

## Participatory Governance: Addressing the Problem of Rising Groundwater Level in Cities

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**ABSTRACT** The 'rising groundwater level' in the cities has become a major concern all around the world. Due to the increasing level of groundwater, it is not only endangering the structures and properties but also causing major environmental problem affecting the health of the city, habitats, and the biotic of the land community. The author proposes an interdisciplinary planning strategy to deal with the issue of rising groundwater level. The fabric of a city reveals the past, present, and the future growth of the city. The technical and non-technical issues are closely interlinked. The groundwater level gets seriously affected due to increasing pressure of various man-made activities. Once the natural flow of the groundwater is affected, it can result in raising the level or lessen the level creating large number of environmental problems. In any democratic society, it has to go through a lengthy complicated process of formalities to respect the individual and social values. Socio-political decisions have always played the most important role in the execution of any project. The *utilitarian* attitude of the democratic government has become counter-productive in the name of maintaining democratic sanctity. The technical advises are overlooked to win the mass support for the political gains. Hence, the author strongly feels that the success of a project, especially if it is related to environment, does not depend on technical knowledge and solution only. The planning body should evolve a policy of 'participatory governance' constituting a well-coordinated multidisciplinary forum comprising experts from the cross-section of the society consisting the technical experts, finance experts, management experts, social organizations, community-level representatives and government agencies is the most essential component.

### INTRODUCTION

The 'rising groundwater level' in the cities has become a major concern all around the world. The increasing groundwater level is not only causing damages to the structures and properties due to water logging and flooding inside the cities but also causing major environmental problems affecting the health of the habitats. Epidemics in various forms and water-born diseases have increased in alarming numbers in many cities all over the world. Along with the deteriorating human health and the constructions and properties, the rising groundwater level is also changing the harmony of the traditional ecosystems. In this paper, the author would like to present the complex socio-political issues related to the problem of 'rising groundwater level'. The author feels that, the technical solution alone without having thorough in-depth study of socio-political aspects can not give long lasting solution.

While we are able to control the human health and protect the structures, we are not able to deal with the slow changes of the biotic. Some times the change in the biotic system is very slow, irreversible and not detectable immediately. The

new form of biotic is born and a new front of confrontation is created. Such changing in the ecosystem is opening up fresh areas of environmental threats. Thus, the changing condition of the land is resulting in destroying the natural harmony of the biotic. Following the changing condition, new financial resources, fresh research, time and energy has to be diverted to control the deteriorating condition of the city. Many important ongoing constructive projects are being stalled in order to tackle the immediate environmental problems due to the rising groundwater level. Some of the problems require immediate attention, such as, epidemics, human health care, and repairing of the damaged structures and properties. Instead of developmental projects, the taxpayer's money is diverted to tackle the immediate need of various environmental problems. Most of the environmental problems are not natural rather they are man-made. The valuable resource of funds are drained out because of unorganized approach.

Along with the short-term immediate action, there are number of long-term measurements to be addressed, such as, - reviewing the planning policy, securing the structures, and changing ecosystem and environmental degradations.

Thus, the rising groundwater level is causing a large number of interrelated complex problems through chain reaction involving the entire living and non-living beings around the site. Therefore, the author is convinced that, it requires a multi-disciplinary approach of planning strategy and execution. It requires a composite approach, involving cross-section of various expertise along with the technical and scientific approach. Under the present fast changing socio-political scenario, only technical solutions will never be able to tackle the complex problem of 'rising groundwater level in cities'. Especially when it involves human beings and environment, it requires multi-disciplinary approach. It is unfortunate, but true that, until now whenever we have come up with any solution it is always approached through an anthropocentric point of view. We have hardly tried to propose a solution that would be beneficial to the entire biotic society including human beings. The author would like to propose a model of 'participatory governance' involving various related agencies. The methodology of executing the philosophy of 'participatory governance' suggests that it should actively involve various agencies in the spirit of 'cooperation and participation'. A multi-disciplinary approach would create a holistic view benefiting the entire biotic society in which human being is also a member only.

