly reducing and triggering mass movements (such as, Arab Spring, "Color Revolutions" and election surprises) against existing institutions, secrecy and corruption. Political and administrative systems are gradually being forced to become more transparent and inclusive. The efficiency of urban systems is the net outcome of millions of

humans interacting with the environment, infrastructure and information systems. To increase efficiency and resilience, reduce wastage and maintain the quality of the environment, it is necessary to conserve and use tap local resources. It is necessary to build circular economy of water energy and materials to reduce environmental footprints. These will facilitate increase in autonomy across sectors, scales and stakeholders, build synergy and ensure sustainability of the urban systems.

Tools for an Anticipatory Culture
Disruptions are going to be the reality of our future. They are going to change not only our lives but also the earth's hydrology, atmosphere and ecosystems. With major advances in ICT and space technologies, we can monitor the changes and impacts of our actions on the earth and its subsystems. We can also model future scenarios using tools such as bio-geochemical, atmospheric, economic models and choose paths without having to resort to knee jerk actions. These scenarios and models can be effectively used in urban planning and management.

Concepts such as biomimicry, cellular automata, artificial intelligence and multiple agent systems are being developed to understand the behaviour of complex systems intermediated by nodes/agents with diverse goals and varying degrees of autonomy. They can also help us to anticipate and minimise mid-course corrections or maladaptation. These tools can help in developing an anticipatory culture and building resilience.

Synergy across Sectors
Traditionally the management of water supply, sewerage, and storm water drainage is entrusted to separate departments. Opportunities for recycling, and building a circular economy around water, energy and materials are lost due to the lack of a holistic approach to manage these closely interconnected functions. In urban systems, water and energy are highly interdependent and need to be addressed together. There is a huge potential for growing part of the city's food requirements by integrating water recycling with urban agriculture. Vegetation cover and urban agriculture can reduce the intensity of urban heat

Circular Economy

Riffat et al. Future Cities and Environment (2016) 2:1

Urban Farming → Food → Domestic Usage

Fertiliser

Domestic Usage → Liquid Waste

Domestic Usage → Solid Waste

Liquid Waste → Water Treatment → Clean Water

Solid Waste → Gastrification → Bio Gas

Solar Energy

Bio Gas → Energy Generation

Solar Energy → Energy Generation
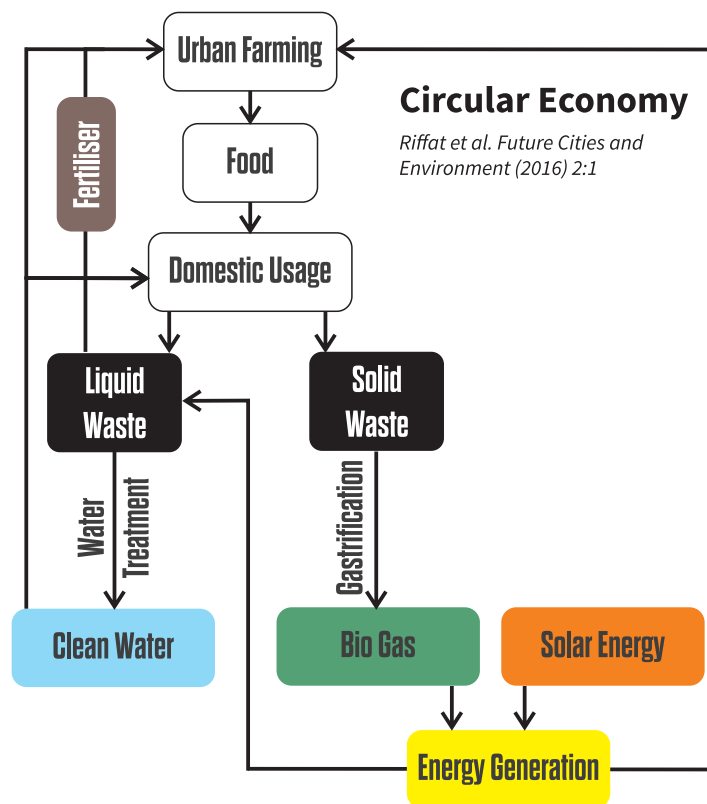
islands. Understanding the urban metabolism and integrating water energy and biomass can increase the efficiency of urban systems.

Synergy across Scales

A city is a complex system, it is now possible to develop significant autonomy at neighbourhood levels and build a circular economy of decentralized water, energy and waste recycling systems. This will lead to a much-desired reduction in overall resource footprints. A disruptive shift from once-through centralised service grids is now a reality through miniaturised generation, process and control technologies. Clean disruptive technologies such as green buildings, solar energy, storage cells, autonomous cars and wastewater recycling can make neighbourhoods nearly autonomous. We need to build local institutions at different scales to harness the power of these technologies and processes at every scale. Our first book "road to RESILIENCE – a guide to leading a resilient life", explored technologies to increase autonomy of

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lifeline services at household and neighbourhood levels. This book explores how these processes can be integrated at city scales through synergistic multi-stakeholder engagement.

Synergy amongst Stakeholders

The cultural theory provides a workable framework to classify the stakeholders into four groups based on social stratification and social bonding. The interactions between these four groups namely; Hierarchists (government, trade unions), Egalitarian (civil society, academia and media), Individualists (private sector, real estate sector, entrepreneurs), and Fatalist (unorganized groups, poor) decide the quality of the urban environment.

Our dreams stop at our doors when we refuse to take responsibility of creating the habitat we desire. We use social media for chatter, but do not engage with others to build a collective vision for our cities. The dysfunctional cities that we see today are the result of the excessive reliance on hierarchists (ULBs) for urban development and management, with other stakeholders behaving independently. This book explains how synergistic cities can be created by orchestrating coordinated efforts between the four types of agents in a 21st century context. It also explains the potential roles each one of them can play and how the groups can work coherently to build more sustainable urban systems.

Time to Transform

We have been externalising the responsibility of management of our urban lifeline services to the ULBs, while using technology disruptions to maximise individual benefits without bothering to optimise collective good for all. This is the root of many a malaise of our urban systems, be it water, energy, mobility or quality of life. Unfortunately, all our lives are closely interlinked and what we do impacts others just as what they do impacts us. Diseases, pollution and resource scarcity collectively impact our cities and us. With the oncoming clean disruptions, there are opportunities to be more efficient and take greater responsibility of managing our neighbourhoods, and joining hands to improve our cities.

It is time to rethink what type of habitats we want and how we can

manage them sustainably. We may need to let go of the past, learn new lessons and see them through the filters of quality of life and sustainability. We must ensure that our children inherit a clean and happy earth, where life is an enriching experience, free of worries about pollution, scarcities and risks. We will need to work together, reflect and collectively adapt to a changing world. At the end of the day, we have only one planet and we belong to it. This book provides paths to build synergy between scales, stakeholders and sectors. This only a primer, and we must observe, learn and adapt as the journey continues.

Synergy Amongst Stakeholders

More social stratification/rules

Grid +

Communities (The Fatalist)

Government (The Heirarchist)

Less social bonding

More social bonding

− +

Group

Private Sector (The Individualist)

Civil Society (The Egalitarian)

−

Less social stratification/rules

Adapted fromThompson M. et al,1990
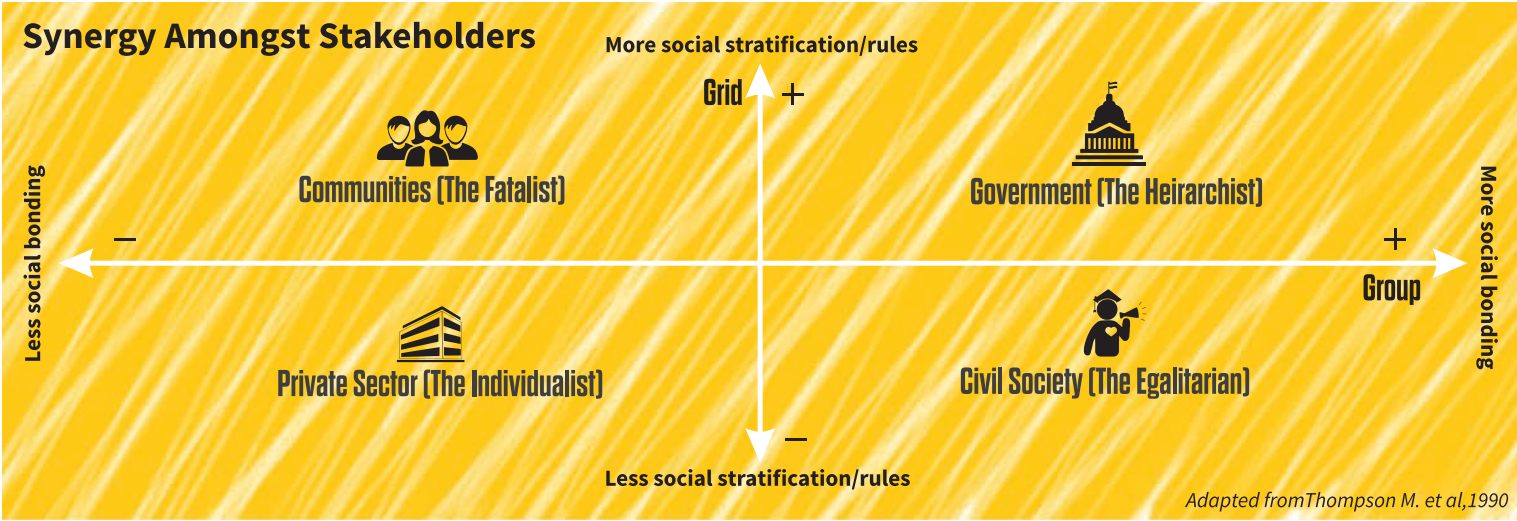
Synergy Across Scales

A=Action; Ad=Advocacy; F=Finance; I=Innovation; P=Policy; R=Research

			Academic/Research institutions (I,P)	Bird watcher/ Urban agriculture groups (A)	Media (Ad)	Private sector (I,F)	Environmental groups (A,Ad)	Civil society organisations (A,P)	Faith groups (A,Ad)
Basin/ State Level	Pollution control board, Water resource dept., Regional planning organisations (P)								
City level	Municipality (P,A)								
Ward/ Micro-catchment	Ward level committees (A,Ad)	Lake conservation groups (A)							
Colony/ neighbourhood	Resident welfare associations (A)	Neighbourhood groups (A)							

The urban systems consist of many interrelated sectors but this book only attempts to address four of the major ones. The actions suggested here need to be contextualised considering specific city situations. Prioritising the sectors & actions is essential for making the change on ground. It is suggested that a situation analysis is conducted to prioritise challenges & contextualise the action.

3.
Urban Resilience and Sustainability

Urban resilience is the capacity of urban systems, communities, individuals, organisations and businesses to recover, maintain their function and thrive in the aftermath of a shock or a stress, regardless of type, frequency or magnitude of impact. The importance of resilience has been explored in a variety of complex social-ecological systems but has only recently been applied in the context of cities. Resilience refers to the entire system, rather than its parts, and considers the implication of social, ecological, technological, economic and institutional dimensions.

Sustainability can be defined as the ability to make development choices which respect the relationship between economy, ecology, and equity. A sustainable community avoids building a burden of reduced natural capital, pollution and an excessive local debt on the future generations.

A sustainable community is one in which improvement in the quality of human life is achieved in harmony with improving and maintaining the health of ecological systems; and where a healthy economy and industrial base supports the quality of both human and ecological systems.

Sustainable cities are those that continue to fulfill the fundamental human needs of subsistence, safety, affection, leisure, identity and freedom. They should be able to foster creativity and unleash the power of participation and collective action.

http://www.indigodev.com/Sustain.html

WHY do we need sustainable cities ?

- ➢ Any society that uses its critical resources unsustainably will collapse.
- ➢ We have been wasteful and are polluting critical resources on which we are dependent.
- ➢ The current growth rate of consumption and city cannot be sustained.
- ➢ Climate change is increasing the uncertainty.
- ➢ We need to build resilience against extreme events.
- ➢ Our legacy urban planning and management is increasing our vulnerability.
- ➢ The urban institutions are unable to develop an anticipatory culture to address uncertainties.

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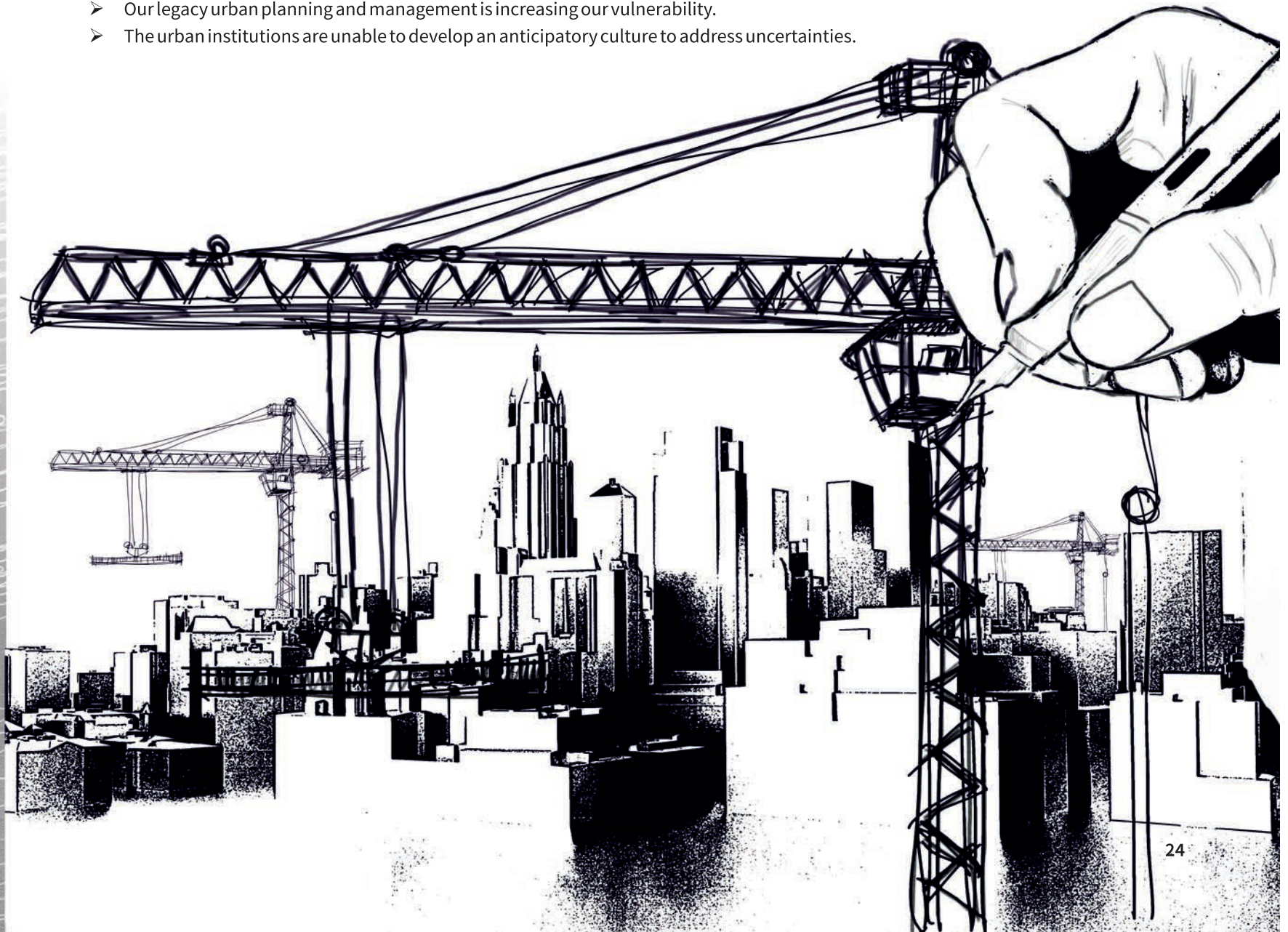
HOW can we transform our cities ?

- ➤ Unleash the city's capacities for learning & innovation.
- ➤ Look backwards, identify the past mistakes of planning and management.
- ➤ Develop an anticipatory culture to live in the age of limited resources and uncertainty.
- ➤ Work to reduce ecological and environmental footprints.
- ➤ Build synergy across scales by devolving and empowering stakeholders.
- ➤ Build autonomy of communities starting from micro to city/region/basin levels. (Cellular autonomy)
- ➤ Develop an equitable and inclusive society where none are poor or vulnerable.
- ➤ Use innovations in social communication to foster cross learning and coherent collective action.

US$350 trillion to be spent on urban infrastructure and usage over the next 30 years will have to be directed towards low to zero carbon emissions.

- WWF

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WHAT are the benefits ?

- The life in sustainable cities can be comfortable, healthy and stress free.
- Efficient and healthy people can make the city more efficient and attract investments.
- Healthy urban ecosystems and biodiversity can provide many ecological services at low cost.
- The ecological services can reduce stresses and shocks and their impacts.
- An inclusive society ensures equitable access to lifeline services and improves efficiency and productivity.
- Strong stakeholder linkages can catalyse a healthier economy and improved livelihoods.

Our future generations can live better without having to inherit vulnerabilities, face resource scarcities and a polluted earth.

WHERE are the challenges ?

"They are too naive"

"We don't trust them"

"They always manage to mess up"

"Don't worry, it's my daily job"

Government

Community   Private Sector   Civil Society
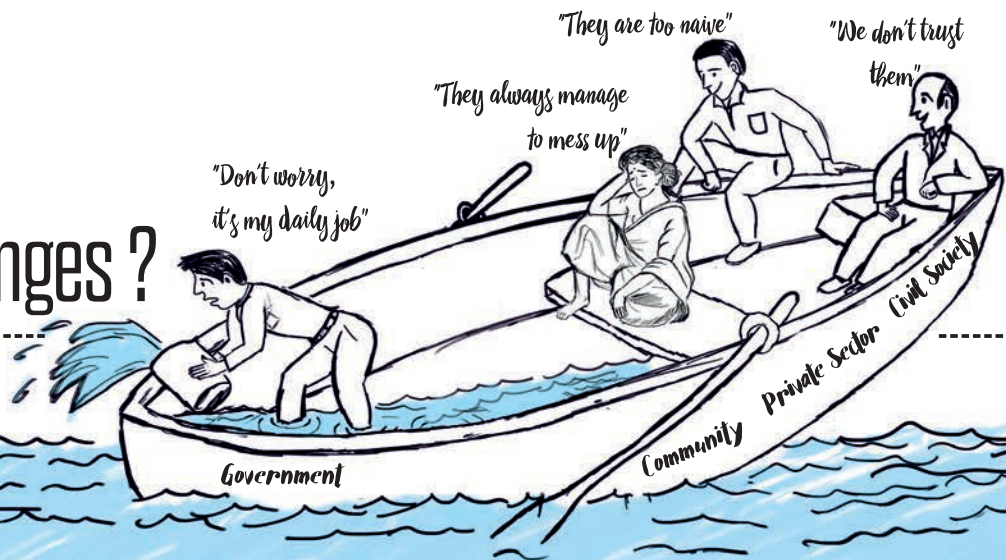
- It is the "Municipality's problem" attitude.
- Legacy urban institutions lacking anticipatory culture.
- "One size fits all" national programmes with limited scope for contextualised solutions.
- Capacity and knowledge gaps in ULBs.
- Booming cities managed by dysfunctional poor municipalities.
- People willing to pay for good quality services, but ULBs unwilling to increase tariffs.
- Selfish individual coping measures.
- Conflicts during scarcities.
- Excessive focus on land, but not on network integrity.
- Until the rich get surplus, the poor get nothing.
- Services and subsidies are cornered by the well-off while the poor have little access.

