WATER GOVERNANCE AND TECHNOLOGIES IN THE SOUTH-WEST NATIONAL CAPITAL REGION OF DELHI: CHALLENGES OF TRANSFORMATIVE SUSTAINABLE CHANGE

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ABSTRACT

Purpose: The significance of water governance and inclusive urbanisation is reflected in the recently launched sustainable development goals. The present study is an attempt to focus on the Gurgaon-Manesar urban complex that forms part of one of the world's top fifteen global mega cities, and likely to witness greater strains of urbanisation. Despite a planned structure, this region lacks a proper mechanism for adequate water, power supply, and sewage handling devices. Groundwater is the primary source of water supply, while the construction sector is the major consumer. This unsustainable consumption of water has led to some deterring consequences.

Design/methodology/approach: To analyse the sustainable use of water and technologies, the present study will attempt to combine the eco-innovation system perspective with the pathway approach. The study has generated primary data through interviews with NGOs and planners.

Findings: The major thrust will have to be the augmentation of water resources, greater participation, and government intervention.

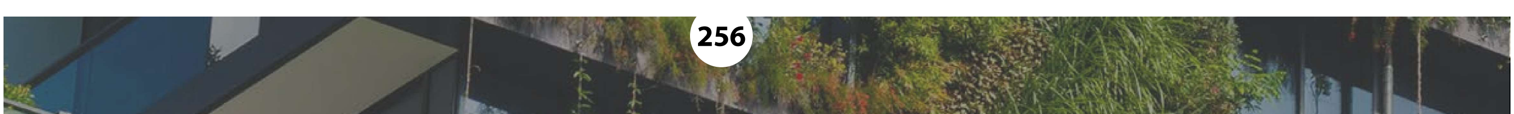
Keywords: Eco-Innovation System; Governance; India; Pathways; Sustainability; SDG; Technologies; Transformation; Water

INTRODUCTION

The concept of sustainable development gained greater recognition worldwide after the adoption of the 17 sustainable development goals by the United Nations for transforming our world by 2030. Together with this recognition, the efforts to evolve methodological and theoretical frameworks to analyse the innovation processes towards sustainable development are also receiving increasing attention. One of the approaches that has emerged is the eco-innovation system perspective. The present paper argues that this approach could be strengthened and made dynamic by combining it with the pathway approach. To analyse the problem of water governance, a combination of these approaches is used with a focus on the Gurgaon-Manesar urban complex (South-West NCR), the National Capital Region of Delhi. This is one of the world's top fifteen global mega cities and is likely to witness greater strains of urbanisation. Despite a planned structure, the study region lacks a proper mechanism for adequate water supply, power and sewage handling mechanisms. Groundwater is the primary source of water supply, while the construction sector is the major consumer. The unsustainable development towards extensive consumption of water has led to some disturbing consequences, with little rainfall, wells drying up and the city slowly turning into a concrete desert. Some of the important SDGs that focus on urbanisation and water are "Make cities and human settlements inclusive, safe, resilient, and sustainable", and "Ensure availability and sustainable management of water and sanitation for all". Whether sustainable development could be achieved without successfully attaining the preceding two goals is currently being questioned.

ANALYTICAL FRAMEWORK

With increasing attention on the innovation processes targeting sustainable development, efforts are also shifting towards evolving theoretical and methodological approaches for analysing these issues. As the nature of the innovation process for attaining sustainable goals is different from the conventional innovation system, a new approach is required for taking care of social and household innovations, the impact of regulatory mechanism on markets, and non-market innovations. Thus, focus needs to be not only on the co-evolution of technological and socio-economic factors, but also on ecological factors for studying eco-innovations (Rennings, 2000; Andersen, 2008). By adding a reflexive dimension, the pathway approach (Leach et al., 2010) is expected to enrich this framework. The pathway approach adds dynamism by identifying the dominant and alternative pathways, governance and power dimension in the transformation process.