Leopold (1980) the renowned ecologist and scientist writes in his book entitled *The Sand County Almanac*, "The Golden Rule tries to integrate the individual to society; and democracy to integrate social organization to the individual (p.238)." In any healthy society, it is an in-built spirit to integrate various sections of the society to be part of decision-making body through the 'spirit of cooperation'. Ideally, the elected representative member of the society is to play the role of catalyst between government agency and the community that they represent. However, unfortunately such practice is not given due respect and importance. The decisions are taken without having the consent of the community. The technical advises being compromised due to political compulsions because of utilitarian attitude, resulting in adverse effects on the environment. The economic compulsions, political will of the government, and the immediate need of the society etc. can create enormous complicated decision-making process. Custodio (1987) writes in the proceedings of the symposium

on the 'Groundwater Economics', "Groundwater economics is an interdisciplinary subject related to ground water exploration, exploitation, management, planning and protection, taking into account those economic concepts, values and guidelines needed for the efficient use of this resources, as well as the social priorities... and also the social implications and environmental consequences, in addition to the classical hydrological considerations (introduction)." Thus, Custodio (1987) has very correctly pointed out that, without such basic philosophy of cooperation and coordination among wide range of disciplines the successful implementation of a project is not possible. The philosophy of *participatory governance* is an essential component in the complex problem of 'rising groundwater level', due to the involvement of human factors. Unless a mechanism of democratic principle based on 'cooperation and coordination' is evolved, the complex problem of rising groundwater cannot bring any permanent solution. Based on the field study the author is convinced that, the philosophy of participatory governance would create a healthy harmonious relationship between various sectors including the environment and be the guiding spirit in executing the technical solutions.

#### **HISTORICAL ROOT OF URBAN DEVELOPMENT**

Studying the history of a city is the most important step towards finding the possible reasons for the rising underground water level. It helps in understanding the fundamental characteristics of the city habitats, original town planning, and growth, cause of changing environment and other related aspects. Unfortunately, in engineering education such humanistic curriculum is not given much importance. Alone engineering education (technical) and laboratory tests will never be able to visualize the complexity of a problem that involves human factors. Engineering and its application in societies have close relationship. All most every engineering application it boils down to human participation. Therefore, without having a socio-political and economic understanding no technology can successfully be implemented. It demands an integrated approach to understand and verify various direct and indirect issues related to the rising underground water level.

In order to understand the cause of rising groundwater level requires information of the original urban planning strategy, topography, land resources, earlier ecosystem, original sewerage system, land distribution policy, study of the old and the new developing areas etc, characteristic of the population growth, population settlement. It is observed that a city keeps on changing its locational importance based on newly available facilities, such as, transportation, communication system, available human and material resources, and strategic position along with suitable environment, such as, -fresh water supply, fertile land, scenic beauty, healthy environment, etc. Traditionally every city settlement chooses various strategic locations based on the topography of the land, water resources, slope of the land, vegetations, agricultural land positions, direction of wind and sunrise, etc.

Visualizing the characteristics of a growing city reveals that, it has its own inner life and it keeps moving like an organic substance. The old areas do not attract new human settlement due to the saturation of the available local resources in term of water, land, air, environmental safety, and other modern facilities, which may cause enormous discomfort. Thus, one time busy active neighborhood loses its attractive environment and business. It draws less importance for the population and the civic authority. The maintenance of the old areas becomes increasingly difficult and expensive. Since the old areas attract less business and human habitation, population prefers to move out of those areas in search of a better living condition followed by fall of real estate prices resulting in generating less revenue. Hence, after a number of years, a new area grows and an old area slowly dies it is a constant process of growth and decay like any other living being. The author feels a city is like an organic substance it keeps on adjusting in the changing environment and tries to survive. Hence, the history and knowledge of the changing pattern of a city helps to understand various hidden unknown factors. The successful execution of a project heavily depends on such social and geological information and data. With the help of above information one is able to study the fall and rise of the city growth, its prosperity and reasons of various environmental changes including the rising or drying groundwater level. Hence, the implementation of technical solution

without having social and anthropological data may show the success for a limited period only. A temporary solution may create an illusion of success and in long term, many of the earlier negative aspects may surface again and affect the health of the environment and the habitat.

Historically it is observed that, most of the ancient cities had grown side by the rivers at a junction where a major highway crosses. Started as a seasonal shelter and resting place for ferrying the travelers on the bank of the river at the crossing of a highway, it had gradually grown to become a hamlet. Construction of an all-weather bridge and introduction of electricity brought major changes in the horizon. The bridge and electricity attracted industries. The small sleepy village gradually became a flourishing center of trade and commerce. With the introduction of industries, people started migrating towards the city in search of employment leaving the age-old family trades. Thus, the same location, which started as a small seasonal resting-place, has become a major place of trade and commerce. The highway, one time that existed outside the village, has become a major avenue within the city planning. Thus, the highway is completely strangled by the city traffic, local population, and small-scale industries. The shops have grown right on the highway; the city traffic is plying and public using the same highway like their own neighborhood roads. The history of Kanpur city illustrates similar pictures that have become the most populated city in the North India. The City of Chicago gives the similar history.