WHO are the key stakeholders ?

Making cities safe and sustainable is everybody's business; the stakeholders of urban development can be divided into four main groups.

Government (The Hierarchists)

This group is structured with hierarchy and rules and has strong group cohesion, especially during crisis. Through mass action, they have the capacity to choke the city services. They are mandated to frame the policies that define development priorities and implement them. The ULBs coordinate with the national/state governments to implement the regulations. The elected representatives from city to national level as well as administrators decide the path of urban development and management. Unfortunately, as cities and their populations are growing by leaps and bounds, the urban local bodies are fund starved and their regulatory controls have weakened. As they are dependent on national flagship programmes, they must follow the national policies and guidelines. This group of stakeholders is comprised of:

➢ Local Authorities
➢ Parastatals (water supply and sewerage board, UDA, smart city SPV etc.)
➢ National Govt.
➢ Regional Govt.
➢ Parliamentarians

Private Sector (The Individualist)

The private sector is essentially driven by individual profits and competition. Over last few decades, the private sector has become the major contributor to the GDP and brings many innovations to the markets. Most formal and informal livelihoods depend on the private sector today. The industry has become one of the major stakeholders of natural resources and source of pollution. The real estate development and infrastructure sectors are major players in urban development, surpassing the urban local bodies in terms of investments. Private financial institutions participate in infrastructure and development projects through start-up capital and loans.

Traditionally, the private sector has contributed to the education, research and social development sectors through philanthropic activities. They are mandated to allocate corporate social responsibility funds, which can promote environmentally and socially relevant ground-level actions. As their share of the GDP increases, they have a major role to play in sustainable development. This group of stakeholders is comprised of:

➢ Business and Industry
➢ Trade associations (CII, FICCI, CREDAI etc.)
➢ Financial Institutions (housing and infrastructure development banks)
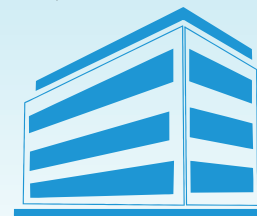
Civil Society (The Egalitarians)

The civil society believes in common good and conserving natural resources and environment. This group has low hierarchy and good cohesion. They have been active in generating debate and action on environmental conservation, human development, equity and justice. This group includes civil society organisations, academic & research institutions. Some of the community of practitioners can also be added in this group. Though the media is increasingly becoming part of the private sector, they also sensitise people and raise questions on government's actions. India also has a history of faith groups leading such debates and action on ground. The egalitarians have carved a niche in influencing policy, action research and development. This group of stakeholders comprises of:

➢ NGOs, CSOs and Advocacy groups
➢ Academia and Universities
➢ Faith groups (religious movements)
➢ City Networks
➢ Community of Practitioners (architects, planners, lawyers, economist, doctors and engineers)
➢ International Donors/Organisations/Foundations
➢ Media

Communities (The Fatalists)

They are an amorphous and mostly unorganised group comprising of different types of communities. In the Indian context, they are controlled largely by the rules imposed on them, have low cohesion, and have ended up as a silent majority of fatalists. This group, essentially comprises of the middle class and the poor & vulnerable sections of the society. Even though they are a majority, they are unable to collectively engage in the urban development debate due to limited cohesion. Often, they are the main victims of urbanisation and suffer from economical and services poverty. Their individual actions determine the direction of urbanisation. This group of stakeholders comprises of:

➢ Poor and migrants
➢ Informal workers
➢ Colony resident groups (RWAs)
➢ Self-help groups

Stakeholder DISCONNECT

Communities
- They will not allow us access to services.
- Don't trust the system, they shift goal posts.
- It is better to informally connect to services.
- Can't upgrade without land titles.

Government
- Planning is ULB's task.
- ULB should manage all services.
- ULB's information is authentic.
- Strict control is required to manage city.

Private Sector
- Self-supply is better since we can't trust ULBs.
- Poor should be made to pay like others.
- If subsidies are given, they should be for all.
- Over extraction is other's problem.
- Private sector can better manage urban services.

Civil Society
- Services should focus on poor.
- Information should be available to all.
- Participatory management is a must.
- ULBs are insensitive to the people's needs.
- Alternatives are needed to the current system.

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Suggested ROLES

Communities (Limbs)

➢ LEARN about conservation and efficient use of resources.
➢ REDUCE coping costs by formalised local solutions.
➢ INCREASE autonomy through community action.
➢ BUILD circular water, energy & carbon economy.
➢ CONSERVE local natural resources.
➢ MONITOR environment and resources and share data.
➢ INTERNALISE the capacities to manage.
➢ PARTICIPATE actively in the policy making.

Government (Spine)

➢ DEVELOP equitable and inclusive policies.
➢ IMPLEMENT policies and legislations.
➢ DESIGN incentives around conservation.
➢ MONITOR and manage resources.
  ➢ PROVIDE open access to information.
  ➢ BUILD and strengthen institutions across scales.
➢ FACILITATE stakeholder's participation.
➢ RESOLVE conflicts between stakeholders.

Private Sector (Brain)

➢ DEVELOP and market clean and disruptive innovations.
➢ ENABLE fast diffusion of clean technologies and services.
➢ REDUCE resource and pollution foot prints.
➢ BUILD urban scenarios informed by innovations.
➢ PROVIDE inputs to enable innovation informed policies.
➢ DEVELOP environmentally and socially responsible culture.
➢ SUPPORT communities to improve autonomy.

Civil Society (Heart)

➢ CONDUCT applied research to surface challenges and options.
➢ GUIDE policies to enable sustainable urbanisation.
➢ CAMPAIGN for equity and inclusive development.
➢ EDUCATE stakeholders on challenges and options.
➢ PROMOTE innovations to improve quality of life.
➢ DEVELOP networks to ensure coherent action.

4. Sectors and Actions

SECTORS

Water

Water is a scarce resource. Better water management is necessary to deal with recurrent scarcities and disasters such as floods and water logging. Demand focussed end use, conjunctive water management, recycling & reuse as well as conserving local resources can significantly reduce the water stress of the cities. Scientific assessment of resources, increasing water use efficiency, reducing pollution, can significantly improve the urban water management. We urgently need a well-defined water ethic to ensure universal access to water in the context of uncertainty and reducing per capita water resources. How we use, manage, waste, or pollute water can determine the sustainability of our environment.

Energy

Energy is the driver of urban systems. The efficiency of urban systems is largely due to use of energy in industrial production, automation of human tasks, lighting, thermal comfort, mobility and reduction of drudgery. Many disruptive innovations in the energy sector are making off-grid and mixed grid energy systems feasible and can transform many consumers into prosumers, (Consumers who are also Producers) and reduce reliance on grid-based energy. It is imperative that we start shifting towards local and renewable energy sources to power our cities as fossil fuel consumption pollutes the air in our cities and induces climate change. There are huge opportunities to reduce consumption, produce energy and to transform our cities to become carbon neutral.

Water leakage costs water utilities worldwide US$14 billion every year
- IBM Smarter Cities

Via its Energy Saving Partnership, Berlin has retrofitted more than 1,400 buildings since 1996. This has delivered increases in energy efficiency of 26% and more.
- WWF

Mobility

Fossil fuel based urban mobility systems enabled human beings to commute over larger distances. The daily operational radius of human beings has increased many times and propelled the growth of urban sprawls. As the public transport systems did not expand simultaneously, people shifted to private vehicles, and as the numbers grew, congestion on the roads and the emissions added to the pollution. Dependence on mechanized transport has also led to increasing sedentary lifestyles, and associated diseases.

Concurrent changes in city planning and behaviour change are necessary to improve access along with mobility. Shift from single use land use zoning to mixed use zoning can improve access to facilities and can reduce daily commuting distances. Enforcement of traffic rules aided by intelligent traffic monitoring systems can significantly reduce traffic jams. A seamless network of comfortable public transport and paratransit can reduce the need for using the private vehicles. It is time to think about promoting non-motorised transport by providing exclusive lanes, user-friendly footpaths and changing our behaviour towards more healthy mobility options. Measures such as work from home, dual office timings etc. can reduce the peak hour traffic. With disruptive innovations, such as electric vehicles, autonomous cars and taxi aggregators, urban mobility is ready for major disruptions.

Environmental Health

Health is the outcome of how we manage our urban services. Poor drainage and sewerage systems cause floods and water logging, which create ideal environments for mosquito borne and water borne diseases. Summer water scarcities can reduce personal hygiene and increase water borne diseases. Poor households living in the riverine and water-logged areas are differentially vulnerable to these diseases. Significant reduction in incidence of vector borne and water borne diseases is possible with improved water management as well as early warning systems

Rising temperatures are already decreasing the thermal comfort of our cities. Indoor thermal comfort can be significantly improved by insulated and well ventilated buildings, as well as retrofitting cool roof and passive ventilation technologies. Air pollution is increasingly becoming a problem in most of our cities. We need to understand the point and the nonpoint sources contributing to poor air quality in our cities. Often knee-jerk actions are being taken to control air pollution without much success. We need better monitoring and regulatory control of the sources to reduce air pollution without sacrificing the comforts of urban life.

In 2015, Surat had 2.18 million vehicles plying on the roads, of which 1.7 million were two-wheelers and 0.26 million cars. This means that for every two residents in the city, there is one vehicle.
- Taru Leading Edge

In some cities the air is so polluted that breathing is equivalent to smoking two packs of cigarettes a day
- Earth Policy Institute

ACTIONS

Enable symmetry of information

Efficient collection and open sharing of information and knowledge is crucial to build vision, to plan and to enable action. Collection and analysis of granular data across scales is essential for enabling decision-making. It is important that multiple modes of communication are used to make the information easily accessible to multiple stakeholders. Surfacing of the challenges such as resource limits, uncertainties and inequity and deliberative participation can lead to improved policies and effective action.

Develop anticipatory culture

We now know that our current lifestyles are resulting in shrinking per capita resource availability, increasing variability in temperature and precipitation, and growing frequency and intensity of urban disasters. Urban planners need to develop an anticipatory culture and use tools such as scenario building to be able foresee, prepare for and address future challenges. They also need to be able to identify and harness emerging opportunities from disruptive innovations.

Devolve functions

A shift from centralised city level grids to modular cells based management can reduce peak demand and increase resilience against extremes. The urban local bodies must devolve some of the functions to neighbourhood level institutions and groups which can increase cellular autonomy though adopting circular economy of water, energy and carbon, thereby reducing wastes and pollution. As neighbourhoods internalise some responsibility of managing urban services, community resilience against shocks and stress can increase. It is necessary to build strong local institutions as well as multi-stakeholder platforms to enable this shift.

Strengthen urban services

As uncertainties are increasingly impacting cities through disasters and scarcities, we need to design urban services to maintain the network integrity under shocks and stresses. Services such as transport, energy, water, health and sanitation must be geared to maintain or quickly recover their functionality during and after extreme events.

Build capacities

As the cities grow, urban governments are unable to manage the services resulting in iniquitous access to lifeline services. Huge capacity gaps, and financial constraints restrict their ability to manage. Civil society needs to understand their role in knowledge creation, building equity and advocacy. The private sector needs to shorten the innovation cycle and inform policy. Communities need to accept their responsibility and increase their autonomy. All stakeholders need to upgrade their knowledge base and attitudes to be able to transform the urban systems.

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- ➢ Design IOT network for integrating data from public and ULB sources.
- ➢ Enable visualisation of data and Information.
- ➢ Create web enabled platforms to share information.

- ➢ Regularly analyse IOT and other data.
- ➢ Build urbanisation, economy and Climate Change informed scenarios.
- ➢ Map innovations and contextualise them.
- ➢ Understand challenges and opportunities.

- ➢ Devolve functions incorporating subsidiarity principle.
- ➢ Create formal institutions across scales & stakeholder dialogue platforms.
- ➢ Build synergistic "cellular autonomy" based city networks.
- ➢ Create start-up ecosystems to design, build & manage "cells" and ensure synergy.

- ➢ Stress-test cell level and network level integrity during extremes.
- ➢ Harden infrastructure & services across scales.

- ➢ Establish information sharing & dialogue platforms.
- ➢ Support, train and strengthen institutions across scales.
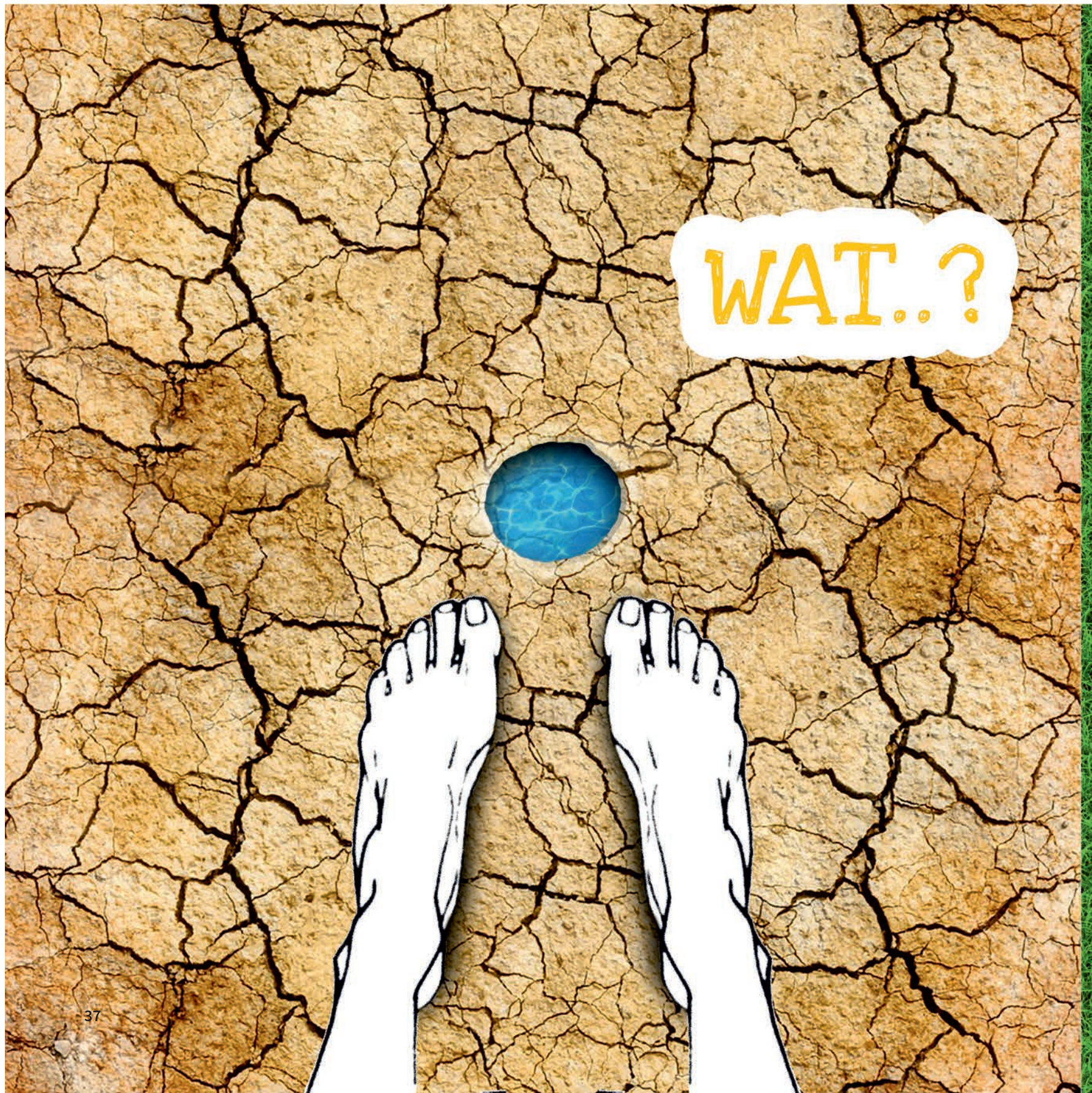
WATER

Water consumption of 135 litres per capita per day (CPHEEO norms) is an unattainable ideal in a water scarce country like India. With less than 1,500 cum of per capita renewable water resources per year, India is already classified as a water scarce country. Most of the water supplied (roughly 90 percent) ends up flowing down the drain. Those who have piped water see it only between the tap and the sink, or shower and drain, but neither do they know where the water comes from nor where the sewage goes to. The common assumption is that the municipality will go on providing as much water as required, but water is hoarded out of the fear that the taps may run dry anytime. Due to these wasteful habits, the poor do not get clean water at their premises. They say, "unless the rich have surplus the poor end up getting nothing."

Water efficient devices and practices are not adopted, nor is the wastewater recycled. As most sewage is still not treated, cities end up polluting the water bodies and groundwater. Waterborne diseases do not respect the socio-economic classes and boundary walls. Diarrhoeal diseases account for more than 5 percent of disability adjusted life years in India. The total life years lost by diarrhoeal diseases in India is about 17 million.

Water supply and sewerage master plans are not informed by the potential of local resources and options such as rainwater harvesting and demand focussed end use, recycling and conjunctive water management. The municipalities are unable to keep the promise of universal access to water, and are able to provide water supply and sewerage only to some parts of the city. The poor and peri-urban residents are left to fend for themselves. Tankers and borewells have become a de facto source for most. They are also used by those who get intermittent supplies to supplement their demand, creating a huge pressure on aquifers. Anticipatory planning based on integrated urban water management framework can offer cheaper, equitable and sustainable solutions. We urgently need to develop resource informed policies and strategies.

The private sector offers multiple gadgets to manage water, but some are redundant and wasteful such as RO filters installed in regions, which only need disinfection by UV filters. The sellers look only at turnover and profit and the people often end up buying gadgets they do not need, or are unsuitable for their context. The private sector needs to focus on innovations and bundle appropriate technologies to address diverse water resource contexts across the country, which can increase our water autonomy at a lesser cost. They have a major role to play in disruptive innovation and diffusion, in decentralised water treatment and reuse, rainwater use and modern water treatment systems. Working with the government and civil society they can make households, neighbourhoods and cities more water autonomous and facilitate creating a water sufficient city.

With emergencies taking up attention, civil society has been unable to take a long-term view of our common water future. In the rush for reacting to "breaking news", and dealing with the immediate, the importance of anticipatory planning is often forgotten. Civil society and research institutions can conduct research on water resource and socio-economic context informed solutions. Working with communities, private sector and governments they can provide much needed granular information that can aid better planning and management.

A water efficient person in urban areas can live with 70 L per capita per day if water efficient devices and recycled water are used to meet low quality water demand (flushing, gardening). In a city, whether we like not, all our lives are interconnected. Let us work together to realise the dream of universal access to safe water.

"We forget that the water cycle and the life cycle are one."

-Jacques Cousteau

List of Actions

Reduce Water Demand

Recycle Water

Prevent Urban Water Pollution

Conserve Local Water Resources

Develop Water Ethics

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1. Reduce Water Demand

Reducing water consumption is the simplest way to improve resilience to water stress. Simple measures such as installing water saving devices, reducing leakage & inculcating water saving habits can save water significantly at household levels. Demand reduction can help in achieving universal access to water without expanding the capacity of water supply systems.

What Problems does it Address?

➢ Water wastage at various scales.

➢ Over-extraction of groundwater.

➢ Degradation of water quality.