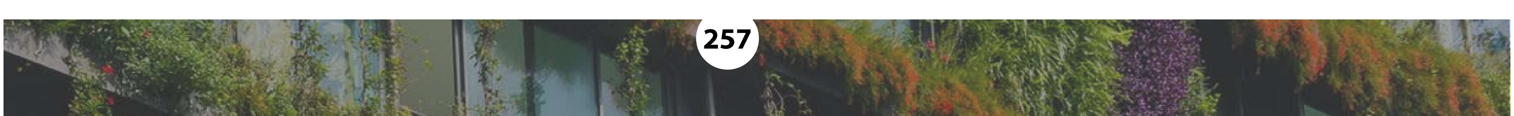


WATER-RELATED ISSUES

Gurgaon (renamed as Gurugram), the millennium city of the National Capital Region (NCR), has grown extensively in the last decade, mainly because it was treated as a satellite town to decongest the growing capital city of Delhi. It is a typical example of neo-liberal urban development. It is with this dominant pathway that this region is witnessing a massive migration and facing acute water scarcity problems, with the top priorities of providing water for the industrial and construction sectors. The situation is compounded by the multiple governance structures and successive rural and urban authorities. However, the government's efforts have been futile in keeping pace with the growth led by the private sector and developing a first-class civic infrastructure. This is evident from the severe water shortage and water logging problems faced by the city. A similar kind of problem is faced by the adjacent city of Manesar, which is an upcoming industrial town bearing a great deal of construction of offices, industries and residential societies. Manesar is also facing the problem of water scarcity by its depleting water table and water pollution.

The growing pollution of water sources through untreated or partially treated sewage and effluents is affecting the supply of safe water and, more importantly, causing environmental and health hazards. Moreover, there has been extensive groundwater pollution caused by tons of untreated waste lying near the Bandhwari waste treatment plant in Gurgaon. This has led to an eruption of diseases such as skin lesions, bloody diarrhoea and dermatitis among people from neighbouring villages. The waste treatment plant meant for the Gurgaon and Faridabad districts has been lying dysfunctional for the last two years. According to Haryana government estimates, around 92 acres in the Aravalis have been recognised as a garbage dumping site, generated from Gurgaon and Faridabad. Due to leachate of the garbage dumping, the groundwater in the entire region is becoming polluted and destroyed (Arora, 2015).

Promoting water use efficiency in the urban sector holds immense promise for curtailing the stress, thereby ensuring sustainable water resource management. There is a need to increasingly move towards opportunities to conserve, reduce, reuse and recycle treated water and wastewater through good governance. Water use efficiencies need to be improved through continuous water balance and water accounting studies (CII, 2013). Therefore, apart from the government's role in solving water related problems, the active participatory role played by NGOs in water conservation and other water related issues needs to be studied in detail. It is in this context that the present paper deals with the water-based initiatives in the Gurgaon and Manesar regions.

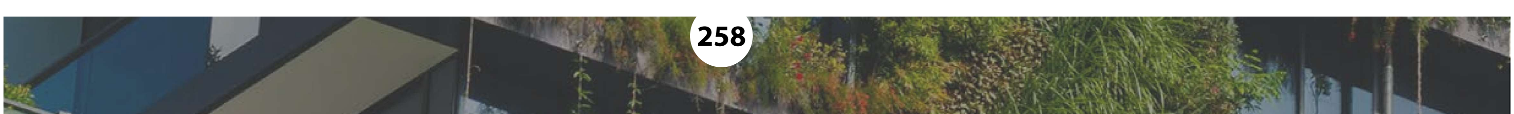


WATER SOURCES IN GURGAON AND MANESAR

There are primarily two agencies supplying water in Gurgaon, depending on the administrative divisions: the Public Health and Engineering Department (PHED), which supplies water in the old city area, while the Haryana Urban Development Authority (HUDA) is responsible for the new city of Gurgaon. The Haryana State Industrial and Infrastructure Development Corporation (HSIIDC), which is a Public Limited Company owned by the Government of Haryana, is responsible for the water supply system, sewage and drainage system in Manesar. The primary sources of the water supply in Gurgaon and Manesar is underground water and, after treatment, surface water from the Gurgaon Water Supply (GWS) canal. Many years ago, the GWS canal was constructed by the Irrigation Department of Haryana, basically for drinking water for Gurgaon city and other towns/villages. The dependability of local underground water has considerably reduced, and it has become an over-exploited zone. The quality of underground water in Gurgaon and Manesar is deteriorating, making it unfit for human consumption in parts of the town. The quality of raw water in the canal is healthy and treatable. This canal water is already a source for many towns and villages including Gurgaon. Water is also extracted from tube wells drilled in various parts of the town; it is then supplied directly into the distribution network. The distribution system in HSIIDC areas has been laid on a sectoral basis; water is received in ground level reservoirs and then pumped to Overhead Service Reservoirs (OHSRs) from where it is supplied through the distribution system. The disinfection of water is done by chlorine. However, the existing tube wells demonstrate a marked decrease in yield and deteriorating water quality (IMT Manesar Water Supply Project Draft Report, 2014).