Without having, a proper urban planning along with the nature of growth and limitations on every city is bound to face increasing environmental problems. Through the passage of time due to the increasing city limits, the industries, which were one time outside the city, have become part of the inner city complex. The urban development authority is not able to match with the rapid growth of the industries and migration of human population. The same river-water, underground water, sky, air and the land, which was needed by a small village population at a specific location, now has to support a full-grown city infrastructure. The requirement of the earth resources and river-water, underground water, sky, and land has drastically changed due to the rapid industrial development. The increasing constructions are disrupting the harmony of the

land, above and below. Groundwater level is seriously affected in many cities due to numerous heavy constructions and uncontrolled use of groundwater. Thus, the rapid dynamism of the city growth, beyond the capacity of possible solutions, has created a large number of environmental problems affecting the health of the city and its habitats. Along with the rapid growth of the city, the slow change in the biotic of the urban environment is causing much more serious problem.

Modern society has forced to bring about changes in such a way that, the characteristics of the settlements have drastically cut themselves from the old traditional binding of environment and man. Rapoport (1969) writes in his book entitled, *House Form and Culture*; "... some of the dominant characteristics of primitive and vernacular building lose force with the greater institutionalization and specialization of modern life (p.126)." The change in the society has introduced a great deal of uniformity and generalization. The modern philosophy of 'globalization' based on anthropocentric attitude has not only affected the economic development but also caused major change in environmental relationship between man and nature. The diversity of nature, where man belongs, is being subject to an unnatural form of uniformity. Large amount of easy loans and purchasing power in recent years have inspired people to construct housing and commercial complexes in areas beyond the natural capacity of the land to accommodate such large populations. Instead of relocating in the new areas for such construction growth the town planners continues to permit constructions until it reaches its saturation. Every land requires resource support for habitation and agriculture with in its limitations. Once it reaches to such saturation the harmony between human beings and land ceases.

While under-taking unnatural rate of rapid growth in shortest possible time, man has created a large number of serious environmental problems including the rising underground water level. In order to create better urban facilities, city administration is allowing large-scale changes by extracting underground water and constructions due to various socio-political and economic demands, affecting the underground water level. Man's anthropocentric attitude is increasingly alienating himself from the traditional relationship of nature and man. Tradi-

tional town planning in India under the laws of *Viswakarma* the architect had never ignored the value of man and nature relationship. The direction of wind, the course of natural groundwater flow and other biotic were maintained carefully. The science of *Vastu* was laid down based on such observations. The present philosophy of consumerism in every sphere of life-style including nature, be needs to be examined extremely carefully.

Therefore, any project without having in-depth information from every possible angle may prove to be a waste of time, money, and energy. If a location is found unfit for habitation by the earlier generation, but lately forgotten and proposed for reclamation without the knowledge of the earlier history it may create environmental problem for the future generation. Before taking up any major structural project, which may have long term effect on the environment, it must be examined carefully with the full support of the local community. Therefore, detailed information of the land and its habitats from the past is an extremely useful exercise.

#### **THE COMPLEXITY IN INTRODUCING THE PLANNING POLICY UNDER THE DEMOCRATIC GOVERNANCE**

The policy maker and the planning agencies have over and again failed to understand the integrate relationship between large number of aspects. Over ambitious projects are being cut short due to the large number of oversight of detail information and implementation difficulties. The political compulsions and decisions, the slow democratic channel of processing and limited contact with the local people makes it almost impossible to execute a project successfully. In such cases, it is found that a vacuum continues to exist between the possible technical solution and the complex socio-politico-economic condition. Hence, the proposed project does not match with the reality, the huge time gap between the project proposal and the actual time of execution. The time changes and it fails to keep up with the rapid growth of population and urbanization. The tremendous influx of population in urban area outdates the expected out-come of the project result. The 'critical triangle' between the policy maker (elected public servant) under the socio-political guideline, planning agencies (technical experts,

bureaucrats, executing officers' etc.) and the public (social organization) have failed to work in harmony.

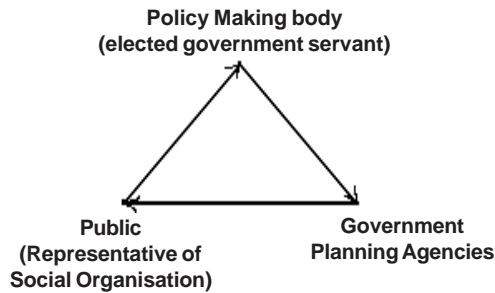


Fig. 1. Participatory governance model

Thus, the gap between the available resources for the execution of the project and demand keeps on increasing due to the unnecessary delay through the complicated democratic channel and the available limited resources are being wasted due to unusual delay in completing the project. Therefore, the much-needed marriage between the above three components has always remained distance dream.