> "Whenever there's a water shortage, we blame the government, but it's not just the government's job, it's also our job to conserve water."
>
> **-Abeed Surti**
>
> His Drop Dead Foundation has been fixing leaking taps free of charge in Mumbai and has saved many millions of litres of water.

Think about it ...

What should we do?

Science & Technology

➢ Design more water efficient devices (faucets, showers, flush tanks, washing machines).

➢ Develop conventional & ecological engineering techniques to process wastewater.

➢ Implement rainwater harvesting to reduce demand.

➢ Monitor water usage across scales.

➢ Conduct water audits & develop annual water budgets including recycled & rain water.

Policy & Praxis

➢ Incentivise water conservation.

➢ Implement differential tariffs, make use of water saving gadgets compulsory.

➢ Enforce wastewater treatment regulations at community & industry level.

Information

➢ Ensure open access to water consumption data from neighbourhood level upwards.

➢ Establish IOT networks to identify & reduce water losses across scales.

Economy & Finance

➢ Estimate the true cost of water including capital & running expenses.

➢ Evaluate environmental, social & economic cost benefit of water demand reduction measures.

➢ Invest on water efficient production systems in water scarce cities.

➢ Allocate budget for water conservation projects.

Who can do what ?

Communities (C)

➢ Assess & encourage water conservation options/appliances. (Cs+P)

➢ Use IOT to monitor, reduce demand & report water use patterns. (G+Cs)

➢ Promote behavioural change to reduce demand. (Cs)

➢ Organise collective action to promote demand focussed end-use. (G+Cs+P)

➢ Internalise capacities to manage water at neighbourhood levels.

➢ Use rainwater & recharge groundwater. (Cs)

➢ Limit dependency on groundwater to stress periods & prevent groundwater decline.

Government (G)

➢ Develop water scenarios informed by demand reduction paths & climate change. (Cs)

➢ Set "Water Drop Rating" for water using appliances & enforce their use. (Cs+P)

➢ Conduct water audits & set budgets at neighbourhood, ward & city levels. (Cs)

➢ Develop ecologically sound "Water Cycle Management Plans" across scales. (C+Cs)

➢ Employ IOT water metering network & incentivise demand reduction. (C)

➢ Implement leakage reduction measures before investing on "augmentation" projects.

➢ Establish "Water Conservation Support Cells" in WLTSCs. (C+Cs)

➢ Allocate budgets for water demand reduction research & projects. (Cs)

Private Sector (P)

➢ Explore technological innovations for reducing demand. (Cs)

➢ Implement "Water Drop Rating" for devices & appliances.

➢ Develop & market water efficient appliances informed by water use behaviours. (Cs)

➢ Reduce dependency on groundwater.

➢ Develop cost effective IOT networks for water system monitoring. (C+G)

➢ Conduct on-site water audits & set water budgets & water efficiency targets.

➢ Carry out CSR activities to promote water efficiency programmes. (G+Cs)

Civil Society (Cs)

➢ Analyse user behaviours & identify interventions to reduce demand.

➢ Conduct research on reasons for change in water demand. (C+G)

➢ Analyse IOT data for water loss assessment & identify intervention options.

➢ Demand & use forecasts for water based on user behaviour. (G)

➢ Sensitise stakeholders & ensure media coverage to promote efficient water usage. (C)

➢ Set up water conservation cells & take up IEC activities.

➢ Provide technical advice to "Water Conservation Support Cells". (G+P+C)

How it connects to other sectors

➢ Energy: Water saved means energy saved.

➢ Urban Water: Less water used leads to less wastewater to handle.

➢ Ecology & Environment: Less groundwater withdrawal, healthy water bodies.

➢ Economy & Finance: Reduced dependency on distant resources, reduced investments for augmentation.

2. Recycle Water

To maintain the health of ecosystems, waste generated should be less than their carrying capacity. Decentralised wastewater recycling systems can lower the required design capacity of centralised sewerage systems. Reuse of treated wastewater at colony levels can reduce the net demand on city water grids. Recycling of wastewater should be a priority before augmenting capacity of water supply & sewerage systems.

What Problems does it Address?

- ➤ Insufficient centralised STP capacity demand for treated wastewater.
- ➤ Local aquifers are polluted by leaking sewage & septic tanks.
- ➤ Competition & conflicts over water resources.
- ➤ Taboos towards the use of recycled water.

> In an age when man has forgotten his origins and is blind even to his most essential needs for survival, water along with other resources has become the victim of his indifference.
>
> **-Rachel Carson**

> Years ago, we all talked about recycling and not dumping things down your drain and all of that, but talking doesn't help much. Basically, it's going to have to be legislation because the impact is so huge and diversified.
>
> **-Ted Danson**

Think about it ...

What should we do?

Science & Technology

- ➤ Use more efficient devices to reduce sewage volume.
- ➤ Monitor sewage generated across scales.
- ➤ Develop treatment systems to stop wastewater discharge into local aquifers.
- ➤ Develop indirect groundwater recharge systems using surplus treated wastewater.

Policy & Praxis

- ➤ Devolve responsibility for wastewater recycling to communities & colonies.
- ➤ Enforce zero discharge policy & separate sewage treatment taxes.
- ➤ Create land use category for waste recycling & allocate land from colony level upwards.
- ➤ Offer incentives to inculcate water recycling from colony level upwards.
- ➤ Impose strict regulations to promote wastewater treatment across scales.

Information

- ➤ Set up open access public IOT sensor network to access recycling data across scales.
- ➤ Estimate sewage leakage into local aquifers & control groundwater pollution.
- ➤ Sensitise stakeholders about benefits of waste recycling.

Economy & Finance

- ➤ Conduct cost benefit analysis of existing/potential options.
- ➤ Estimate benefits of water-recycling systems in water scarce areas.
- ➤ Allocate budgets for water recycling projects.

Who can do what ?

Communities (C)

➢ Sensitise people about water crisis & reduce social stigma of wastewater reuse. (Cs)

➢ Assess & encourage water recycling options/appliances. (Cs+P)

➢ Set up & manage the water recycling systems. (P)

➢ Internalise capacities to manage recycled wastewater at neighbourhood levels.

➢ Use IOT to monitor & report water recycling in the community. (Cs+G+P)

➢ Use greywater/treated wastewater for urban agriculture.

➢ Use recycled water to reduce dependency on groundwater except during stress periods.

Government (G)

➢ Set standards & enforce use of water-recycling systems.

➢ Develop ecologically sound "Water Recycle Management Plans" across scales. (C+Cs+P)

➢ Regulations & systems to monitor recycled water quality. (Cs)

➢ Conduct wastewater audits across scales based on IOT data. (C+P+Cs)

➢ Develop IOT monitoring systems to cover full water cycle. (C+Cs)

➢ Develop & implement incentive structures for recycling. (C)

➢ Establish "water technology cells" in WLTSCs. (C+Cs)

➢ Allocate budgets for water recycling projects.

Private Sector (P)

➢ R&D on context/scale specific solutions for recycling wastewater. (Cs)

➢ Design & promote domestic recycling devices & appliances.

➢ Develop IOT networks for water reuse monitoring. (C+G)

➢ Recycle wastewater generated in production systems.

➢ Conduct wastewater audits of production systems & set water efficiency targets. (G)

➢ Promote culture of recycling & highlight best practices among industry network. (Cs)

➢ Carry out CSR activities to implement water recycling across scales & contexts. (Cs+G)

Civil Society (Cs)

➢ Regularly analyse IOT data to develop city level situation analysis.

➢ Conduct periodic water audits incorporating wastewater recycling across scales. (C+G)

➢ Understand consumer behaviour & identify interventions to promote recycling. (C+P)

➢ Sensitise communities about water recycling benefits & success stories in recycling. (C)

➢ Help communities/businesses identify & implement water-recycling measures. (C)

➢ Ensure & facilitate media coverage to promote efficient water reuse. (C)

How it connects to other sectors

➢ Ecology & Environment: Ecological engineering can be used for treating wastewater & improving the environment.

➢ Ecology & Environment: Cheap & reliable source of watering in parks, gardens & sports fields.

➢ Ecology & Environment: Less surface & groundwater pollution.

➢ Energy: Wastewater sludge can be used to produce biogas, a renewable energy source.

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3. Prevent Urban Water Pollution

In India, only about 30% of the urban wastewater is treated. As the sewage pollution plumes grow, downstream cities are getting impacted. The poor households differentially bear the brunt of degraded urban water quality. At sub-city levels, lack of sewerage & widespread use of septic tanks impact downstream users as well as local aquifers. Identification & characterisation of these sources is possible through dense network of monitoring stations. It is necessary to ensure isolation of sewage from drinking water.

What Problems does it Address?

- Inadequate sanitation systems & waste treatment plants.
- Degradation of water quality from sewage.
- Downstream impacts of pollution.
- Public health impacts.

Sooner or later, we will have to recognise that the Earth has rights, too, to live without pollution. What mankind must know is that human beings cannot live without Mother Earth, but the planet can live without humans.

-Evo Morales

Environmental pollution is an incurable disease. It can only be prevented.

-Barry Commoner

Think about it ...

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What should we do?

Science & Technology

- Establish real time IOT monitoring networks for surface water & aquifers.
- Develop pollution dispersion models.
- Develop remediation technologies for different contexts.
- Integrate ecological engineering methods with conventional techniques to treat water bodies.

Policy & Praxis

- Implement regulations & incentives for recycling across scales.
- Increase access to sanitation for poor.
- Reduce over-extraction of groundwater & prevent contamination of aquifers.
- Enforce "polluter pays" regulations.

Information

- Develop open access IOT networks to monitor key parameters & indicators.
- Enable real time warnings on pollutant discharges & quality warnings.

Economy & Finance

- Estimate true cost of polluted water on health.
- Estimate benefits of protecting local aquifers during water scarcity.
- Conduct social & economic cost benefit analysis of preventive measures & treatment options.

Who can do what ?

Communities (C)

➢ Separate rainwater, drinking water, grey & black & recycled water streams.

➢ Protect groundwater & water bodies from pollution. (Cs+G)

➢ Adopt toilet technologies based on geological & hydrological contexts. (Cs+P)

➢ Ensure universal access to toilets with safe disposal of sewage. (G)

➢ Adopt a zero discharge framework: Treat most wastewater at community levels.

➢ Internalise capacities to manage wastewater & sludge treatment. (Cs)

➢ Use public IOT sensors to monitor full water cycle. (Cs+G)

Government (G)

➢ Implement zero discharge water policy.

➢ Enforce decentralised reuse facilities in new properties.

➢ Develop & implement incentive structures for safe water quality management. (Cs)

➢ Include pollution prevention in mandate of "Water Technology Support Cells". (C+Cs)

➢ Establish groundwater & surface water quality monitoring systems. (Cs)

➢ Separate drinking water supply from other uses, in extreme cases.

➢ Conduct water quality audits from neighbourhood to city levels. (C+Cs+P)

➢ Prevent solid waste entering drainage & sewerage systems. (C)

Private Sector (P)

➢ Develop & market cost-effective & decentralised wastewater treatment systems. (Cs)

➢ Adopt zero discharge policy in each industry or use common effluent treatment systems.

➢ Organise industry network meetings to promote state of art technologies for wastewater treatment. (Cs)

➢ Allocate CSR funds to support water pollution control & communication. (Cs)

Civil Society (Cs)

➢ Create awareness about causes & impacts of water pollution on public health. (C+G+P)

➢ Promote pollution impact & mitigation research. (C+P)

➢ Conduct periodic water pollution studies. (C+G)

➢ Analyse IOT data to explore context specific solutions to water pollution.

➢ Understand citizen behaviour & identify recycling options.

➢ Conduct research on waste treatment techniques. (G+P)

➢ Explore feasibility of retrofitting waste treatment in neighbourhoods & industries. (P)

How it connects to other sectors

➢ Energy: Reduced wastewater leads to reduced energy use.

➢ Urban Health: Improved water quality helps maintain a better health especially in informal settlements.

➢ Economy & Finance: Opportunities for small businesses & microenterprises in water recycling.

➢ Ecology & Environment: Healthy aquifers & adjacent wetlands provide habitat for fish.

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4. Conserve Local Water Resources

Urban water bodies can serve as emergency sources of water & recreational areas. They remediate pollution & cool the neighbouring areas. Healthy water bodies are important for building city resilience against climate extremes. Water body restoration & conservation requires technical, social & institutional interventions, & collaboration between multiple stakeholders.

What Problems does it Address?

- ➢ Urban floods.
- ➢ Water scarcities.
- ➢ Water pollution & reducing land values.
- ➢ Vector borne diseases & foul smells from weed infested degraded water bodies.

A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature.

-Henry David Thoreau

Many cities across India are reliant on distant water sources and electricity for pumping. Power breakdowns and conflicts/competition with traditional users can threaten the water supply. Local water bodies and ground water are only emergency sources in such cases.

-Taru Leading Edge

Pure water is the world's first and foremost medicine.

-Slovakian proverb

Think about it ...

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What should we do?

Science & Technology

- ➢ Introduce technologies for water quality monitoring.
- ➢ Develop water budgets from neighbourhood level upwards.
- ➢ Develop bioremediation & ecological engineering technologies.

Policy & Praxis

- ➢ Develop water body conservation policies.
- ➢ Devolve conservation & management water bodies to local communities.

Information

- ➢ Allow public access to monitoring data, analysis & results.
- ➢ Disseminate water balance & budget information.
- ➢ City water scenarios.

Economy & Finance

- ➢ Assess value of ecological services.
- ➢ Allocate budgets for water body restoration & conservation projects.
- ➢ Develop livelihood activities to support conservation & management.

Who can do what ?

Communities (C)

➢ Organise public monitoring of local water sources. (Cs+G)

➢ Sensitise people about the challenges & benefits of conservation. (Cs)

➢ Form neighbourhood level institutions to manage small water bodies.

➢ Develop & implement community water body conservation plans. (Cs+G)

➢ Seek funds for restoration projects from local sources, private sector, or municipalities. (G+P)

➢ Develop & implement alternatives to idol immersion. (G)

Government (G)

➢ Devolve small waterbodies to local communities/private sector/civil society. (C+Cs+P)

➢ Control pollution including control of sensitive issues such as idol immersion. (C+Cs)

➢ Establish real-time monitoring systems. (C+Cs)

➢ Include & mainstream water body conservation in municipal programmes.

➢ Allocate budgets for water body restoration & conservation projects.

Private Sector (P)

➢ Include zero discharge policy in environmental management plans.

➢ Reduce abstraction of water from water bodies by recycling.

➢ Work with communities in conservation. (C)

➢ Develop models for income generation activities for O&M.

➢ Use CSR funds to support water body restoration & conservation. (C+G)

Civil Society (Cs)

➢ Conduct catchment studies, develop water balance budget & pollution models. (G)

➢ Highlight the importance of healthy water bodies to reduce vector borne diseases. (C+G)

➢ Develop plans, strategies & options for reducing abstraction & pollution. (C+G)

➢ Create community buy-in through demonstrating restoration & conservation. (C+G+P)

➢ Ensure regular media coverage on water body conservation. (C+P+G)

➢ Assist capacity building of local organisations to manage & monitor water bodies.

➢ Build a federation of multiple stakeholders to support city level initiatives. (C+G+P)

How it connects to other sectors

➢ Urban Health: Conserved water bodies can reduce vector/water borne diseases.

➢ Economy & Finance: Water bodies can reduce costs of managing floods & scarcities.

➢ Ecology & Environment: The natural beauty of lakes & river enhances quality of life in the cities.

➢ Urban Health: Lakes act as cooling agents & reduce thermal stress in neighbouring areas.

5. Develop Water Ethics

Water poverty, recurrent floods & pollution are growing challenges in cities. Water ethics should address challenges of water poverty, conservation, sanitation, sustainability, biodiversity & health etc. It should be based on principles of equal respect for human dignity, equity, solidarity, common good, responsible stewardship & deliberative participation. It should respect geophysical & ecological rules, cultural & democratic values.

What Problems does it Address?

➢ Competition for water between cities & their hinterlands.

➢ Hoarding by few, "water poverty" for the rest.

➢ Wastage & pilferage.

➢ Pollution of water resources & downstream impacts.

➢ Flooding due to encroachment of flood plains & inappropriate construction.

➢ Degradation of water bodies of religious & cultural importance.

For many of us, water simply flows from a faucet, and we think little about it beyond this point of contact. We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports. Today's water institutions-the policies and laws, government agencies and planning and engineering practices that shape patterns of water use-are steeped in a supply-side management philosophy no longer appropriate to solving today's water problems.

- Sandra Postel

Think about it ...

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What should we do?

Science & Technology

➢ Develop IOT sensor network to monitor water resources, quality & use across consumers & scales.

➢ Develop water resource models & scenarios.

➢ Develop water conservation & recycling options.

Policy & Praxis

➢ Develop, document & disseminate water ethics.

➢ Develop water policy informed by water ethics, resource contexts & limits.

➢ Create equitable sharing frameworks & embed circular water economy.

➢ Protect the interests of minorities & the poor.

➢ Notify rules for reuse of water at different scales & prevent over-extraction.

➢ Prioritise ecological & environmental conservation & ensure ecological flows.

➢ Ensure conservation of water bodies of cultural & religious significance.

Information

➢ Collect data on different aspects of urban & regional water cycle & usage.

➢ Create open access platforms to share water information.

➢ Collect spatially explicit information on water access/ poverty across Communities.

➢ Create platforms to share water technology options.

Economy & Finance

➢ Conduct social & environmental cost benefit of available options.

➢ Create incentive & disincentives to promote water conservation & to prevent pollution.

Who can do what ?

Communities (C)

➢ Use IOT sensors to monitor water quality, usage, losses & wastage & share data. (G+Cs)

➢ Establish social rules to discourage water hoarding & respect other's rights.

➢ Develop mechanisms to share water with poor neighbourhoods during crisis.

➢ Conjunctive use of surface & groundwater. (Cs)

➢ Promote "Waste Not-Pollute Not" attitudes & behaviours. (G+P)

➢ Enforce use of recycled water for low end uses across scales. (Cs+P)

➢ Promote ecologically sound water use practices.

➢ Inculcate respect for cultural values towards water.

Government (G)

➢ Set up open access IOT networks to understand the full water cycle from colony upwards. (C+Cs)

➢ Develop near real-time database on resources, quality, demand, access, use etc. (Cs)

➢ Develop water scenarios informed by climate change, demand growth & innovations. (Cs)

➢ Engage stakeholders, experts & develop 'Water Ethics" in simple language. (C+Cs+P)

➢ Develop water policy informed by water ethics. (Cs)

➢ Declare water as a basic right & provide to all citizens on demand. (Cs)

➢ Set & enforce "Water Drop Rating" standards for water consuming appliances. (Cs+P)

➢ Conserve drainage systems & water bodies including one with cultural significance. (C+Cs+P)

Private Sector (P)

➢ Include water ethics in environmental policy of organisation.

➢ Respect other users' rights over water & solve competition through negotiations. (C+Cs+G)

➢ Prevent encroachment of natural drainage & water bodies. (Cs+G)

➢ Ensure water sensitive real estate development. (C+Cs)

➢ Refrain from dumping waste or effluents in to water bodies.

➢ Allocate CSR funds for revitalising water resources. (Cs+G)

Civil Society (Cs)

➢ Conduct social & environmental cost benefit of available options. (G)

➢ Facilitate a paradigm shift from consumerism to conservation. (C+G+P)

➢ Motivate lifestyle change to value water & the rights of others. (C+G)

➢ Ensure media coverage to mainstream water ethics. (C+G)

➢ Promote water harvesting & recycling & highlight the benefits. (C+G)

➢ Analysis & sharing of water utilisation & wastage data & its implications. (C+P+G)

➢ Motivate environmental friendly water behaviour & ecological awareness. (C+G+P)

How it connects to other sectors

➢ Energy: Reduced domestic energy consumption by less water use.