It is evident that the water table in Gurgaon and Manesar has gone down considerably. With the presence of 265 construction projects, there is a huge water scarcity problem since most of the water is being extracted and used by these builders. They do this either by taking water from HUDA, or illegally extracting groundwater from borewells.

According to the Central Ground Water Board (CGWB), the water level in Gurgaon in 2003 was 43 metres below ground level (mbgl): in 2006, it had declined to 51mbgl. The fall in the water level has been reported to be as high as 3m per year in this period. An integrated groundwater resource mapping of Gurgaon district has revealed that the water table is falling at a rate of 1-1.2m annually. According to HUDA, the groundwater table had dropped from 12-15m in 1986 to 35-40m by 2006. In this context, the CGWB has warned that once the water table dwindles below 200m, only rocks will be left. The alarming drop in Gurgaon's water table has raised awareness for the Central Ground Water Authority (CGWA) under the Union Ministry of Water Resources. In December 2000, it had issued directions under Section 5 of the Environment Protection Act, 1986:



> "No person/organisation/agency (government or non-government) shall undertake the operation of drilling, construction, installation of any structure and any scheme/project of groundwater development and management in Gurgaon town and its adjoining industrial area of Manesar, without prior specific approval of the Authority."

It had also directed authorities to register all existing groundwater abstraction structures. Between 2 July and 31 October 2001, 8,500 such structures were registered. However, implementation of the order was not properly undertaken (CSE, 2013).

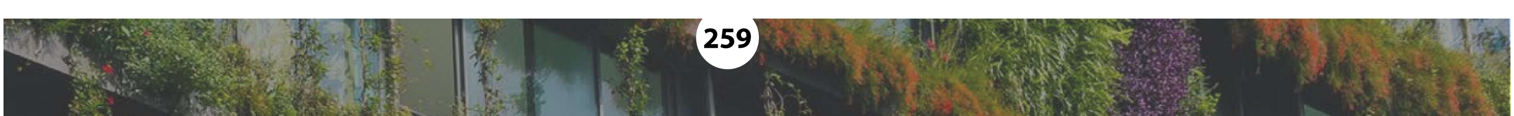
After dealing with the sources of water supply and the related demand side gap in Gurgaon and Manesar regions, it became imperative to discuss the status of water pollution in the area. With the increase in water-borne diseases being reported every day, experts believed the level of contamination in Millennium City's water had reached alarming levels and is not fit for drinking. Water pollution is a major problem in the city; nearly 40% of the water available for drinking or cooking has high concentrations of nitrate, chlorine, fluoride[1], iron, salinity and TDS (total dissolved solids). The desirable amount of TDS ranges between 500mg per litre and 2,000mg per litre; the figure in Gurgaon exceeds 7,000mg per litre (Thakur, 2013).

DEMAND AND SUPPLY GAP

With the growing population and increasing pressure on land and water resources, the per capita water availability is declining day-by-day. The official estimation of the overall demand for water in Gurgaon is almost 51% higher than the figures arrived at by the norm set by the Central Public Health and Environmental Engineering Organization (CPHEEO). Supply does not match either demand estimation: the gap between official demand and supply is about 42%. According to a 2006 draft report prepared by a Delhi-based engineering and construction consultancy, the total water supply in Gurgaon's PHED limits amounted to a little over 30 million litres a day (MLD) for a population of 0.295 million, at a rate of 103 litres per capita daily (LPCD). The estimated water demand in this area was about 35 MLD; this, therefore, worked out to be 157 LPCD (CSE, 2013).

With demand and supply gaps continuously increasing, there is a necessity to reduce this gap with sincere efforts from government and civil society. The initial 20-30% gap can be filled through simple, cost-effective demand side measures; these include water pressure management, effective leak control mechanisms, proper

[1] Shockingly, Gurgaon and Manesar have 3.6mg/l fluoride in their ground water, which can definitely cause health hazards after consumption if left untreated (Segaran, 2016).



pipelines, management of assets, and awareness programmes. These can be tagged as low-cost initiatives. A further 20-30% reduction, falling under the category of low to medium cost interventions, can be attained through recycled treated waste waters, accurate measurements and control through digital instrumentation such as remote sensing and landscaping. On the other hand, supply side interventions, such as rainwater harvesting structures, can help in reducing the demand-supply gap. These measures need to be undertaken by medium to high-cost interventions that require strategic decision-making and prudent investments. After treatment, the water for drinking purposes has to meet the Indian Standard- Drinking Water Specification (IS 10500: 1991).