In most of the ancient cities around the world grew on ad-hoc basis without having a proper plan of land distribution, sewerage system, planned street ways, housing, open-space concept, fresh-water supply, etc. The cities that had started with no previous town planning, had very little control over the growth once the population started increasing in an unnatural momentum. The vision of the city administration could not match with the unexpected growth of the city population and increasing demand for better livelihood. There was no regular street pattern, no checking on building constructions. They were most of the time guided by the field boundaries of individual holdings. Under the present democratic political framework, number of ethical issues is considered as the essential spirit of modern democratic society. Clean air, fresh water supply, housing, security, comfort, equal opportunity, etc., are some of the basic requirements are to be provided to the citizen by the city administration under the spirit of democratic principles.

'Participatory Governance' - is a socio-political mechanism that has to undertake a larger role and responsibility to evolve a holistic view of the problem and find the possible solution(s). The governance by the elected members may not

fulfill the desired requirement due to administrative and political compulsions. Therefore, the responsibility of finding the cause and coming up with the possible solutions would be a joint or shared responsibility of the participatory agencies. The basic spirit of democratic principle emerges out of such cooperative and participation of every member of the society. The author would like to hold every participating agency responsible in handling and executing such complex issues. Every major project that may have wide range of effects on man and environment would have to be discussed and debated in length on a common platform.

The 'democratic principle' is based on the philosophy of cooperation, equality, equal opportunity, and respect to fellow member of the society so that each member or collectively a group of people can nurture their cultural heritage, ethos, worldview, and national characters. Therefore, the policy makers and the planning agencies being the brain of the democratic machinery have tremendous responsibility. The integration between the administrative functionary and individual community largely depends on the attitude of the government agencies.

Various government agencies, under the democratic rule, evolve planning strategy based on the political agenda of the elected representatives. The social and political decisions have always played the leading role in drawing policies based on public requirements. The elected member representatives of various communities have duties to fulfill the necessary requirements of their respective communities. Unfortunately, the requirements are always projected from anthropocentric point of views. The immediate needs of private and public buildings, roadways, railway-tracks, building dam, etc. are perceived important due to human requirements. The difficulties, suffering, amusement, or comfort of fellow human being is considered more valuable. Man tries to rationalize and induce value ethics in such decisions than environmental considerations. Human and environmental values are not harmonized under the same democratic philosophy and aspirations.

Construction of underground metro-rail system or high-rise building for mass transit system and housing of hundreds of people have become synonymous to every growing city. The scarcity of land space within the city for the housing, business, entertainment, industry etc.

has forced the city to undertake large-scale building structures for mass transit, mass shopping complexes, mass entertainment, and multistoried buildings for housing and commercial purposes. The policy makers have considered building multistoried building structures, large roadways, metro-rail, to facilitate the urban movements and comfortable life style. Such twentieth century constructions and projects are more valuable and urgent than evaluating its micro level effect on environment. Influxes of population growth in urban areas are causing major environmental damages. The city planners are squeezed between the rapid demand of urban infrastructural facilities and the population growth. While trying to tackle such unprecedented situation people have sacrificed various environmental issues that may in long run affect our own survival. Thus, we tend to ignore the fundamental spirit of the democratic principles. Interestingly, while we are so concerned about the future prosperity and comfort of our own fellow human beings we are least bothered about a major partner of the same community- 'environment'. Building a dam, housing or railway tracks all are targeted towards better living, pleasure, comfort, or survival of fellow human beings. The primary value of democratic principle is directed towards the benefit of mankind. When a human community does not get enough water for drinking or farming, canals, and dams are built to save them. It is not built for enhancing the quality of surrounding environment and its habitat. The environment is given importance only if man is benefited. Thus, environment that includes water, air, soil, etc. has the larger share in the biotic, does not get the equal status. Ethically it is never considered wrong to construct high-rise buildings that may affect the underground water level in long run. It is wrong only when it affects the property or health of human beings due to the rising groundwater level. Such anthropocentric attitude of the governments around the world has increased the suffering of both, man and environment in long run. Therefore, the policy makers need to consider every project from multi-disciplinary angles.

Ray (1997) writes on the issue of conflicting value system, "It is found that norms, beliefs, values and habits that form various values and world views. Such value commonly emerges out of cultural traditions, and it is transmitted from one generation to another by respective societies.