➢ Economy & Finance: Increased water availability for other productive purposes.

➢ Urban Health: Universal access to clean water.

➢ Ecology & Environment: Ensuring ecological flow & conservation of biodiversity.

➢ Social Development: Reduced impacts of water scarcity amongst the marginal communities.

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"By the time electricity comes back, my clothes will be dry."

ENERGY
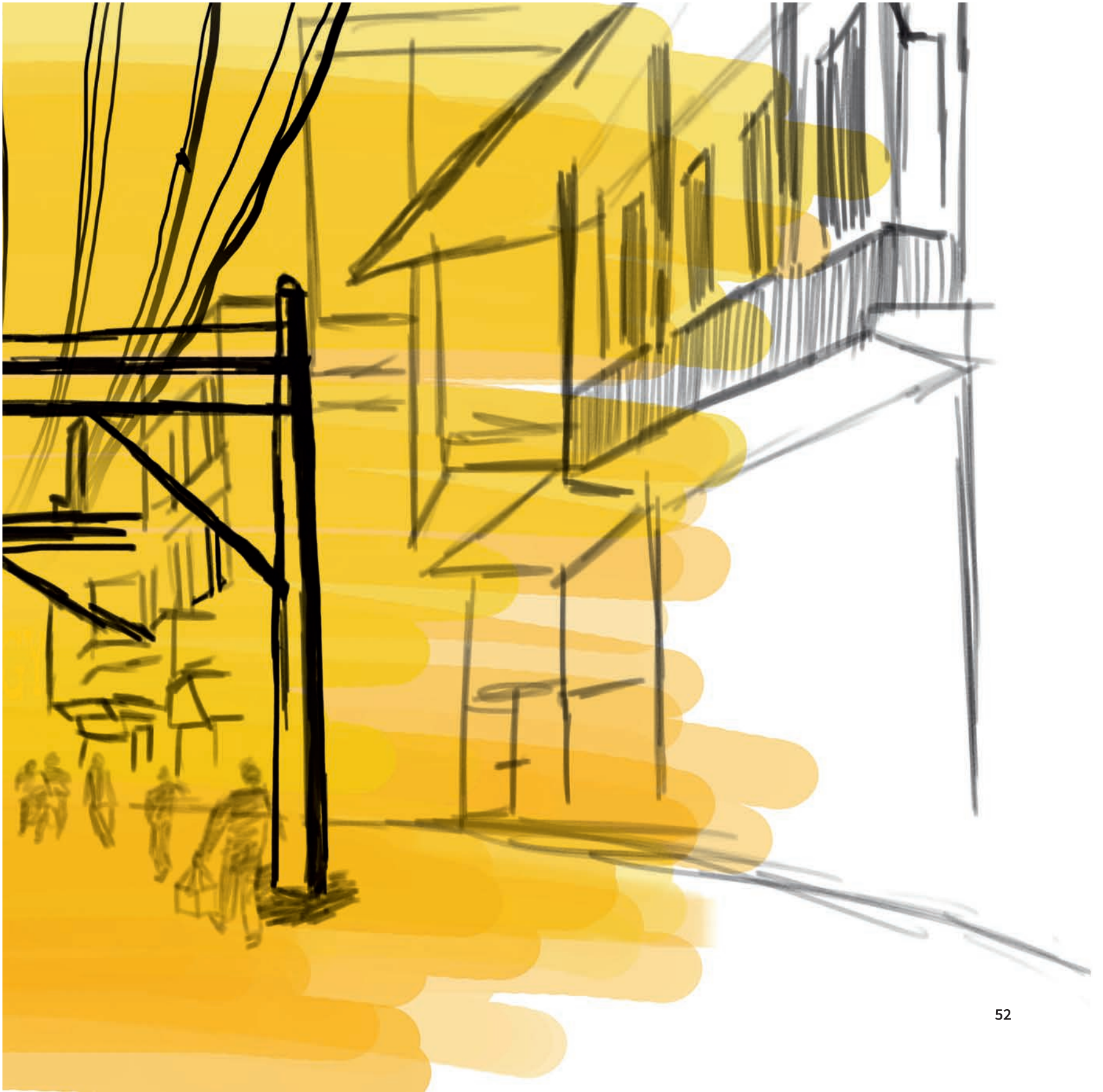
ENERGY

Energy is an essential driver of our urban lives. We are reliant on energy to maintain almost all the urban functions, to reduce drudgery, to keep us safe, healthy and comfortable. Unfortunately, a large section of the urban population is still crippled by energy poverty which degrades their quality of life and forces them to rely on fuel wood and coal which are less efficient and more polluting sources of energy.

Most of our energy is generated from burning fossil fuels (oil, coal, and natural gas) in processes which also guzzle large quantities of water. As these processes emit carbon dioxide, dust and methane, they contribute to global warming and pollution. Over the geological history of four billion years, biological activity removed oxygen from carbon dioxide and stored fossil fuels underground, making the earth habitable for human beings. Extraction and burning of fossil fuels is warming the earth again to higher temperatures that humans are not adapted to. Scientists knew about the possible impacts of increased carbon dioxide on our atmosphere as far back as the end of the 19th century, but in the interests of economic growth our dependence on these fuels has kept increasing. Today our cities are facing major challenges as the deteriorating air quality impacts our health.

Reducing reliance on fossil fuels, increasing energy use efficiency and universal access to energy are options that can solve most of the urban energy challenges. By using renewable energy, we decrease the damage that fossil fuels cause to both human health and the environment. Solar and wind energy are becoming cheaper, leading to a disruption that is expected to make energy systems more distributed and accessible to all. Concepts such as solar or wind micro-grids and net metering are expected to expand by leaps and bounds. Participatory energy generation has the potential to transform consumers into "prosumers" (producers and consumers) and achieve significant energy autonomy at household and community scales. Cheaper systems for storing the

energy will be another major disruption that can transform the energy sector.

The utilities are yet to wake up to these oncoming disruptions in the energy sector. In this emerging scenario, fossil fuel based utilities need to focus on increasing efficiency and thereby reducing loads rather than augmenting capacity. Our utilities' energy development plans may have to be significantly modified to rely less on fossil fuels, in line with international carbon/climate covenants.

As electric and autonomous cars are getting ready to disrupt fossil fuel driven vehicles, the automobile industry is ready for another transformation. Electric cars can reduce air pollution in our cities and autonomous cars and taxi aggregator system can reduce the number of vehicles needed in cities to ensure mobility. The "right to light" laws of the 18th century are taking a rebirth through "right to sunshine" and Solar Easement rights in the 21st century. Urban planners may have to learn to design their new buildings adhering to these new sets of rules.

The civil society and media in India are finally waking up to the growing menace of air pollution and considering alternative options. Understanding the implications of disruptions and creating awareness is necessary to enable fossil fuel deaddiction and chart a smooth transition to a renewable energy based world. Coordination between the stakeholders is necessary for developing anticipatory culture, understanding the energy use, enabling conservation and production options and building energy-smart carbon neutral cities.

"I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that."

- Thomas Edison
in conversation with Henry Ford, 1931

List of Actions

Reduce Energy Demand

Create Energy Security

Shift to Renewable Energy

Develop Energy Ethics

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1. Reduce Energy Demand

Reducing energy consumption is the simplest way to improve resilience to energy stress. Simple measures such as using energy saving devices and changing usage habits can reduce energy demand from household level upwards. Electric cars have a grid-to-wheels power efficiency of more than 60%, while fossil fuel based cars have about 20%. Reducing losses from transmission & distribution systems is cheaper than augmentation of generation capacity.

What Problems does it Address?

➢ Energy wastage at various scales.
➢ Over extraction of fossil fuels.
➢ Air pollution.
➢ Lack of energy security.
➢ Soaring energy demand.

> There are a lot of different ways of building a prosperous society, and some of them use much less energy than others. And it is possible and more practical to talk about rebuilding systems to use much less energy than it is to think about trying to meet greater demands of energy through clean energy alone.
>
> **-Alex Steffen**

Think about it ...

What should we do?

Science & Technology

➢ Innovate to improve energy efficiency of appliances.
➢ Develop decentralised renewable energy options like wind & sun.
➢ Develop ecological engineering measures to alleviate heat island effects.
➢ Shift to more efficient devices (air conditioners, computers, lights, stoves).
➢ Monitor energy usage & losses across scales.

Policy & Praxis

➢ Develop incentives for energy conservation & net metering.
➢ Make use of energy efficient appliances compulsory.
➢ Implement regulations to promote waste to energy systems across scales.

Information

➢ Install IOT systems to monitor consumption & losses across scales.
➢ Ensure open access to energy consumption & loss data from neighbourhood level upwards.
➢ Analysis of real time energy data to facilitate adaptive management.

Economy & Finance

➢ Conduct economic & environmental cost benefit analysis of different energy options.
➢ Invest to promote public renewable energy systems.
➢ Allocate budgets for energy conservation projects.

Who can do what ?

Communities (C)

- Promote behavioural change to reduce demand. (Cs)
- Develop neighbourhood level energy conservation plans. (P+Cs)
- Use IOT enabled appliances to monitor & report energy end-use patterns. (G+C+Cs)
- Internalise capacities to manage energy at neighbourhood levels.
- Reduce dependency on grid supply except during peak/stress/lean periods.
- Use vegetative & cool roof measures to reduce energy consumption for cooling/heating. (G)

Government (G)

- Establish IOT networks for monitoring energy consumption across end uses & scales. (P+Cs)
- Prioritise efficiency improvement/loss reduction measures over "augmentation" projects.
- Create climate & local energy resource informed scenarios, energy budgets & plans.
- Enforce energy saving building regulations & retrofitting options.
- Enforce "BEE" ratings for all appliances for improving energy efficiency.
- Promote energy conservation through WLTSCs. (C+Cs)
- Allocate budgets for energy conservation & research projects. (Cs+P)

Private Sector (P)

- Develop & market IOT enabled appliances with automated/remote control. (Cs)
- Install networks to collect energy use data from IOT enabled appliances. (C+G)
- Conduct applied research on energy use behaviours.
- Conduct energy audits of factories & set energy efficiency targets.
- Promote local start-ups to provide installation & AMC services. (G)
- Carry out CSR activities to promote energy efficiency. (G+Cs)

Civil Society (Cs)

- Analyse IOT data for energy loss assessment & identify intervention options. (P+G)
- Conduct economic & environmental cost benefit analysis of different energy options.
- Conduct studies on micro grids, energy use & losses across scales & end uses. (C+G+P)
- Demand & supply forecasts for non-renewable resources. (G)
- Assess consumer behaviour patterns & design practical interventions to reduce demand. (C+G)
- Help communities/businesses identify & implement efficiency measures. (C+P)
- Ensure media coverage to promote energy efficient living. (C)
- Sensitise all stakeholders on efficient energy use. (C)

How it connects to other sectors
- Urban Water: Energy saved is also water saved.
- Economy & Finance: Reduced dependency on non-renewable resources, less financial investment for augmentation.
- Ecology & Environment: Less investments for dealing with extreme temperatures.
- Ecology & Environment: Circular economy of energy & carbon means less pollution.
- Economy & Finance: Reductions in energy bills & peak power usage.

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2. Create Energy Security

The energy policy should aim at supply of lifeline energy to all our citizens irrespective of their ability to pay for it. Priority should be given to including the economically vulnerable sections through transparent & effective mechanisms.

What Problems does it Address?

➢ Reliable energy is inaccessible for a large section of the population.

➢ Energy demands are growing rapidly.

➢ At the current consumption rate India's coal resources will be depleted in about 40 years.

➢ Health is impacted by indoor air pollution due to fossil fuels.

➢ Insufficient energy generation, transmission & distribution capacity to meet demands.

➢ Increases in supply interruptions cause high economic & health costs.

An estimated 1.2 billion people, 16% of the global population, still do not have access to electricity. An estimated 2.7 billion people, or almost 40% of the global population who are concentrated in sub-Saharan Africa & developing Asia, still rely on the traditional use of biomass for cooking.

-World Energy Outlook 2016

The most important asset you need to protect in order to manage the demands of a job or an investment portfolio is your production of energy. And, just like with money, if you do a great job managing your energy, you'll get a great return.

-Jim Loehr

Think about it ...

What should we do?

Science & Technology

➢ Develop context specific miniaturised appliances.

➢ Design cost effective decentralised renewable energy systems for different contexts.

➢ Develop intelligent mixed grids to reduce peak demands.

Policy & Praxis

➢ Enact policies to ensure energy security to the poor.

➢ Develop incentive structures to shift to high efficiency energy paths.

➢ Shift from fossil fuels to clean, centralised grids to renewable energy sources.

➢ Reduce import dependence by substituting imported fuels by local sources.

Economy & Finance

➢ Reduce risk of price shocks by shifting to local energy sources & building strategic reserves.

➢ Reduce costs by "just-in-time" investments to leverage disruptive innovations.

➢ Prevent inclusion & exclusion errors in subsidies (LPG, kerosene, electricity & so on).

Information

➢ Regularly monitor energy usage pattern across scales, sectors & socio-economic groups.

➢ Implement IOT systems to monitor & forecast energy demands.

➢ Enable rapid diffusion of renewable energy technologies.

Who can do what ?

Communities (C)

➢ Use IOT enabled intelligent appliances to monitor & report energy use patterns. (G+P+Cs)

➢ Create awareness about clean energy & decentralised systems. (Cs)

➢ Invest on decentralised energy systems, micro grids & net metering. (P)

➢ Source diversification for demand focused end use based systems. (P)

➢ Reduce dependency on grid supply. (G+P)

➢ Develop mechanisms to share surplus energy with poor neighbourhoods.

Government (G)

➢ Declare access to energy as a basic right & provide "on demand" supply.

➢ Develop energy policy informed by accessibility & affordability constraints. (Cs)

➢ Set up IOT based network to monitor energy consumption across end-uses.

➢ Adhere to energy efficiency & thermal comfort norms in poor housing projects. (Cs)

➢ Attract private players to invest on decentralised & clean energy generation systems. (P)

➢ Create a pool of skilled workers to serve clean energy markets. (Cs)

Private Sector (P)

➢ Innovate & market cost-effective decentralised waste to energy plants. (C+G)

➢ Develop affordable micro grid energy systems off grid appliances. (C+G)

➢ Develop circular energy economy based options for different contexts.

➢ Develop & market IOT enabled appliances to monitor energy use by demand type. (C+G)

➢ Allocate CSR funds for poor focussed solar appliances for cooking & lighting. (G+Cs)

Civil Society (Cs)

➢ Conduct research on energy efficiency to inform pro-poor energy policy. (G+C+P)

➢ Consumer behaviour studies focused on poor & identify interventions. (C+P)

➢ Demand & use forecast systems. (G)

➢ Ensure media coverage to highlight the energy access challenges & solutions. (C)

➢ Sensitise all stakeholders on energy security challenges. (C+P+G)

➢ Advocacy to ensure on-demand access to energy for all. (G)

➢ Research cheaper, efficient, renewable & less polluting energy technologies. (C+G+P)

How it connects to other sectors

➢ Economy & Finance: Reduced work time loss & reduced energy expenses.

➢ Urban Health: Less thermal discomfort & loss of productivity due to energy poverty.

➢ Urban Health: Reduced indoor air pollution due to use of biomass-based fuels.

➢ Ecology & Environment: Improved environment from reduced consumption of polluting fuels.

3. Shift to Renewable Energy

Reducing energy consumption is the simplest way to improve resilience to energy stress. Simple measures such as using energy saving devices and changing usage habits can reduce energy demand from household level upwards. Electric cars have a grid-to-wheels power efficiency of more than 60%, while fossil fuel based cars have about 20%. Reducing losses from transmission & distribution systems is cheaper than augmentation of generation capacity.

What Problems does it Address?

- ➤ Demand-supply gap due to increasing population & decreasing resources.
- ➤ Depletion of fossil fuels.
- ➤ Global climate change & environmental degradation by pollution.
- ➤ Health issues due to indoor air pollution from burning of biomass fuels.
- ➤ Increased dependence on energy imports.

It is our duty as states, citizens, and industry leaders to make the energy transition a reality with the ultimate aim of reconciling two major priorities: to meet ever-increasing demand and to confront the complex issue of climate change.

-Christophe de Margerie

Solar power is going to be absolutely essential to meeting growing energy demands while staving off climate change.

-Ramez Naam

Think about it ...

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What should we do?

Science & Technology

- ➤ Develop technology options to harness the potential of multiple Renewable Energy (RE) sources.
- ➤ Develop decentralised RE systems.

Policy & Praxis

- ➤ Prioritise RE sources in energy policy.
- ➤ Practice integrated energy resources planning from neighbourhood to city levels.
- ➤ Devise regulations & strategies for maximising the benefits of RE.

Information

- ➤ Disseminate information on RE technologies & vendors.
- ➤ Increase awareness & promote of various schemes & policies related to RE.
- ➤ Implement robust monitoring & verification for renewable systems.
- ➤ Establish data gathering systems informing regulatory & policy initiatives.

Economy & Finance

- ➤ Allocate budgets for developing RE systems.
- ➤ Provide incentives to make decentralised RE systems more competitive.
- ➤ Access low cost funds for promoting decentralised renewable energy systems.
- ➤ Introduce new business models for incubating RE technologies.

Who can do what ?

Communities (C)

➢ Collect information on RE technologies, costs & specifications.

➢ Analyse energy use patterns & explore avenues for shifting to RE systems. (Cs)

➢ Identify community level champions to promote RE systems.

➢ Adopt smart & efficient RE systems & net metering.

Government (G)

➢ Assess renewable energy potential across scales & contexts.

➢ Develop energy policy to enable large-scale adoption of RE at the grassroots. (Cs)

➢ Disseminate simplified information on RE policies & benefits. (P+Cs)

➢ Incentivise RE manufacturers to promote RE technologies. (P)

➢ Provide incentives to RE prosumers across scales. (C)

➢ Allocate budgets for purchase of surplus electricity from RE prosumers. (C+P)

Private Sector (P)

➢ Allocate R&D funds for new RE technologies. (Cs)

➢ Innovate & market RE options focussed on different economic groups. (Cs)

➢ Create low-cost debt funds for promoting RE in slums & poor areas.

➢ Establish a skilled network to provide AMC & post-sale services. (C+G+Cs)

➢ Engage with the government to develop & improve RE policies. (G)

➢ Allocate CSR funds to implement RE projects in different contexts. (Cs)

Civil Society (Cs)

➢ Sensitise public & government officials on benefits of RE.

➢ Influence policymakers to develop renewable energy policies.

➢ Create platforms for constructive engagement of diverse stake-holders in RE sector.

➢ Prepare for major disruptions in energy sector from decentralised RE generation.

➢ Ensure & facilitate media coverage on RE policies & programs to create buy-in.

How it connects to other sectors

➢ Economy & Finance: Improved livelihood opportunities due to energy security.

➢ Economy & Finance: Reduced dependence on imported fossil fuels.

➢ Economy & Finance: Markets for biomass energy sources.

➢ Social Development: Renewable energy as an important & cost-effective role in slum electrification.

➢ Ecology & Environment: Reduce pressure on natural resources.