In the preceding milieu, some NGOs active in the NCR region have come forward with suggestions for solving various water related issues in the Gurgaon and Manesar region, by taking effective measures for the same. The following description provides a brief account of the work undertaken by several NGOs in the water related area.

In this process, large tracts of agricultural land, together with water bodies, were taken over for developing large residential complexes. Further efforts have also been made by the government to develop Special Economic Zones and other commercial enclaves in new peri-urban locations. These are outside the city administration but within a specified development zone for which agricultural land was also acquired. This process of annexing agricultural land has caused much threat to the lives and livelihoods of the local villagers around Gurgaon. The residents in the peri-urban villages of these cities not only lost their primary source of livelihood, but also access to water, in quality and quantity, forcing them to migrate to the city for alternative sources of livelihood. In recent times, continuous pressure on available groundwater sources has increased the groundwater overdraft leading to acute water scarcity for people, especially the poor and marginalised.

Out of eight NGOs (which were interviewed), it was surprising to discover that all of them are working towards tackling water scarcity issues by establishing rainwater harvesting (RWH) structures, mainly using low-cost rooftop rainwater harvesting structures.

Four NGOs conducted awareness generation campaigns, three of them were involved in training and capacity building programmes for water conservation and safe water use. They also train people in establishing RWH structures in housing societies and schools. The NGOs stated that people are mainly becoming aware of the water scarcity scenario, and are also participating fully in such campaigns. Moreover, only four NGOs reported that they work on water pollution by solving the problems of pathogens, arsenic and turbidity by the use of different kind of water filters and applying bioremediation measures. While three NGOS were found

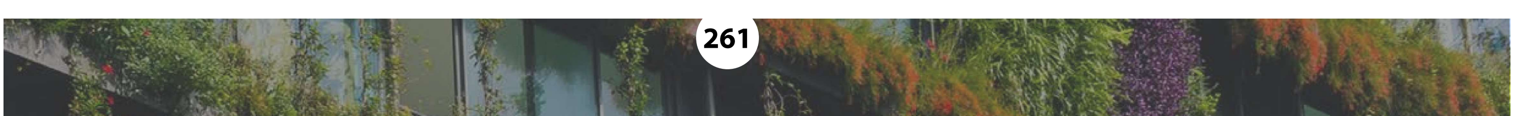
[2] SCI Order on Writ Petition (C) No. 230 of 2001.

to be focussing on wastewater treatment, some of the NGOS have also adopted mapping techniques for water and watershed development approach, and one of them abreast about water audits applied by them in villages nearby Gurgaon and Manesar.

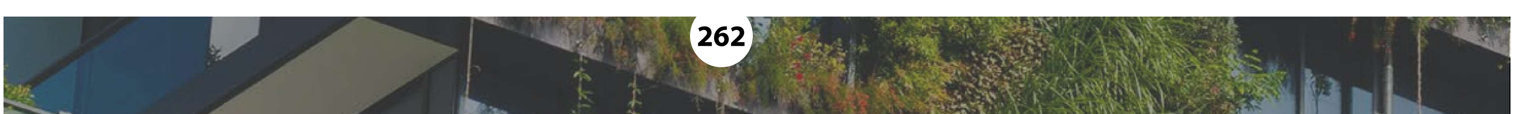
WATER TECHNOLOGY INITIATIVES:

It is noteworthy that judicial intervention[2] triggered the knowledge production in the area of water. The technology mission on Winning, Augmentation and Renovation (WAR) was launched in 2009 to undertake research-led solutions and identify technological options for various challenges in different parts of the country. The following table shows the technological options identified by the Department of Science and Technology, Government of India that apply to the present study area.