4. Develop Energy Ethics

Despite nearly a century of fossil fuel addiction, access to energy is iniquitous while we face greenhouse gas induced climate change and energy conflicts. This raises several ethical questions about equity, pollution, environmental degradation & health. The worst impacts of fossil fuel use are felt by the poor, who are also victims of energy poverty. It is important to develop energy ethics to address these issues. Transdisciplinary inputs & multi-stakeholder engagement are necessary for developing the energy ethic.

What Problems does it Address?

➢ Disparities in access to energy.
➢ Energy poverty amplifying inequity.
➢ Environmental challenges from fossil fuels & nuclear energy use.
➢ Global climate change concerns.

> Cities generate most of the global economy, and most of its energy use, resource demands and climate emissions. How we build cities over the next decades will largely determine whether we can deliver a bright green future.
>
> **-Alex Steffen**

> The ultimate test of man's conscience may be his willingness to sacrifice something today for future generations whose words of thanks will not be heard.
>
> **- Gaylord Nelson**

Think about it ...

What should we do?

Science & Technology

➢ Assess the environmental & ecological impacts of energy production systems.
➢ Build availability, access & impact scenarios.
➢ Develop decision support tools to inform energy policies.
➢ Conduct research on alternate energy systems & demand focused end-use.
➢ Develop monitoring systems to assess energy use & its impacts on health & ecosystems.

Policy & Praxis

➢ Develop multi-stakeholder led energy ethics informed by transdisciplinary inputs.
➢ Design policies, regulations & monitoring systems to embed energy ethics in the society.
➢ Sensitise stakeholders about need to eliminate energy poverty of the poor.
➢ Enable lifestyle change to motivate energy conservation & shift to clean energy options.

Information

➢ Monitor energy challenges & impacts across socio-economic groups.
➢ Develop tools to ensure information symmetry across various stakeholders.

Economy & Finance

➢ Carry out environmental & social cost-benefit analysis of energy options.
➢ Apply "polluter pays" principle & carbon taxes.
➢ Analyse livelihood shrinkage due to energy poverty.

Who can do what ?

Communities (C)

➢ Learn to value energy & discourage illegal & inefficient use.

➢ Ensure equitable sharing of energy with neighbourhoods, especially the poor.

➢ Shift to "prosumer" mode at colony levels by adopting solar/wind/waste-to-energy systems.

➢ Adopt net metering & energy efficient devices to share excess power. (G+P)

➢ Use IOT enabled monitoring systems for energy consumption across end-uses. (G+Cs)

➢ Organise preventive maintenance campaigns for energy systems & devices.

Government (G)

➢ Develop energy policy integrating energy ethics & decarbonisation goals. (P+Cs+C)

➢ Declare clean energy a basic right & provide sufficient energy to all citizens on demand. (Cs)

➢ Practice inclusive energy planning. (C+Cs+P)

➢ Ensure equitable energy access & differential tariffs targeting poor.

➢ Discourage conversion of food growing areas to energy plantations/solar energy sprawls.

➢ Conduct EIAs for energy mining/production/biofuel plantations.

➢ Implement transparent energy audits. (C+P+Cs)

➢ Incentivise energy conservation & clean RE use. (C+P+Cs)

➢ Discourage tampering of meters, wastage & pollution.

Private Sector (P)

➢ Sensitise all staff about energy ethics & its application.

➢ Design & market environmentally benign & energy efficient products.

➢ Install IOT networks in industries to monitor & audit energy use & pollution.

➢ Improve energy efficiency & reduce over-extraction of natural resources. (Cs+G)

➢ Financially support communities in energy conservation & RE projects. (C+G)

➢ Allocate CSR funds for promoting energy ethics. (G+ Cs)
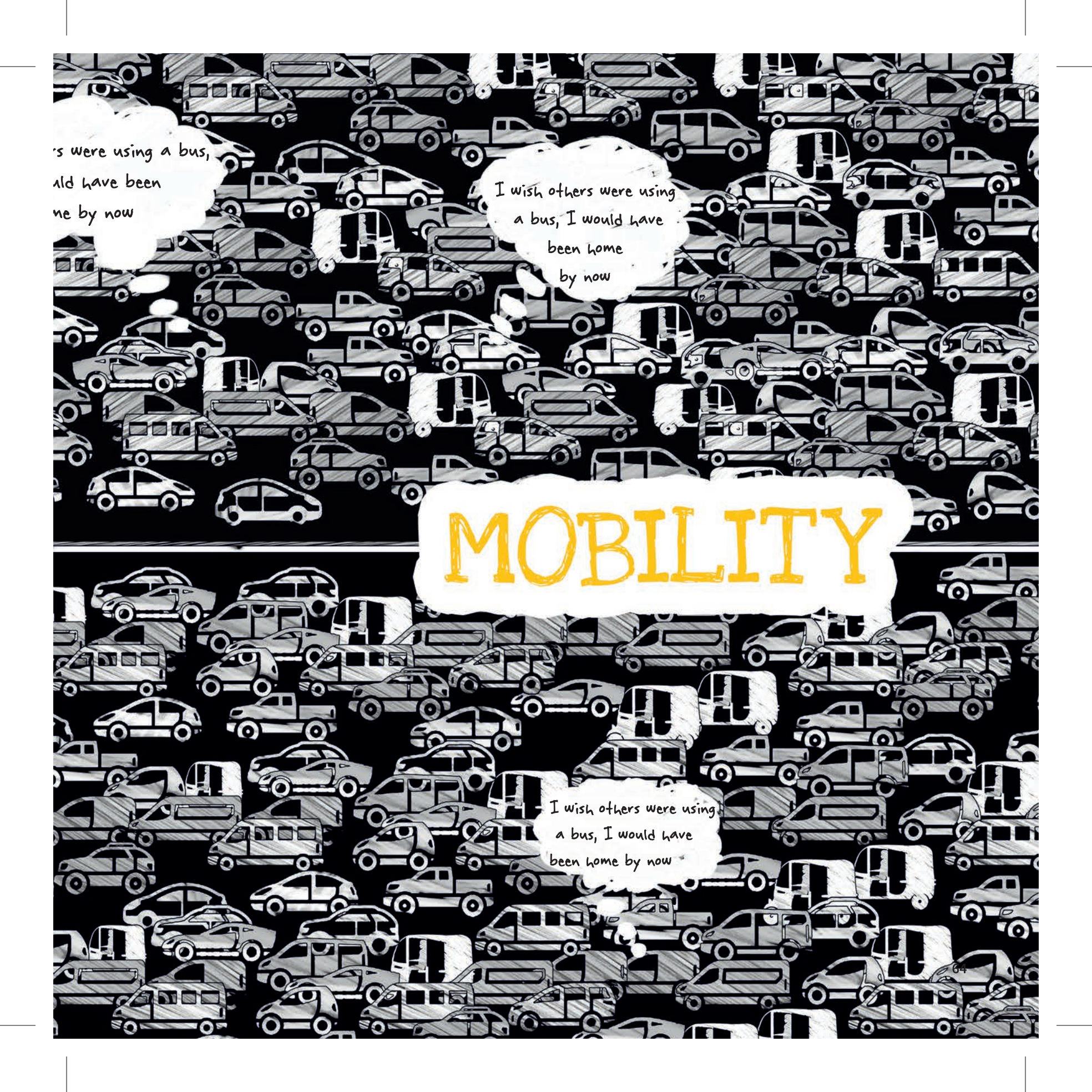
Civil Society (Cs)

➢ Conduct "carbon footprint" studies, environmental & social cost-benefit analysis of energy options.

➢ Conduct applied research for developing energy ethics. (G+P+C)

➢ Ensure regular media coverage to mainstream energy ethic.

➢ Sensitise stakeholders on ethics & it's implications. (C+G)

➢ Engage in advocacy to ensure universal access.

➢ Analyse granular data on energy access, poverty across socio-economic groups. (C+P+G)

How it connects to other sectors

➢ Economy & Finance: Reduced environmental impacts from energy production & use.

➢ Urban Health: Reduced health impacts from indoor pollution.

➢ Ecology & Environment: Sustainable resource use can reduce damage to ecology.

➢ Social Development: Improved energy access to poor can reduce conflicts over energy.
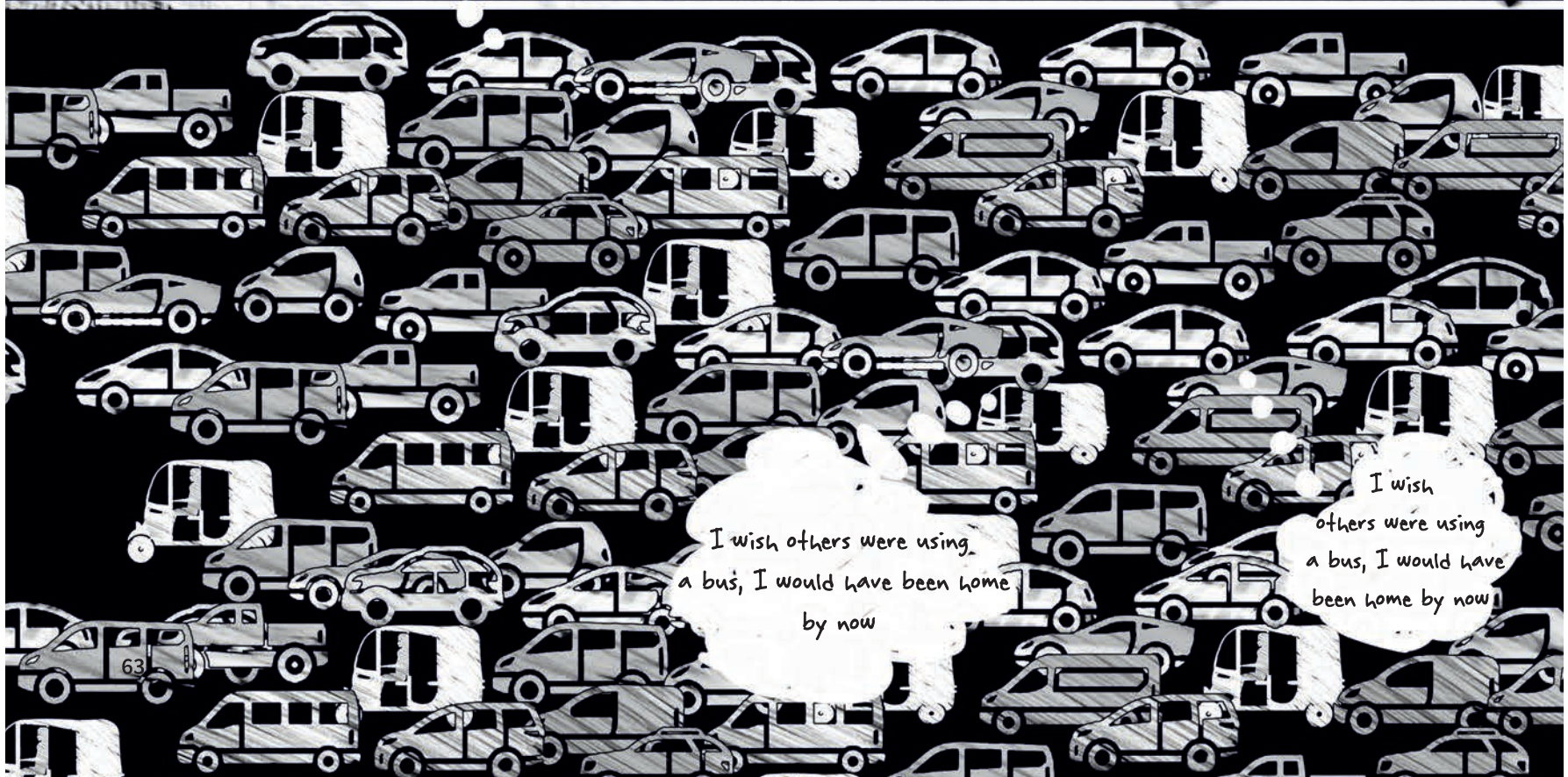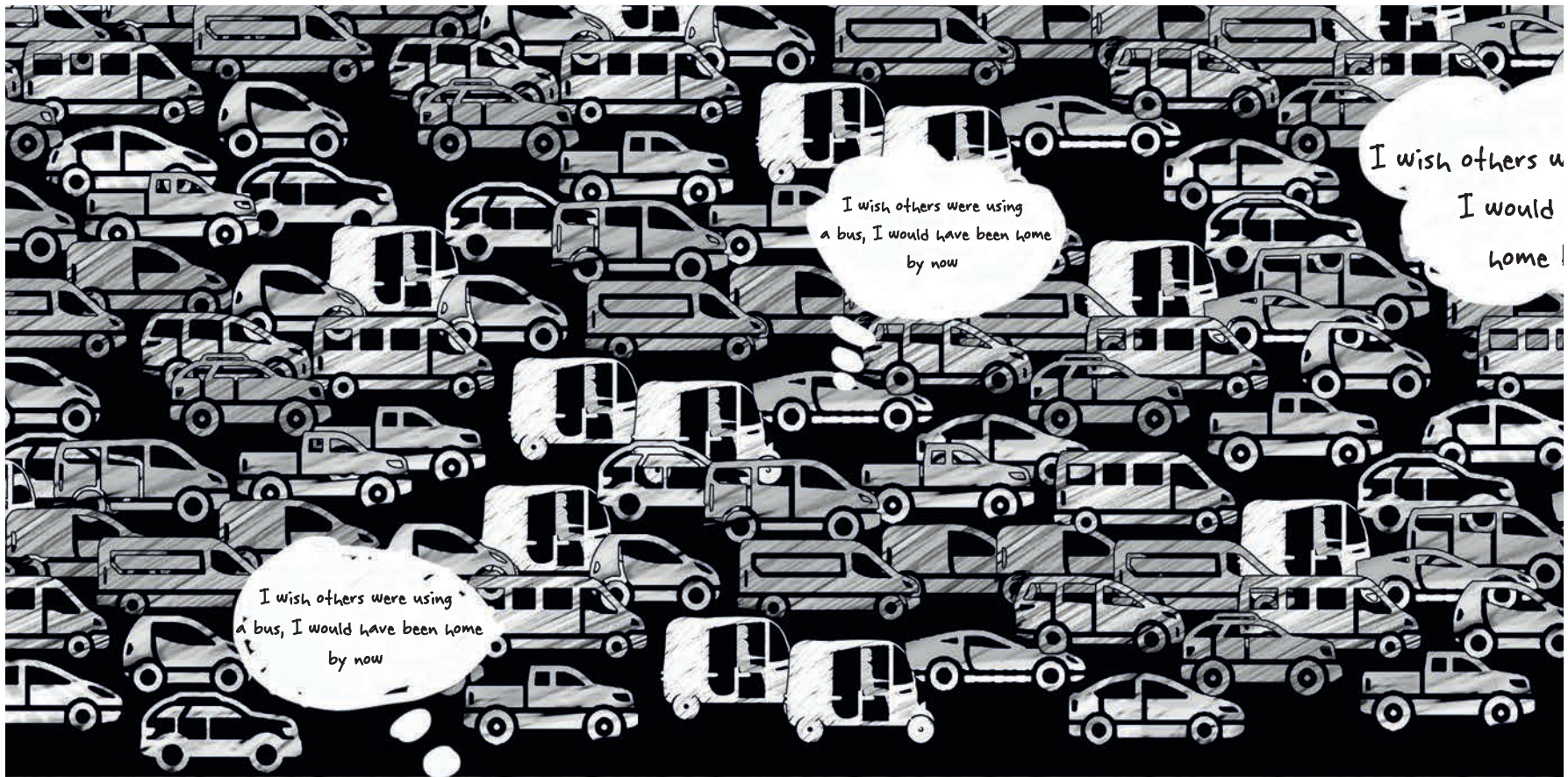
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MOBILITY

Over the years as cities expanded, the urban sprawl spread deep in to the hinterland and desakota areas sprouted, easy mobility became an important concern for economic activities and livelihoods. The introduction of steam locomotives at the end of 18th century and cars in the 1850's paved the way for the transportation revolution. The 20th century was an era of internal combustion engine based vehicles. Now the millions of road vehicles are mostly driven by fossil fuel and the automotive industry is one of the large industries across the world. We created automobiles to improve mobility, but urban sprawls, increasing commuting distances and longer wait times in traffic jams neutralised the benefits.

Commuting long distances became the norm due to the single use zoning adopted by planners and enforced by city managers. With work places located far off, the demand for mobility increased. The lack of investments in the public transportation sector, made private ownership of vehicles a necessity. Most urban residents in large cities end up spending several hours in vehicles every day shuttling from distant homes to work places.

The 1970's planning paradigm of low rise-high density settlements was not designed for large private vehicle ownership. Large areas with low passenger loads make public transport network extension a financial nightmare and subsidies make it worse. Narrow roads, a high proportion of diverse private vehicles, the use of roads for parking and vending activities, stray animals, and inadequate traffic control lead to perpetually congested roads across cities. The impatience and rude behaviour of aggravated drivers and beleaguered pedestrians further complicates the situation. Powerful private vehicles that can cruise at more than 100 km/hour end up moving at speeds at an order of magnitude less, make them unfit for Indian urban contexts. Extensive use of vehicles has given rise to unhealthy sedentary life styles and the stress of the daily commute adds to the health issues of the

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common man. The burgeoning transport sector is also one of the major causes of air pollution, impacting our wellbeing.

The urban infrastructure and services report (2011) estimates that the urban roads and transport sector alone needs 55 percent of the total additional investments for urban infrastructure over the 20-year period. Since then, taxi aggregators have disrupted the urban mobility market and electric and autonomous cars are expected to further disrupt the mobility by reducing the potential number of vehicles needed per city. Buying serviced kilometres will take the game away from private car ownership, make mobility less costly and polluting, and can reduce the time spent strapped into cars that are air conditioned, piped music playing prisons.

While these disruptions will take a decade or so, soft options such as a shift towards more public transport, enforcement of traffic and parking rules can significantly reduce the clogging of roads and travel times. The existing roads can take nearly double the passengers, if context specific soft solutions and enforcement are seriously implemented. Traffic cameras, and networked, intelligent traffic control systems can considerably smoothen the traffic, without expanding the road infrastructure. Willingness and cooperation between the commuters/drivers and the urban local bodies will be required.

The automobile industry's goal of selling more private vehicles is at variance with the possible efficient mobility solutions for the Indian cities. One of the major automobile manufacturers has stated that the private vehicle market is showing signs of plateauing with people increasingly opting for serviced kilometres from the taxi sector, alleviating the stress of driving, parking and maintaining a vehicle. The automobile industry needs to accept the disruptions and move away from legacy, low efficiency, fossil fuel driven cars. A shift towards more efficient and intelligent cars will require different buyers, such as aggregators. There are going

to be major shifts in accident liability insurance, from drivers to manufacturers.

In 2013, the Indian automobile industry contributed to almost 7 percent of the country's GDP and had 22 percent share of India's manufacturing GDP. If the automobile sector wants to continue to contribute positively in the current urban situation of traffic jams and air pollution, it must transform into more environmentally friendly and public transport centred models. It must develop anticipatory scenarios and shift from less efficient fossil fuel guzzling engines towards better technologies such as electric vehicles. The urban population will continue to be mobile, but the way they travel needs to be less time consuming, less stressful and more carbon neutral.

"Transportation is the center of the world! It is the glue of our daily lives. When it goes well, we don't see it. When it goes wrong, it negatively colors our day, makes us feel angry and impotent, curtails our possibilities."

- Robin Chase

"For every $1 billion we invest in public transportation, we create 30,000 jobs, save thousands of dollars a year for each commuter, and dramatically cut greenhouse gas emissions."

-Bernie Sanders

List of Actions

Promote Non-Motorised Transport (NMT)

Use Public & Para Transit Systems (PPTS)

Alternative Transport Technologies

Promote Low Carbon Mobility

Develop Mobility Ethics

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1. Promote Non-Motorised Transport (NMT)

NMT includes walking, cycling & cycle rickshaws. The share of NMT seems to be decreasing in most cities across India, though many poor are still largely dependent on it. Increasing commuting distances, changing work styles & safety issues are main reasons for the shift to other mobility modes. Walking & cycling have significant health benefits. Mixed land use, pedestrian & cyclist friendly road designs & prevention of encroachment by other users can enable a shift towards NMT. Major changes in the master planning process are required to ensure NMT friendly cities.

What Problems does it Address?

➢ Declining use of NMT.

➢ Worsening air pollution from growing number of motorised private vehicles.

➢ Traffic congestion.

Everyone has the right to walk from one end of the city to the other in secure and beautiful spaces. Everybody has the right to go by public transport. Everybody has the right to an unhampered view down their street, not full of railings, signs and rubbish.

-Richard Rogers

Traffic in the streets of Bombay is chaotic at best. Riding a bicycle is a dangerous occupation. However, there are hundreds of them on the streets competing with the cars and buses and lorries because it is the poor man's mode of transport.

-Rohinton Mistry

Think about it ...

What should we do?

Science & Technology

➢ Design streets to become pedestrian & bicycle friendly.

➢ Action research on improving safety issues for NMT users.

Policy & Praxis

➢ Develop NMT friendly mobility plans.

➢ Allocate road space equitably based on people rather than vehicles.

➢ Create obstruction free dedicated corridors for walking & bicycling.

➢ Enforce speed limits to reduce high speed traffic.

➢ Provide exclusive parking spaces for NMT in fast transport nodes.

Information

➢ Sensitise people on NMT.

➢ Create a WebGIS on NMT information access options.

Economy & Finance

➢ Conduct cost benefit analysis of NMT vs other modes under different scenarios.

➢ Levy NMT cess on private vehicle owners to finance the development of NMT.

Who can do what ?

Communities (C)

➢ Encourage people to use cycles for commuting.

➢ Inculcate the habit of walking/cycling to short distances.

➢ Develop community cycling clubs.

➢ Start bicycle sharing services within the community.

Government (G)

➢ Review existing policies & projects related to land use & NMT. (Cs+P)

➢ Integrate city specific NMT policies & strategies in mobility plans. (Cs)

➢ Create NMT priority zones, exclusive NMT zones & a real-time WebGIS to support NMT.

➢ Levy NMT cess on private vehicles to finance NMT infrastructure & services.

➢ Introduce special legislation for NMT related accidents.

➢ Designate exclusive bicycle parking at all public transport nodes.

➢ Incubate & support NMT based start-ups. (P)

➢ Make sidewalks & footpaths user friendly.

Private Sector (P)

➢ Innovate and develop NMT vehicles (e.g. Copenhagen wheels).

➢ Develop IOT network infrastructure for tagging & monitoring bicycles & rikshaws. (G)

➢ Explore opportunities for supporting NMT support initiatives & start-ups.

➢ Allocate CSR funds for provision & maintenance of cycling infrastructure in cities. (Cs)

Civil Society (Cs)

➢ Conduct periodic walkability & cycling studies & suggest options for addressing gaps.

➢ Conduct cost benefit analysis of NMT vs other modes under different scenarios.

➢ Develop NMT network plan, showing city-level NMT streets & priority. (G)

➢ Conduct action research on innovative designs to improve NMT. (G)

➢ Develop NMT sensitisation programmes. (C)

➢ Build stakeholder capacities to improve NMT mobility. (G)

How it connects to other sectors

➢ Economy & Finance: Reduced fuel imports & economic & environmental benefits from NMT.

➢ Energy: Reduced energy consumption for mobility.

➢ Ecology & Environment: Reduced air & noise pollution.

➢ Ecology & Environment: Reduced need for expanding road widths.

➢ Urban Health: Reduction in diseases caused by air pollution & sedentary lifestyle.

2. Use Public & Para Transit Systems (PPTS)

Indian cities did not invest sufficiently on public transport in the last century. The gap was met partially by paratransit systems. Current deficits in passenger comfort & uncertain timings restrict the growth in share of PPTS. Both components of the system should be seamlessly integrated to provide origin-to-destination solutions to facilitate modal shift towards PPTS. Prioritising PPTS & dedicated lanes can reduce the time of travel & the stress of driving on congested roads.

What Problems does it Address?

- High levels of air pollution due to vehicle emissions.
- Inadequate parking facilities & network of pickup/drop nodes for PPTS.
- Lack of traffic segregation.
- Inefficient & poorly maintained public transport.
- Safety issues in PPTS, specifically for women, children.

What should we do?

Science & Technology

- Develop scenarios and models for shift towards PPTS based mobility.
- Develop context specific solutions for integrated PPTS.

Policy & Praxis

- Integrate PPTS & NMT in mobility planning.
- Recognize paratransit as a public transport service.
- Laydown quality norms for PPTS & training of operators.
- Allocation of road space for PPTS based on passenger loads.

Information

- Develop WebGIS based systems for information on timing, crowding etc.

Economy & Finance

- Conduct cost benefit analysis of PPTs vs other mobility scenarios.
- Create barriers for private vehicles through regulatory & tariff measures.

Politicians who lack the vision to lead the community on big issues like public transport often hide their inaction by blaming other levels of government when anyone complains.

-Anthony Albanese

Think about it ...

Who can do what ?

Communities (C)

➢ Encourage greater use of public transport modes among the family/community members.

➢ Work with PPS operators to provide nodes in the neighbourhood. (G+P)

➢ Build neighbourhood level groups to promote PPTS use.

Government (G)

➢ Review existing PPTS & NMT infrastructure & service levels & identify options. (Cs+P)

➢ Increases density of PPTS nodes & provide seamless integration. (Cs+P)

➢ Create disincentives for private vehicle ownership.

➢ Integrate PPTS with mobility & decarbonisation plan of the city. (Cs)

➢ Develop & enforce quality norms for PPTS & training of operators.

➢ Periodically assess issues related to PPTS quality & improve services. (Cs)

➢ Develop integrated open access WebGIS enabled real-time tracking system.

➢ Create ecosystem for private sector investments in mass transit systems. (P)

Private Sector (P)

➢ Invest on city wide PPTS.

➢ Support innovations in intelligent mass transport & electric vehicle technologies.

➢ Allocate CSR funds for supporting PPTS in cities. (Cs+G)

Civil Society (Cs)

➢ Conduct cost benefit analysis of PPTs vs other mobility scenarios. (G+P)

➢ Conduct PPTS mobility studies to develop adaptive options. (G)

➢ Create a mass movement for shifting to PPTS & NMT. (C+G)

➢ Conduct research on innovative designs & methods to encourage use of PPTS & NMT.

How it connects to other sectors

➢ Economy & Finance: Savings from use of PPTS & time saved in commuting.

➢ Energy: Reduced energy consumption.

➢ Ecology & Environment: Reduced air & noise pollution.

➢ Ecology & Environment: Reduced per capita road area requirement releases land for environmental conservation.

➢ Economy & Finance: Increased economic productivity from less commuting time & stress.

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3. Alternative Transport Technologies

Increasing traffic congestion & air pollution are challenging cities across the world. Major disruptions in the transportation sector are expected over the next decade with innovations in cost effective electric & self-driving vehicles & taxi aggregators. Soon, people may choose to buy "serviced kilometres" rather than buying private cars.

What Problems does it Address?

➢ Environmental concerns such as pollution & global warming from burning of fossil fuels.

➢ High import dependence on fossil fuels & unpredictable prices.

➢ Growing traffic jams and parking of sleeping vehicles on road.

> Only electricity can give the transport sector the flexibility to switch fuels when one or more become too expensive.
>
> **-Frederick W. Smith**

> It is definitely true that the fundamental enabling technology for electric cars is lithium-ion as a cell chemistry technology. In the absence of that, I don't think it's possible to make an electric car that is competitive with a gasoline car.
>
> **-Elon Musk**

Think about it ...

What should we do?

Science & Technology

➢ Develop & market Electric & Hybrid Vehicles (EHV) & Self Driving Vehicles (SDV).

➢ Build mobility scenarios of cities post EHV & SDV introduction.

Policy & Praxis

➢ Develop a migration plan for mobility within city decarbonisation plan.

➢ Policies for promotion of EHVs & SDVs including insurance & liability regulations.

➢ Tax incentives for EHVs & SDVs.

➢ Encourage taxi aggregators to migrate to EHVs & SDVs.

Information

➢ Keep informed about latest urban mobility trends, & emerging challenges.

➢ Educate & sensitise city managers about these disruptive technologies.

Economy & Finance

➢ Conduct cost benefit analysis of these technologies & their impacts on livelihoods.

➢ Increase incentives & coordination between industry, cities & civil society.

➢ Create business models for "car as a service".

Who can do what ?

Communities (C)

- Get ready for the shift to alternate mobility technologies.
- Do not build excessive parking spaces in the colonies or develop migration plans.
- Shift to EHVs & plan solar/wind microgrids to charge vehicles.
- Demand installation of charging stations in the neighbourhoods.
- Explore "car as a service"options & avoid buying new fossil fuel vehicles. (P)

Government (G)

- Create disruption informed mobility scenarios and plans. (Cs)
- Prepare for liability & insurance regulations for SDVs. (P)
- Create a plan for "just-in-time" setting up of charging stations.
- Begin revamping the public transport systems to incorporate EHVs. (Cs)
- Incentivize EHV & SDV manufacturers to diffuse these technologies faster. (P)
- Establish renewable energy generation & charging station networks "just-in-time". (P)
- Create alternate livelihood options for drivers through skill building. (Cs)

Private Sector (P)

- Create migration plans & invest on EHV & SDV & battery technologies.
- Innovate, develop & market EHV & SDVs.
- Increase awareness among consumers about the oncoming disruptive innovations. (Cs)
- Provide advisory & advocacy support to government to promote these systems. (G)
- Improve the taxi aggregator system to get EHV & SDV ready.
- Coordinate with utilities & government to set up EV charging networks.

Civil Society (Cs)

- Analyse transportation policies & programmes, through the lens of these cleaner disruptions. (G)
- Conduct cost benefit analysis of these technologies & their impacts on livelihoods. (G+P)
- Facilitate dialogue between government, manufacturers & end users. (C+G+P)
- Sensitise stakeholders about disruption from alternate vehicle technologies. (C+G+P)
- Influence policymakers to develop anticipatory policies to deal with mobility disruption. (G)
- Alternate skill training to drivers & other transport sector staff.

How it connects to other sectors
- Economy & Finance: Increased efficiency, reduced environmental costs; reduction in demand for drivers & mechanics.
- Ecology & Environment: Reduced air, noise & water pollution.
- Energy: Electric vehicles can link to microgrids & can also power houses in emergencies.
- Urban Health: Reduced pollution hazard & accident mortality rates.

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4. Promote Low Carbon Mobility

The transport sector accounted for 26 percent of all GHG emissions in 2014 and it is a major contributor to urban air pollution. Shifting to public transport, solar/wind powered electric vehicles & NMT will reduce fossil fuel consumption & environmental impacts. Disruptive innovations such as electric vehicle & solar/wind based electricity microgrids are expected to facilitate a shift to low carbon transport systems.

What Problems does it Address?
- Increasing fossil fuel powered vehicles.
- Growing air pollution in cities.
- Increasing fossil fuel import costs.

Every day I get to 'Think' and work on everything from digitizing electric grids so they can accommodate renewable energy and enable mass adoption of electric cars, helping major cities reduce congestion and pollution, to developing new micro-finance programs that help tiny businesses get started in markets such as Brazil, India, Africa.

-Ginni Rometty

I think there are more politicians in favor of electric cars than against. There are still some that are against, and I think the reasoning for that varies depending on the person, but in some cases, they just don't believe in climate change - they think oil will last forever.

-Elon Musk

Think about it ...

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What should we do?
Science & Technology
- Integrated transport planning with decarbonisation goals.
- Promotion of low-emission vehicles such as electric vehicles.
- Use of higher efficient transport technologies (e.g., improved vehicle efficiency).

Policy & Praxis
- Develop city decarbonisation plan incorporating energy use in mobility.
- Prepare network informed city plan to reduce commuting distances.
- Modify the urban structure to reduce sprawl & mobility demand.
- Encourage cycling & walking.
- Promote electric vehicle based public transport systems.
- Discourage fossil fuel driven vehicles through carbon taxes.
- Promote PPTS & NMT.

Information
- Geotag/ITS to monitor fossil fuel driven vehicles & charge carbon tax per kilometre use.
- Develop a near real-time database of fossil fuel consumption for mobility.

Economy & Finance
- Conduct environmental cost benefit analysis of existing & fossil fuel driven transport systems.
- Allocate budgets for promoting low carbon & shared transport systems.

Who can do what ?

Communities (C)

➢ Sensitise the community about impacts of fossil fuel use including air & noise pollution.

➢ Limit use of private vehicles, shift to NMT/PPTS systems/ buy "serviced kilometres". (P)

➢ Avoid congested roads & rush hours.

➢ Stop buying fossil fuel driven vehicles & shift to electric vehicles.

Government (G)

➢ Develop decarbonisation plan incorporating mobility, land use & network integrity. (Cs)

➢ Improve carbon free mass rapid transit & integrate pedestrian & bicycle infrastructure.

➢ Conduct "conservative surgery" of core cities to integrate PPTs and NMT. (Cs)

➢ Develop stricter emission standards, carbon taxes, fines for violations. (Cs+C)

➢ Implement geotagging/ ITS to track fossil fuel use for transport. (C+P+Cs)

➢ Introduce electric vehicles for public transport systems & government vehicles.

➢ Increase parking charges of fossil fuel driven vehicles.

➢ Adopt drone technology as alternative for transporting high value-low volume materials. (P)

Private Sector (P)

➢ Invest in R&D of low emission transport technologies.

➢ Develop migration plan to electric vehicles.

➢ Invest on integrated networks of solar/wind microgrids & electric transport systems.

➢ Allocate CSR funds for implementation of low-emission transport.

Civil Society (Cs)

➢ Develop scenarios based on different mixes low carbon transport options to inform policy. (G)

➢ Conduct environmental cost benefit analysis of existing & fossil fuel driven transport systems. (G+P)

➢ Prepare mobility plans integrating land use, infrastructure, technologies, & behaviour patterns. (G)

➢ Develop exclusive freight corridors & alternative intra-city goods transport systems. (G+P)

➢ Study route rationalisation & scheduling of vehicles to improve their efficiency. (G+P)

➢ Sensitise stakeholders about the ill effects of vehicular air pollution. (C+P+G)

How it connects to other sectors

➢ Urban Health: Reduction in "life years lost" from air pollution.

➢ Ecology & Environment: Reduced air, noise & water pollution.

➢ Energy: Reduced energy consumption for fuel extraction.

➢ Economy & Finance: Reduced import of fossil fuels, reduced mobility & health costs.

5. Develop Mobility Ethics

Urban mobility is a complex challenge that requires alternate framework defining its goal & methods to evaluate current urban forms, transport infrastructure & services. The urban mobility ethic should aim at mobility that is efficient & can provide equitably distributed economic, environmental & social benefits. There needs to be respect for the rights of others to access the services as well as minimal negative impacts on health & environment.

What Problems does it Address?

- ➤ Urban traffic congestion.
- ➤ Limited "right of way" for NMTs & public transport.
- ➤ Low modal share of public transport.
- ➤ Rash road behaviours & road rage.
- ➤ Unsafe roads.
- ➤ Fossil fuel dependency & air pollution.

The industrial revolution has tended to produce everywhere great urban masses that seem to be increasingly careless of ethical standards.

-Irving Babbitt

You cannot separate the buildings out from the infrastructure of cites and the mobility of transit.

-Norman Foster

In western cities, in the early years of 20th Century, horses were causing so much pollution with their dung, that cars were seen as the "green" alternative It took only a decade to shift from horse drawn carriages to cars.

Think about it ...

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What should we do?

Science & Technology

- ➤ Study current gaps in urban mobility design & management.
- ➤ Conduct research on environmental, economic & social impacts of current mobility systems.
- ➤ Explore soft options for providing just & equitable access to mobility to all.

Policy & Praxis

- ➤ Create a multi-stakeholder platform to develop urban mobility ethics.
- ➤ Prepare mobility ethics document informed by transdisciplinary knowledge & stakeholder views.
- ➤ Develop mobility plan informed by mobility ethics.
- ➤ Shift from "automobility" to "economic, environmental & social good" centred mobility.
- ➤ Shift paradigm from mobility to access.
- ➤ Adopt measures to address special needs of old, children, women & poor.
- ➤ Give priority to people, rather than vehicles.
- ➤ Develop safe, comfortable & affordable NMT& PPTS.
- ➤ Leverage disruptive innovations to implement mobility ethics.

Information

- ➤ Sensitise people on mobility ethics.
- ➤ Use media to promote mobility ethics.

Economy & Finance

- ➤ Conduct environmental, social & economic cost benefit analysis of various mobility systems.
- ➤ Allocate budgets for mainstreaming mobility ethics.

Who can do what ?

Communities (C)

➢ Sensitise the community about root causes of current mobility challenges & its impacts.

➢ Inculcate mobility ethic among all with specific focus on children. (Cs)

➢ Make neighbourhoods NMT friendly.

➢ Demand PPTS nodes in the neighbourhoods.

➢ Reduce dependency on private cars.

➢ Respect other people's rights, especially children, women & vulnerable.

➢ Plan trips & learn to be patient & humane in traffic jams.

Government (G)

➢ Develop anticipatory culture & realise possible of impacts of disruptive technologies. (Cs+P)

➢ Set up multi-stakeholder platforms to develop "Mobility Ethics" document. (Cs+C+P)

➢ Revisit & modify mobility plans integrating mobility ethics, & shift to access based planning. (Cs)

➢ Make city NMT & PPTS friendly & prioritise them.

➢ Develop & enforce regulations to control air pollution, private/fossil fuel vehicles. (Cs)

➢ Cross subsidise poor & vulnerable in public transport systems.

➢ Limit number of private vehicles by fixing ratio of vehicles to population.

➢ Develop intelligent transport & big data collection systems.

Private Sector (P)

➢ Automobile manufacturers to migrate to EHVs & SDVs & public transport systems.

➢ Develop & market environmentally friendly transport technologies.

➢ Improve safety specifications & limit maximum speed of urban vehicles.

➢ Develop a culture that incentivises/encourages use of PPTS & stop gifting cars.

➢ Sensitise employees & drivers about mobility ethics.

➢ Provide a pick-up service for employees.

➢ Allocate CSR funds for improving NMT infrastructure. (Cs+G)

Civil Society (Cs)

➢ Conduct environmental, social & economic cost benefit analysis of various mobility systems. (G)

➢ Create awareness about environmental impact of private/fossil fuel driven vehicles. (C+G)

➢ Ensure regular media coverage to mainstream mobility ethic. (C+P+G)

➢ Conduct periodic mobility surveys & provide options to mainstream mobility ethic.

How it connects to other sectors

➢ Economy & Finance: Reduced pollution related life years lost.

➢ Ecology & Environment: Reduced air, noise pollution.