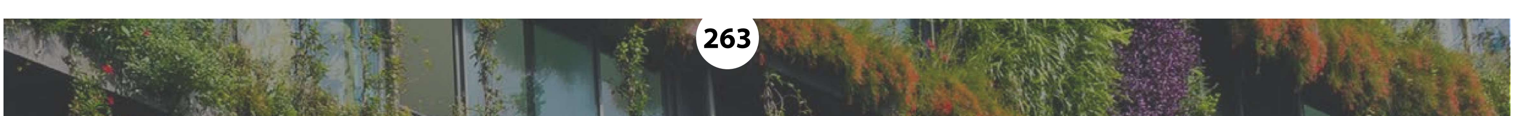
Water Problems	*Water Technologies*
Arsenic	Zero valent iron filtration system Arsenic Removal Unit (ARU) based on co-precipitation, pre-filtration, adsorption and post-filtration processes Household filter using modified laterite Ion-Specific Resins and Membrane-based system Liquid Membrane-based Separation Technique
Arsenic and iron	Ceramic membrane based contactor
Ammonia	Development of a novel hybrid process for the economic removal of ammonia from wastewaters
Ammonia, arsenic and odorous compounds	Ozone microbubbles based plant for waste water treatment
Alkaline earth metal, salinity, hardness and surface runoff	Recharge of aquifers, water conservation, water harvesting in community-based tanks, and fresh water pocket formation in schools
Bacteria	Dielectric Barrier Discharge (DBD) based micro-discharge systems Mercury Free Plasma UV (MFP-UV) lamp Zero B water purifier based on resin technology
Bacteria, viruses, parasites, protozoa, amoebae, worms, heavy metals, arsenic	Bio-sand filter



Contaminated water	Electrocoagulation based Continuous-Flow System Buoyancy driven Distillation Unit Powered by Solar Combi-collector Dielectric Barrier Discharge based plasma system Three stage filtration system consisting of pre-filtration, ultrafiltration and ultraviolet (UV) filtration unit Surface Plasmon resonance (SPR) based Watermaker, Atmospheric Water Generators (AWGs)
Dyes	Utilisation of Plant Bioresources for biosorptive removal of dyes from water Bioremediation of indigo dye containing textile effluents using microbial biofilms with adapted microorganism
Fluoride	Household de-fluoridation system Ion-exchange membranes and mixed bed resin based electro-deionisation process Magnetic and Nano-magnetic Biochars Amine-based polymer adsorbent Column adsorption media with enhanced fluoride removal capacity by mixed metal oxyhydroxide-bio polymer composite beads Graphene-metal ferrite composite RO system based on membranes, including extensive pre-treatment such as sand filtration, exposure to activated carbon, hardness removal, anti-scalant and post treatment using UV and ozonisation
Grey-Water	Grey-Water Treatment Unit
Herbicides	Advanced Electro-oxidation processes
Iron	Sand filter using ungraded sand coated with manganese dioxide Household filter and community filters based on river sand
Iron and Fluoride	Local biomass process
Iron and bacteria	Domestic filter coated with nanosilver coatings
Iron, fluoride and microbial contaminants	Rice Husk Ash Filters

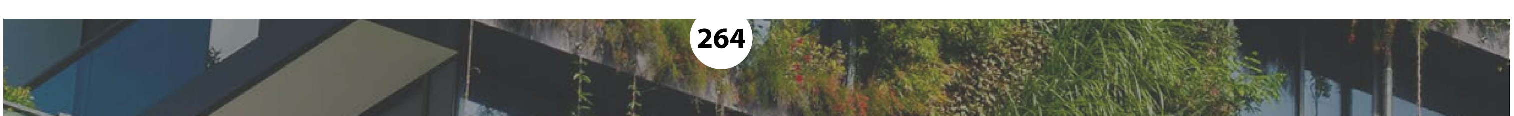


Iron and suspended impurities including pathogens	Bio-sand filters
Low per capita availability, high levels of suspended solids, bacteria	River Bank Filtration, drilling with eccentric bit and percussion drilling technique, for construction of production wells in high-energy fluvial environments
Mineral salts	Demineraliser system based on ion exchange techniques of counter current regeneration
Mineral industry effluents	Synthesis of anionic, cationic and nano-ionic flocculants based on amphoteric amylopectin for waste water treatment
Microbes, bacteria and other matters	Nanotechnology-based filter
Nutrients	Anaerobic treatment
Nitrogenous compounds	Catalytic Oxidation of Nitrogenous Aromatic compounds in wastewater
Pathogenic micro-organisms like coliform, salmonella, shigella, iron and arsenic	Non-chlorinated product in the form of magnesium peroxide in composition with immobilised copper and silver nanoparticles for the purification of drinking water
Recalcitrant compounds in industrial wastewater	Enzyme supplemented membrane based bio-reactor
Salinity	Steam generation by concentrated solar energy Low-temperature thermal desalination technology Solar multi effect distillation Multi-effect distillation (MED) with thermo vapour compressor (TVC) desalination system consisting of a linear fresnel reflector (LFR)
Salinity and fluoride	AMRIT (Arsenic and Metal Removal by Indian Technology) water purifier based on nanomaterials
Salinity, dissolved solids, bacteria, fluoride, suspended solids, hardness, Iron	Pre-aeration, pre-chlorination, pre-settling, multimedia filtration, micron filtration, Reverse osmosis and UV treatment
Strontium	Hydroxyapatite-based ceramic adsorbent
Suspended and colloidal particles	Ultrafiltration (UF) plants based on low-pressure membranes
Sewage including dissolved, colloidal, emulsified and other stable compounds	Development of nanoporous carbon by microwave pyrolysis water purification Sewage treatment plant using E-flocx as an accelerated electrocoagulation system