➢ Urban Health: Reduced health impacts caused by air pollution & stress.

➢ Social Development: Equitable access to mobility.

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Environmental Health

ENVIRONMENTAL HEALTH

Illness leads to loss of livelihoods, expenditure on medicines and decrease in effective life years. The health and quality of life challenges faced by urban residents are the result of dysfunctional urban infrastructure, inadequate services planning, and suboptimal design of management systems. Most cities managers inherit legacy systems which were augmented piecemeal over several decades. It is necessary to revisit the design and management paradigms to rebuild cities which can provide better quality of life.

Cities are now reliant on distant sources of water, which are increasingly contaminated by fertilisers, pesticides and industrial wastes. Excessive withdrawal of groundwater has resulted in increased fluoride and arsenic in water sources. Conventional water treatment systems are just not designed to handle these complex chemicals. We see that flourishing agriculture and industrial areas such as Punjab are reporting a rising incidence of cancer and other pollution induced diseases. The pollution plumes from large cities such as Delhi are reaching downstream cities such as Agra, which had to commission very costly treatment systems. These basin level challenges need to be addressed by better monitoring and major changes in water treatment systems. Payment agreements with upstream basin areas for ecosystems services may become necessary as the scale of challenges grows.

Excessive reliance on urban mobility systems has made us sedentary. Most of the open public spaces and footpaths have been encroached upon taking away any residual desire to walk, whether to work, or to go to the market, or for leisure. The increasing incidence of cardiovascular diseases is partly a result of this sedentary lifestyle. Most people can neither afford to buy gym memberships nor have spare time for such luxuries after pursuing their livelihood activities. Preventive public health measures such as group physical exercise sessions at the community level can combine social interactions with fitness.

Our much beloved automobiles are a significant source of the air pollution in cities. Indian cities are perpetually "under construction" creating clouds of dust. Power stations located nearby add their share of particulate matter to the already polluted air. Generators installed to supplement the unreliable power supply add to the toxic mix. Inversion layers and no-wind conditions concentrate the pollutants, especially during winters. Pollution from distant sources gets a bad rap, though they may be adding very little to the load, but that small addition can take the levels from "very unhealthy" to "hazardous." The health-conscious take walks in the remaining city gardens, hoping to improve their health, oblivious to the fact that their lungs are accumulating undesirable dust particles. Recently a famous cardiac surgeon showed a comparison of photos of the lungs of a mega city resident and a villager, demonstrating the impact of the polluted city air.

The municipalities are unable to implement effective solid waste collection, transport and disposal systems. In many ULBs, the solid waste management is done by the health/sanitation department and is often headed by a medical professional, whereas this task requires expertise in managing social behaviour, logistics and knowledge of recycling and processing. ULBs are saddled with a large workforce of semi-skilled solid waste management staff. Several private sector models and technologies have been tried, but without enforcing simple segregation rules at household and colony levels, we are ending up with mountains of solid waste. Occasional strikes by the staff bring the city to its knees as the stink pervades the streets. Waste collection bins are dining tables for stray cows, pigs and dogs. who process the organic waste and redistribute the dung in the streets. Ragpickers collect the reusable materials, leaving behind solid waste rich in dust and poor in organic content. There is no control over burning waste, which adds to local air pollution. Unsorted garbage disposed of in municipal dumps occasionally catches fire and releases toxic fumes.

The urban heat island effect in tropical countries result in heat extremes and poorly designed buildings trap and retain heat. The excessive heat stress continues into the nights as the buildings release heat gained during the day. With global climate change increasing temperatures, impervious and black road surfaces can further amplify the local temperatures. Most Indian cities face heat related deaths during peak summers. Air conditioners, a luxury few decades back have now become a necessity. Electricity breakdowns can cause additional heat stress in indoor environments, and generators used to provide backup power add to the air pollution. Slums with poor roof insulation, limited space and few cooling devices are differentially impacted by heat waves. Due to inadequate ventilation, especially in poor settlements, indoor air quality is often worse than outdoors.

There are huge opportunities to build synergy between multiple stakeholders, including communities, civil society, the private sector and ULBs to solve the growing problem of solid wastes. Sensitisation to enable household level segregation is the first step in making solid waste management functional. Decentralised biogas plants and composting can significantly reduce the volume of wet organic waste that needs to be transported over large distances. We need dedicated land for decentralised sewage and waste processing, starting from the colony upwards, and must devolve the process of organic waste management to the neighbourhood groups and resident welfare associations.

Public health experts say that Indian urban lifestyles and pollution are shifting the epidemiological curve, robbing their residents of an average 10 years of effective life. Earlier cardiovascular and Chronic Obstructive Pulmonary Disease (COPD) were common after the age of 50, but now younger people are affected. About 18 percent of the Years of Life Lost (YLLs) due to premature mortality are accounted for by diarrhoea, ischemic heart disease and COPD, with the latter two showing an increasing trend between 1990 and 2010[3] . Medicines, supplements and therapeutic solutions fly off

[3] *www.healthdata.org/sites/default/...profiles/GBD/ihme_gbd_country_report_india.pdf*

the counters of the city as residents hope to maintain their quality of life. Sunlight is replaced by Vitamin-D pills, walking is replaced by gyms, air pollution is "managed" by air filters and masks.

The media is bothered more about "breaking news" of epidemics and air pollution while urban diseases silently rob years of life from millions. Questions about the environmental issues of festivals are taboo, idols are disposed of, and firecrackers lit, without a second thought for the damage and pollution. While it is the norm to question the municipalities and private sector for all urban health problems, there is a need for coordinated and coherent action effort by all stakeholders to make our cities pleasant, clean and healthy.

List of Actions

Improve Air Quality

Mitigate Rising Temperatures

Reduce Water & Vector Borne Diseases

Urban Health Surveillance Systems

Manage Basin Level Water Quality

Solid Waste Management (SWM)

1. Improve Air Quality

Urban air pollution is caused by emissions from diverse point and non-point sources. Indian cities have very few air quality measuring stations, which limits systematic assessment of air pollution sources and identification of hot spots. Systematic data collection and coordinated action between multiple stakeholders is necessary to control growing air quality challenges.

What Problems does it Address?

➢ Increasing emissions from cities.

➢ Limited access to cleaner fuels or electricity.

➢ Air pollution related morbidity & mortality.

> Poor air quality, which can be influenced by a variety of fumes, chemicals and allergens, is arguably the leading cause of triggers for most asthmatics in urban areas.
>
> **-Ian Smith**

> Like a tracer running through the veins of the city, networks of air quality sensors attached to bikes can help measure an individual's exposure to pollution and draw a dynamic map of the urban air on a human scale, as in the case of the "Copenhagen Wheel" developed by new start-up Superpedestrian.
>
> **-Carlo Ratti**

Think about it ...

What should we do?

Science & Technology

➢ Establish "high quality-low density" & "high density-low quality" IOT sensor network.

➢ Identify hot spots across seasons & sources from real-time air quality models.

➢ Develop mitigation/control measures for point & nonpoint emission sources.

➢ Conduct research on health impacts of air pollution by pollutant types.

Policy & Praxis

➢ Develop clean air policy based on emission types & sources.

➢ Include clean air & emission control concerns in city energy & industry plans.

➢ Enforce mitigation measures from large pollution sources.

➢ Promote solar & wind energy at neighbourhood levels.

➢ Implement intelligent transport systems & electric vehicles to reduce traffic jams.

➢ Enact regulations to control dust pollution from construction sites & roads.

Information

➢ Provide open access to real-time air quality data from neighbourhood level upwards.

➢ Sensitise stakeholders on health impacts of air quality to enable behaviour change.

Economy & Finance

➢ Conduct cost benefit analysis of both soft & hard air pollution mitigation options.

➢ Offer soft loans for reducing pollution to different polluters.

➢ Payment for ecosystems services to hinterland to reduce biomass burning.

Who can do what ?

Communities (C)

➢ Install public IOT sensors to monitor & report air quality. (G+Cs+P)

➢ Adopt clean fuels & solar energy. (Cs+P)

➢ Use efficient, improved cooking appliances & improve ventilation.

➢ Prevent burning of waste at neighbourhood levels.

➢ Increase vegetative cover in the neighbourhoods.

Government (G)

➢ Install IOT sensor network to monitor & report air quality. (Cs+C+P)

➢ Develop & adopt city specific clean air policy. (P)

➢ Enforce emission regulations informed by emission audits. (P)

➢ Prepare proactive action plans to address challenges before high pollution seasons.

➢ Shift to electric vehicles & promote NMT & PPTS. (Cs+P)

➢ Include air pollution control in mandate of "WLTSC". (C+Cs)

➢ Enforce "zero waste burning" & door to door collection of segregated waste.

➢ Install network of environmentally safe decentralised waste-to-energy systems.

➢ Provide subsidised clean fuels to marginalised communities.

Private Sector (P)

➢ Allocate funds for R&D on air pollution reduction, monitoring & control.

➢ Develop & market less polluting household cooking appliances. (Cs)

➢ Design & build energy efficient & well-ventilated houses.

➢ Set and adhere to air quality goals in industries & construction sites.

➢ Promote air pollution mitigation & technical support to SMEs. (Cs)

➢ Install IOT air pollution sensor networks with open access to real-time data. (Cs+G)

➢ Plant trees around industries to reduce air pollution.

➢ Use CSR funds to support air pollution monitoring, reduction & mitigation. (Cs)

Civil Society (Cs)

➢ Sensitise citizens about air quality & its impacts. (C+G+P)

➢ Support city wide sensor network to assess air quality & advise on policy interventions. (P+G)

➢ Develop open access WebGIS platforms for real-time granular air quality information. (C+G)

➢ Publish real-time air quality bulletins & warnings in media.

➢ Promote air pollution impact & mitigation research. (P+G)

➢ Conduct research on air purification measures. (G+P)

➢ Identify & share best practices for air quality management. (G)

➢ Network with government to enforce clean air policy. (G)

How it connects to other sectors

➢ Urban Health: Reduction in "life years lost" from air pollution.

➢ Economy & Finance: Reduced health care costs.

➢ Energy: Impetus for development of clean energy options.

➢ Climate Change Resilience: Reduced greenhouse gas emissions.

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2. Mitigate Rising Temperatures

Almost all cities across India are reporting unprecedented summer heat extremes, which are probably due to the conflation of heat islands & global climate change. With limited numbers of weather stations in cities, we are unable to identify hotspots & address the heat challenge. Keeping the city cooler & reducing thermal stress will require diverse sets of actions such as increasing vegetative cover & pervious areas, using cool roofs & ventilation systems, changing outdoor working hours & diffusion of space cooling devices.

What Problems does it Address?

- Urban heat island effect.
- Indoor & outdoor thermal discomfort.
- Ventilation & thermal discomfort challenges in informal settlements.
- Increase in morbidity & mortality due to conflation of extreme heat & air pollution.
- Increased energy consumption in air-conditioned buildings.
- Lack of granular information on hot spots.

Collective human actions are transforming, even ravaging, the biosphere - perhaps irreversibly - through global warming and loss of biodiversity.

-Martin Rees

The indoor and outdoor temperature extremes can be reduced by 5°C using simple technologies such as increasing tree cover and cool/green/black roofs.

-TARU leading Edge

Think about it ...

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What should we do?

Science & Technology

- Develop cool/green roof & passive ventilation technologies for diverse building types.
- Develop a network of high density low quality temperature & humidity sensors.

Policy & Praxis

- Declare extreme heat as a major health risk.
- Develop & implement heat action plans.
- Devolve local actions for mitigating urban heat effects to the communities.
- Identify the vulnerable populations & implement special measures to protect them.
- Launch mass campaigns to increase vegetative cover & reduce impervious areas.

Information

- Monitor indoor & outdoor thermal & humidity data & undertake advocacy for mitigative actions
- Identify hotspots & suggest mitigative measures.
- Provide open access to heat data from neighbourhood levels & release media advisories.

Economy & Finance

- Estimate social, economic & health costs of heat extremes & benefits of "cooling the city".

Who can do what ?

Communities (C)

➢ Increase area under vegetation & cool pavements in neighbourhoods.

➢ The indoor and outdoor temperature extremes can be reduced by 5°C using simple technologies such as increasing tree cover and cool/green/black roofs. (P+Cs)

➢ Insist on green housing technologies & retrofit the old buildings.

➢ Install public IOT sensors to monitor & report weather & air pollution. (G+Cs)

Government (G)

➢ Set up real time sensor network for monitoring temperature, humidity & air quality. (Cs)

➢ Prepare heat & air quality action plans including area/socio-economic group specific actions.

➢ Release regular location specific bulletins on heat conditions & hotspots.

➢ Declare & enforce "No Outdoor Work" periods & provide cool shelters. (Cs)

➢ Develop regulations for & promote green/cool/black roofs & cool pavements. (Cs+P)

➢ Protect & increase the green/pervious areas within the city. (C+Cs+P)

➢ Organise thermal comfort design competitions for dominant building types & retrofits. (C+P+Cs)

Private Sector (P)

➢ Develop & promote local/engineered insulating building materials. (G+Cs)

➢ Design built environments to withstand wind & temperature extremes.

➢ Use cool roofs, cool pavements in new developments.

➢ Allocate CSR funds to identify low-cost thermal comfort solutions. (Cs)

Civil Society (Cs)

➢ Manage public IOT networks & release granular heat stress information bulletins. (G+P)

➢ Prepare a catalogue of thermal comfort options.

➢ Develop heat triggers & granular advisories specially focused on vulnerable population.

➢ Conduct empirical research to understand UHI & its impacts.

➢ Develop low-cost thermal comfort options for new & old buildings.

➢ Build public awareness of health risks from urban heat.

➢ Promote tree plantations at schools, public buildings, colonies, etc. (C+G)

➢ Build capacities of health workers to recognise & treat heat-related illnesses.

How it connects to other sectors

➢ Urban Health: Reduced morbidity & mortality rates amongst the vulnerable population.

➢ Energy: Reduced energy use for cooling the living environment.

➢ Economy & Finance: Better working conditions for daily wageworkers.

➢ Economy & Finance: Reduced expenses for cooling of homes/offices.

➢ Ecology & Environment: Green roofs help develop micro-ecosystems.

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3. Reduce Water & Vector Borne Diseases

Poor sewerage & inadequate drainage systems are the root causes of the increased incidence of water & vector borne diseases. Reduction of water logging & monitoring potential mosquito breeding sites is the first step to control disease vectors. Isolating sewage from drinking water supply is necessary to control waterborne diseases. It is also important to monitor disease incidences to identify hotspots & reduce transmission of these diseases.

What Problems does it Address?

➢ Spread of serious diseases such as malaria, dengue, cholera etc.

➢ Water logging & other root causes of vector borne diseases.

➢ Lack of immediate controlling measures.

➢ Vector borne epidemics.

Anyone who thinks that they are too small to make a difference has never tried to fall asleep with a mosquito in the room.

-Christine Todd Whitman

Think about it ...

What should we do?

Science & Technology

➢ Design monitoring & surveillance systems for early detection & delineation of hotspots.

➢ Conduct context specific research to identify environmental windows for mosquito breeding/viability.

➢ Conduct research on city specific disease control methods.

➢ Develop safe & cost effective mosquito repellent technologies.

➢ Use spatially explicit risk modelling for identification of vulnerable populations.

Policy & Praxis

➢ Recognise vector/water borne disease as a major health risk.

➢ Develop policies to control waterlogging & ponding of water in construction sites.

➢ Devolve mosquito breeding surveillance & control roles to communities.

➢ Implement leak reduction measures & prevent direct pumping of water from city grid.

Information

➢ Implement water & vector borne disease forecast & warning system.

➢ Ensure open access to real-time disease incidence maps at neighbourhood scales.

Economy & Finance

➢ Conduct cost benefit analysis of water/vector borne disease control.

➢ Highlight economic benefits of disease control methods.

➢ Budget for mitigation of water/vector borne diseases.

Who can do what ?

Communities (C)

➢ Sensitise citizens about risk of water/vector borne diseases & preventive strategies. (Cs)

➢ Contribute disease data to public monitoring & surveillance systems for early detection. (G+Cs)

➢ Separate drinking water supply & reduce waterlogging in neighbourhoods. (G)

➢ Maintain healthy lakes & water bodies in neighbourhoods. (G)

➢ Prevent mosquito breeding in household & community water storage systems.

➢ Adopt window screens in buildings.

➢ Promote use of appropriate water filters, mosquito repellent devices & creams etc.

Government (G)

➢ Develop & implement sewerage & storm water drainage plan. (Cs)

➢ Declare water & vector-borne diseases as major health risks.

➢ Setup water/vector borne disease surveillance system & helplines. (C+P+Cs)

➢ Control waterlogging & encroachment of natural drainage & maintain healthy lakes.

➢ Setup helpline to report instances of contamination & water logging. (Cs)

➢ Provide safe sanitation in slum areas. (C)

➢ Establish standard operating procedures for managing water & vector borne outbreaks.

➢ Provide quick & effective medical treatment, regardless of ability to pay.

Private Sector (P)

➢ Innovate & market water filters & safe mosquito control products. (Cs)

➢ Adhere to SOPs to prevent waterlogging & mosquito control at industry/construction sites. (G)

Civil Society (Cs)

➢ Demonstrate context specific water filters/vector control initiatives. (G+C)

➢ Generate public awareness of health risks from water/vector borne diseases. (C)

➢ Conduct epidemiological research & identify hotspots & root causes.

➢ Support health authorities in surveillance systems management. (G)

➢ Build capacity of officials on clinical management, diagnosis & vector control. (G)

How it connects to other sectors

➢ Economy & Finance: Reduction in workdays lost due to water/vector-borne diseases.

➢ Urban Health: Reduced disease incidence.

➢ Social Development: Reduced number of sickness days.

4. Urban Health Surveillance Systems

Communicable & lifestyle disease surveillance systems are feasible with regular data collection from weather stations, hospitals & diagnostic centres. The time series data can be used to develop forecasting systems that can be used for identifying hotspots and vulnerable population groups. By understanding disease environment-lifestyle associations, it is possible to take preventive measures & control outbreaks with greater effectiveness.

What Problems does it Address?

➢ Morbidity & mortality from communicable diseases, heat stress & lifestyle diseases.

➢ Health impacts of climate change related extreme events.

➢ Loss of workdays due to disease.

Over and over, nature shows that it's a really tough adversary. That's why it's important that we invest in laboratories, disease detectives, research, mosquito control, the public health system around the world to find, stop, track, prevent health threats.

-Tom Frieden

Think about it ...

What should we do?

Science & Technology

➢ Develop mobile based disease surveillance tools with integrated web-mapping.

➢ Understand linkages between environment, lifestyles & diseases.

➢ Develop disease risk information & forecast systems.

Policy & Praxis

➢ Develop structured response mechanisms.

➢ Prepare & share action plans.

➢ Develop standard operation procedures for urban public health surveillance.

Information

➢ Use public IOT sensors to monitor environmental parameters.

➢ Establish data collection networks for communicable & lifestyle diseases.

➢ Sensitise people to prevent water/vector borne diseases.

Economy & Finance

➢ Estimate cost and benefit of quick response mechanisms.

➢ Allocate budgets for preventive measures.

➢ Highlight economic benefits from disease forecasting & control.

Who can do what ?

Communities (C)

➢ Sensitise citizens about the association between environment, lifestyles & diseases. (G+Cs)

➢ Contribute to public weather & disease incidence reporting system. (G+Cs)

➢ Develop local systems for infrastructure maintenance & reporting. (G+Cs)

➢ Prevent degradation of neighbouring water bodies.

Government (G)

➢ Implement comprehensive urban disease surveillance systems. (Cs+P)

➢ Train public health workers to monitor, report & respond effectively. (Cs)

➢ Launch public helpline to receive disease/urban service complaints. (Cs)

➢ Devolve disease reporting & neighbourhood environmental management to communities. (C+Cs)

➢ Enforce compulsory epidemiological data reporting from private sector institutions. (P)

➢ Initiate outdoor workout programmes in public spaces. (C+Cs+P)

Private Sector (P)

➢ Provide technical & financial support to real-time disease surveillance systems. (G+Cs)

➢ Provide real time data on disease incidences. (G+Cs)

Civil Society (Cs)

➢ Sensitise community leaders about the benefits of effective surveillance. (C)

➢ Create awareness on the use of monitoring system through the media. (C+G)

➢ Support training of medical practitioners & health officers. (G)

➢ Analyse bottlenecks within existing health surveillance systems & recommend options. (G)

➢ Conduct research on climate, urban services, lifestyles & epidemiology associations. (G)

How it connects to other sectors

➢ Urban Health: Reduced paperwork & increased efficiency of the public health services.

➢ Economy & Finance: Contextualised solutions to reduce economic costs of diseases.

5. Manage Basin Level Water Quality

Anthropogenic activities over the last two centuries have introduced many pollutants into the water cycle. Natural contaminants such as arsenic & fluorides, & anthropogenic pollutants such as chemical fertilizers, pesticides, hormones & industrial effluents are major causes of deterioration in basin level water quality. As the anthropogenic impact on water quality is growing, monitoring & control of waterborne contaminants is becoming increasingly necessary.

What Problems does it Address?

➢ Water pollution from upstream sources.

➢ Chemical contamination of water from agriculture, industry, mining & upstream cities.

➢ Growing incidences of cancers & other serious health problems from water contamination.

Ranchers need clean water for their stock, farmers need it for their crops, every employer needs it to stay in business, and every living thing needs it for life... The law needs to be clear to protect water quality and the rights of landowners.

-Mark Udall

Think about it ...

What should we do?

Science & Technology

➢ Conduct research on context specific pollutants & their sources.

➢ Develop ecological options for remediation for upstream pollutants.

Policy & Praxis

➢ Establish advanced water quality monitoring networks & warning systems (all sources).

➢ Develop basin level water quality management plan.

➢ Payment for ecosystem services agreements with upstream users to improve water quality.

➢ Context specific advanced water treatment systems.

Information

➢ Implement open access data & WebGIS system to track real time water quality.

➢ Identify & set up triggers & issue advance warnings to people.

Economy & Finance

➢ Cost benefit analysis of variety of interventions to improve water quality.

➢ Budget for water quality improvement programmes.

Who can do what ?

Communities (C)

➤ Test all water sources for contaminants regularly & seek solutions. (G+Cs)

➤ Seek context specific information on water quality & pollutants. (G+Cs)

➤ Use appropriate water filters & isolate drinking water supply from other uses.

➤ Keep community water sources, like wells & water holes, safe.

➤ Provide clean water to neighbouring poor communities facing water quality issues. (G)

➤ Report all chemical contaminant related diseases to municipality. (G)

➤ Avoid using toxic chemicals for any household use. (P)

Government (G)

➤ Establish advanced water quality monitoring labs & networks as necessary. (C+Cs)

➤ Collect regular data on all chemical pollutant related diseases. (P)

➤ Establish basin level water quality monitoring systems. (Cs)

➤ Adopt zero discharge policy & ecological engineering systems to reduce pollution.

➤ Develop regional water quality management plan & SOPs. (Cs+P)

➤ Create separate budget for water quality improvement, if necessary.

➤ Implement "pay for ecosystems services" agreements with upstream communities. (C)

➤ Separate drinking water supply from other uses, if the water treatment costs are high.

Private Sector (P)

➤ Ensure that factories/mines treat their wastes & set up water quality reporting systems.

➤ Develop & market low-cost, water treatment options, water-testing kits & IOT sensors.

➤ Implement voluntary disclosure policy for spills & contamination. (G)

➤ Identify legacy pollution sources & launch remediation programmes. (G)

➤ Provide safe drinking water at construction sites & other on-site workers.

➤ Label all products (food & non-food) with information on toxic & persistent chemicals.

➤ Allocate CSR funds for water quality improvement programmes.

Civil Society (Cs)

➤ Generate awareness about the city specific water contamination issues & possible solutions.

➤ Prepare city specific plan to address the root causes of the water contamination. (G)

➤ Conduct periodic surveys & generate open access hotspot maps. (G)

➤ Launch multidisciplinary research programme on water pollution & epidemiology. (G)

How it connects to other sectors

➤ Urban Health: Prevention of pollutant related diseases.

➤ Economy & Finance: Reduced loss of effective life of workers & treatment costs.

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6. Solid Waste Management (SWM)

Our cities have developed a use-and-throw culture, frugality and reuse have been discarded, and new words such as "Plasticene" and "Garbocene" have been coined to describe the era of huge piles of trash. With waste generation of 0.5 kg/capita/day on a worldwide basis, we produce about 1.3 billion tonnes of municipal waste per year. We must learn to deal with our solid wastes so that our next generations need not deal with mountains of compacted waste and floating garbage patches in the oceans.

What Problems does it Address?

➢ Growing solid waste mountains and fires.

➢ Contamination of our food system from plastics, heavy metals etc.

➢ Growth disorders from endocrine disruptors from plastics.

> I only feel angry when I see waste. When I see people throwing away things we could use.
>
> **-Mother Teresa**

> Solid wastes are the discarded leftovers of our advanced consumer society. This growing mountain of garbage and trash represents not only an attitude of indifference toward valuable natural resources, but also a serious economic and public health problem.
>
> **-Jimmy Carter**

> Pollution is nothing but the resources we are not harvesting. We allow them to be dispersed because we've been ignorant of their value.
>
> **-R. Buckminster Fuller**

Think about it ...

What should we do?

Science & Technology

➢ Create from cradle to grave tracking systems for plastics and other persistent materials.

➢ Innovate decentralised options for managing biodegradable wastes.

Policy & Praxis

➢ Include ragpickers and other informal solid waste chain operators and train them.

➢ Develop and enforce environmentally sound SWM policy.

➢ Develop & enforce rules for decentralised management and segregation.

➢ Create land use category for waste treatment/recycling.

➢ Create a tagging system for tracking plastics and environmentally harmful materials.

➢ Prevent any disruption to SWM services by developing fall-back options.

Information

➢ Implement open access data & WebGIS system to track SWM.

➢ Develop a database of harmful solid wastes such as heavy metals, plastics etc.

Economy & Finance

➢ Cost benefit analysis of variety of interventions to improve SWM.

➢ Develop a incentive/disincentive system to prevent mismanagement of wastes.

Who can do what ?

Communities (C)

➤ Identify context specific challenges to segregation.

➤ Prevent burning of solid wastes.

➤ Set up colony level integrated solid waste management system. (G+P)

➤ Incentivise segregation habits & discourage use of plastics.

➤ Work closely with the municipality, ragpickers & SW buyers to keep neighbourhood clean.

➤ Set up a monitoring system and report collection efficiency.

Government (G)

➤ Establish a total solid waste tracking system from neighbourhood level upwards. (Cs)

➤ Develop a context informed SWM policy. (C+Cs+P)

➤ Create an open data WebGIS for presenting SWM data. (Cs)

➤ Enforce disincentives for littering in open places.

➤ Formalise & train ragpickers & SW traders in safe management of wastes.

➤ Develop and enforce environmentally sound SWM policy. (C+Cs)

➤ Build decentralised bio-waste & construction waste recycling plants at strategic locations. (P)

➤ Include SWM in the mandate of WLTSC. (Cs)

Private Sector (P)

➤ Ensure that factories treat their solid wastes.

➤ Encourage start-ups for SWM at various scales.

➤ Develop & market low-cost decentralised bio-waste to energy systems. (G)

➤ Implement voluntary disclosure policy for all solid wastes. (Cs+ G)

➤ Identify & remediate legacy solid waste issues. (G)

➤ Label products with recycling information & collection system.

➤ Allocate CSR funds for SWM programmes. (C+ Cs)

Civil Society (Cs)

➤ Sensitise all stakeholders about growing challenges of SWM. (C+G+P)

➤ Conduct applied research on health impacts of plastics and harmful chemicals. (G+P)

➤ Regularly conduct solid waste generation and disposal surveys. (C+G+P)

➤ Launch multidisciplinary research programme to address SWM challenges. (G)

How it connects to other sectors

➤ Urban Health: Prevention of air pollution from stink and burning of wastes.

➤ Economy & Finance: Reduced costs of SWM.

➤ Ecology: Cleaner environment, rivers and oceans.

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"We must recognise that societies, economies, and the environment are all deeply connected. Individual human beings and people find meaning in this connectedness, not in separation and isolation... So every effort of ours to find solutions and to find meaning, must strengthen this connectedness."

-Azim Premji

5. CONCLUSION

Cities are the habitats for more than half of the people on earth. Cities have huge resource footprints and are major contributors to global pollution. How we manage our cities ultimately determines the quality of our life. The effective lifespans of citizens shrink year after year and billions of work hours are lost due to the impacts of shocks and stresses on the inadequate and poorly managed urban systems. The "panopticon" based centralized urban management systems are neither able to address the complexity nor help us to build resilience across scales. Modular systems provide opportunities for deliberative policy making and build synergistic management systems.

Panopticon

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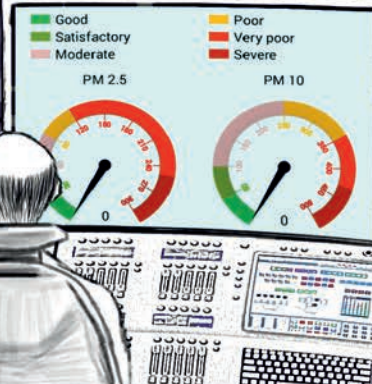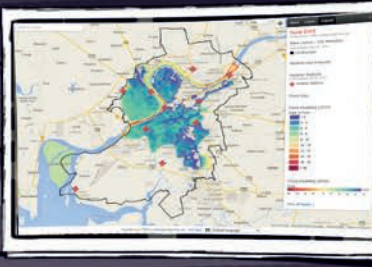
We need multiple institutions built on mutual trust and shared responsibilities to develop a coherent and inclusive vision for the future. It is necessary to realign our institutions, policies and management to address the complexity by harnessing the power of technical innovations, which can increase "cellular autonomy" from neighbourhood levels and build synergy. The urban local bodies need to create and maintain the "ecosystem" for cooperation between stakeholders, and enable knowledge sharing and innovation through better policies and governance. This will lead the way for all stakeholders to coordinate and work to improve the city's resource use and economic efficiency, and at the same time reduce risks. We should aim to build an equitable society where responsibilities are devolved based on subsidiarity with the common goal of improving the quality of life while conserving the environment. It is high time we changed our world views and mental maps. We should be able to leave behind a better earth than what we inherited for our future generations.

Cellular Autonomy

W Water E Energy B Biomass
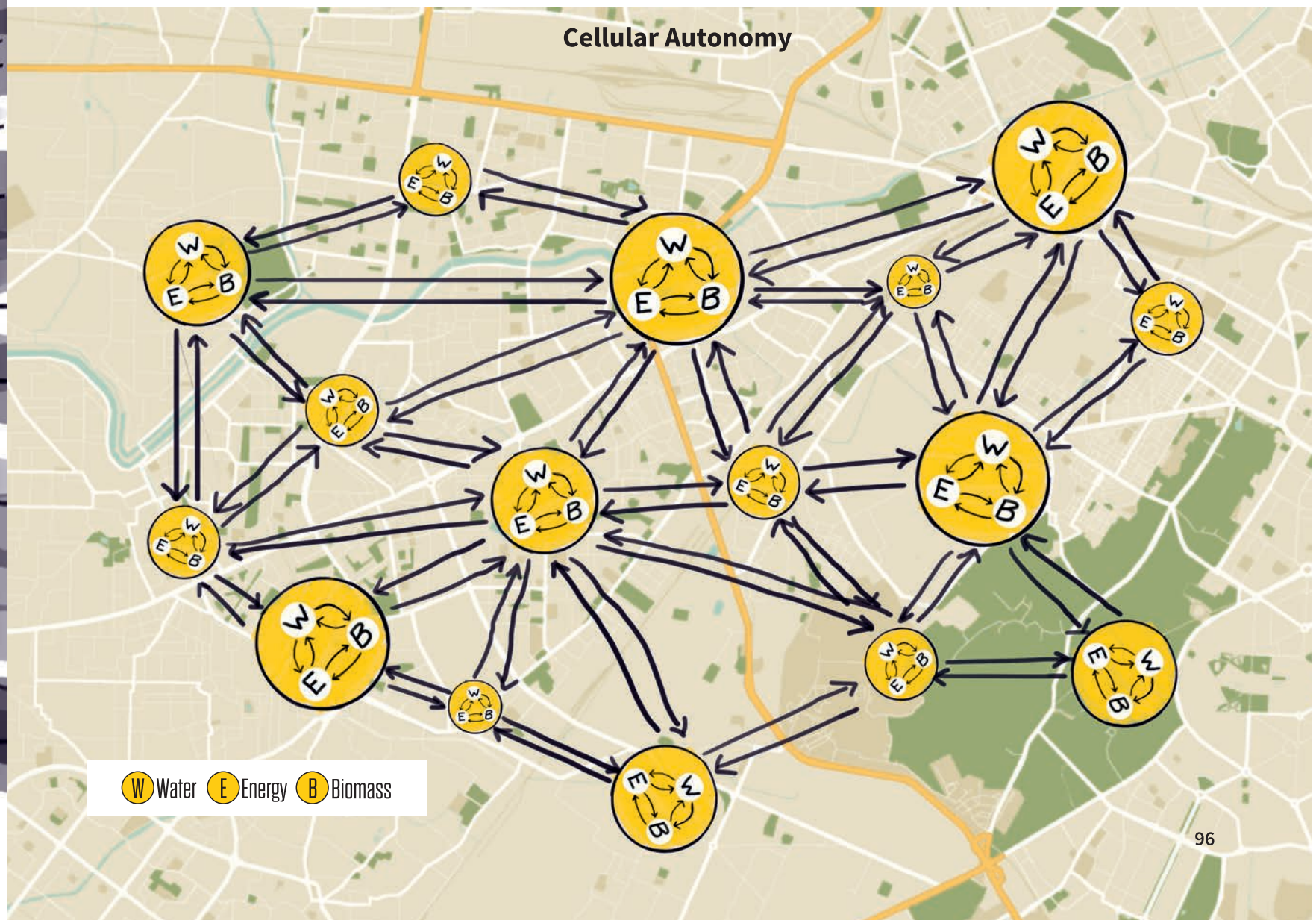
Glossary of Terms

74ᵗʰ Amendment
Amendment to the Indian constitution enacted in 1992 under which the municipalities were given power and authority to enable them to function as institutions of self-government. The municipalities were added as the third tier of government, which earlier had only two tiers namely; state and national government.

Advocacy
The act or process of supporting a cause or proposal.

Anthropocene
The Anthropocene is a proposed geological epoch dating from when human activities started to have a significant global impact on Earth's geology and ecosystems. The year 1950 is considered to be the starting point of this epoch. The radioactive elements dispersed by nuclear bomb tests, plastic pollution, soot from power stations, concrete, and, bones left by the global proliferation of the domestic chicken are considered as markers to identify this epoch.

Anticipatory culture
A culture that plans and takes mitigative action based on possibility of major changes that can impact the society or systems.

Aquifers
Any geological formation containing or conducting ground water, especially one that supplies the water for wells, springs, etc.

Autonomous cars
An automobile that is navigated and maneuvered by a computer, without a need for human control or intervention.

Big data
Extremely large data sets (e.g. data on human behaviour/ from sensors) that may be analysed computationally to reveal patterns, trends, and associations.

Bio-geochemical
Relating to the partitioning and cycling of chemical element /compounds between the living and non-living parts of an ecosystem.

Biomimicry
The design and production of materials, structures, and systems that are modelled on biological entities and processes.

Cellular autonomy
Ability of cells/components of a system to be able to take up some of the functions without having to depend on larger systems/grid (e.g. A neighbourhood autonomously able to manage its water/energy without having to depend on the urban grid/system).

Chotuu
A term of endearment for someone you care for. meaning, "little one" or "child" or "baby".

Circular economy
A circular economy is one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. An alternative to a conventional "once-through" economy (make, use, dispose).

Conjunctive resource management
Optimal use of multiple resources together (e.g. using groundwater and surface water across seasons).

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Cool roof
A roofing system that reflects most of the solar energy and reduces ingress of heat into the building.

Decarbonisation
Process of reducing reliance on carbon for production of energy and materials.

Decentralisation
The process of redistributing or dispersing functions, powers, people or things away from a central authority.

Desakota region
Areas in the extended surroundings of large cities, in which urban and agricultural forms of land use and settlement coexist and are intricately intermingled.

Disruptive innovation
An innovation that creates a new market and value network and eventually disrupts an existing market and value network, displacing established market leading firms, products and alliances. (e.g. mobile phone in the age of landline phones).

Ecosystem
A community of organisms & its environment functioning as unit.

Egalitarian
A person who advocates or supports the principle of equity for all people.

Esoteric
Intended for or likely to be understood by only a small number of people with a specialised knowledge or interest.

Ethics
The branch of knowledge that deals with moral principles.

Fatalist
A person who submits to fate and does not believe in his capacity to change the course of his life.

Favela
Slum settlement of Brazilian cities.

Floodplain
An area bordering a river which is prone to flooding.

Granular
The scale or level of detail in a set of data.

Green roof
Roof with a vegetative layer grown on a rooftop, which can reduce heat influx into the building.

Grey water
The relatively clean waste water from baths, sinks, washing machines, and other kitchen appliances.

Groundwater
Water held underground, which can be tapped.

Hierarchists
A person who believes in hierarchical principles, rule, or influence.

Hinterland
The area neighbouring to cities, which provide resources to support it.

Incentives
A payment or concession that motivates or encourages someone to do something.

Glossary of Terms

Iniquitous
Grossly unfair and morally wrong.

Internet of things
The interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data.

Literati
Well-educated people.

Micro-grids
A small-scale power grid that can operate independently or in conjunction with the area's main electrical grid.

Panopticon
A circular prison with cells arranged around a central observatory, from which prisoners can be observed without prisoners being able to communicate with each other. It also means total central control without any horizontal communication among the citizens.

Para Transit
Transportation service that supplements public transport systems (e.g. autorikshaws, mini buses)

Parastatal
A company or organization which is owned by a country's government and often has some political power.

Passive ventilation
A natural ventilation system that makes use of natural forces, such as wind and thermal buoyancy, to circulate air to and from an indoor space.

Prosumers
Consumers who are also producers. (e.g. electricity consuming households generating their own energy from solar panels).

Resilience
The capacity to recover quickly from disasters and be able to learn and improve the system.

Sahab
A polite title or form of address for a man.

Stakeholder
One who is involved in or affected by a course of action.

Synergy
The interaction or cooperation of two or more organisations, or agents to produce a combined effect greater than the sum of their separate effects.

Urban agriculture
The practice of cultivating food in or around a town, or city.

Vector borne disease
Diseases or infections transmitted by macro-organisms such as mosquitoes.

Water borne disease
Diseases or infections transmitted through contaminated water.

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