Surface runoff and low ground water table	Construction of check dams and catchment areas
Turbidity and bacteria	Seeds treatment using agro-based seeds such as Molinga oliefera (Drumstick), Strychnos potatorum (Nirmali), Zeemays (Maize), Coccinia Grandis (Dondakaya), Abelmoschus esculentus (Lady finger), Pisum sativum (Peas), Phaseolus vulgaris (Beans). These seeds are non-toxic and efficient coagulant aids
Toxic contaminants, fluoride, lead, hazardous metals	Phytoremediation: plants like ramacham, tamarind seed and clove are efficient in the removal of fluoride. Amaranthus spinosus and Ludwegia Peruviana helps in removal of lead and other hazardous metals.
Total dissolved solids, Fluoride, low per capita availability and over exploitation of ground water	Drinking water made available through rainwater harvesting structures, community-based tanks and Kunds
Waste water	Membranes and adsorption technology Wastewater treatment using micro-algae and bio-coagulant Development of effective absorbents from waste rubber tire for waste water treatment Development of hydrolysed and unhydrolysed polyacrylamide grafted tamarind kernel powder (TKP) as flocculants for waste water treatment Modified guar gum
Water Scarcity	Ground water recharge systems Rooftop rainwater harvesting, rainwater harvesting in paved and unpaved areas and lakes and tanks Digging borewells and enhancement of catchment areas for ground water recharge Blue and green water harvesting techniques, check dams with plastic materials and recharge filters

Source: Compiled from the DST Annual Reports, 2009-2016



In addition to declining per capita water availability and increasing salinity and pollutant levels, there are other issues such as equitable water distribution between agricultural and industrial use, rural and urban communities, privileged and marginalised populations. Therefore, it is not adequate to use a wide range of technologies that are available or the add-on or incremental innovation. Given the fact that the only water resources available in this region are the ground water, rain water/storm water and waste water, augmentation of water resources and governance issues become more relevant. This requires a transformative process of sustainable change.

URBAN WATER RELATED ISSUES IN POLICY AND PLANNING

A study by urban scholars (Chaudhry et al., 2008) indicates that the land use pattern in Gurgaon has changed, largely because of rapid urbanisation and the expansion of the city into the peri-urban areas. Using remote sensing and GIS, the study shows how the expansion of Gurgaon and development of the new satellite town of Manesar saw the total built-up area increasing from 26.58sq. km in 1996-97 to 124.15sq. km in 2001-02. Most of this expansion has taken place in areas that were earlier scrubland, pastures, water bodies, land susceptible to waterlogging with a high water table, or agricultural land.

Peri-urban areas of large cities are subject to being taken over by expanding boundaries and often grow on land where the natural water cycle once occurred, such as forests, meadows, or wetlands. This can harm the recharging of the groundwater table and can affect local water bodies. The natural water cycle is disrupted, and often new pollutants, such as pesticides, can create problems for an area's ecology.

Urban development policies also need to revisit and revise the existing by-laws in urban areas. This is because these by-laws often ignore the negative consequences of urban expansion for the socially and economically marginalised communities who are affected by the development enclaves, leading to reduced access to clean and safe water sources as well as other natural resources.

Often the expansion of an urban water supply is at the expense of the rural water supply, as peri-urban residents give away their land and water to allow canals to pass through to quench urban thirst, or allow water to be transported from their villages to the city in tankers. An active policy for conserving natural resources, especially water and forests in peri-urban areas, should be formulated. They are often a source of livelihood for the landless as well as for resource-poor farmers.