Barbour (Ian) wrote on the empirical study conducted by Abraham Maslow on human need. The study clearly shows the order of needs in the following way- survival, security, belonging, self-esteem, and self actualization (p.321)" Therefore, the value system is largely controlled by man's own perspective of anthropocentric attitude. Naturally, the possible future problem of underground water level due to high-rise building or Underground Railroad does not evoke similar sentiment compare to the suffering of a fellow human being that requires immediate shelter or faster transit system. The question of survival between underground water level and man can never be compared on same platform or compassion. Hence, construction of building may draw much greater attention and appreciation. It would be considered more seriously even though it may disrupt the flow of the underground water level. However, over the years when the same housing and constructions are being badly effected due to the rising water level causing damage to the properties and health hazards very little one realizes the fault of the policy neglecting a valuable aspect-environmental value. Thus, environmental values may have some time direct conflict, especially when they concern livelihood. Construction of an oil refinery is one such activity, which evokes contradicting values where environmental pollution conflicts with survival of man (employment). Thus, the environmental degradation and social justice are linked together.

Leopold (1980), in this connection writes that, there is very little obligation or ethical considerations dealing with man's relation to land, animals and plants that grow upon it. The relationship between man and land is strictly economic; entailing privileges but not obligations. The respect or appreciation of a land is mostly based on economic considerations. The forestland, seaside resorts, mountains, farmland etc. can generate revenue; therefore, it draws more developmental attention than other lands. Increasingly, nature is being treated like any other consumer product. The value of land is raised through glossy advertisements.

A land, which is no use to mankind, does not attach any sentiment or value. The strong anthropocentric attitude grown in the recent years, has driven away man from its ancient friend, - nature. Unfortunately, the sentimental relationship between man and nature, which has

given man shelter, food, and creative inspiration, is today measured in term of profit and loss. Therefore, before it is too late, the author strongly feels that, it is necessary to seek such planning policy and political coalitions that would synthesize environmental values and social justices to create a harmonious relationship with environment. It is unfortunate state of affairs when planners do not visualize such conflicts in values and forces to implement a policy.

Therefore, it appears that while trying to solve the problem of survival for the fellow human being we have created number of other serious problems for man and nature in the end. Some of the newly created environmental changes have effected the biotic of the land and has much more far-reaching consequences. Krutch (1970) writes in his article entitled, 'Wilderness As A Tonic', "...the magic word cybernetic- or self-regulating. 'Feedback' is the secret of our most astonishing machines. But the famous balance of nature is the most extraordinary of all cybernetic systems. Left to itself, it is always self-regulated. The society we have created is not, on the other hand, cybernetic at all. The wisest and the most benevolent of our planning require constant attention.... The society we have created puts us in constant danger lest we ultimately find ourselves unable to direct the more and more complicated apparatus we have devised (p.243)." Krutch (1970) rightfully indicated that, nature has its own form of rhythm and harmony that ultimately recreates its own deficiency routinely (p.240). Krutch (1970) reminds that, "... nature's plan did work fairly well, but it is not certain that man's plan will...(p.240)."

In order to establish the argument of this paper in support of the model of *Participatory Governance* to protect the environment the author would like to site the example of Indo-Dutch Ganga Pollution Control Project. *Kanpur* City, the largest industrial city in North India, has a classic example of rising water level in many older areas along with pollution of the Ganges River. The rapid increasing pollution of Ganges River water, one of the most important rivers in North India, had compelled Government of India to undertaken a major water pollution control project in late 1980s. The Indo-Dutch Project on Ganga River Cleaning is a glaring example of failure where huge money, time, and energy were spent with relatively little

success achieved. The project appeared extremely successful as long as the money was flowing and the project people were around. The moment the first phase of the project was completed, the project experts and staff members handed over the project to the local authority and people to supervise the work; the project failed to show the same result. After a few years many of the water treatment plants are out of order, the local people have gone back to the same old habit of polluting the water and dumping garbage in the river. The toxic chemicals are again steadily running in to the river. The impact of the project as viewed in the beginning has started disappearing slowly. The author conducted field studies on the above project in Kanpur. The first survey was conducted in 1992 when the project was in full swing and it appeared quite affective in term of the functioning of the treatment plant, the enforcement of law for the industries and improving the environment along the bank of the river. In 1997 during the next survey, the Indo-Dutch experts had already handed over the project to the Indian administration and left. The condition of the same plant, environment, the cooperation from the neighborhood communities and industries had drastically deteriorated. The reason behind failure is the local civic body had not realized the complex socio-political compulsions while taking charge of the project. In order to improve any social and environmental condition through technical project, the policy maker has to depend on the community where it is to be implemented. Hence, the author is convinced no project can be successful unless a thorough understanding of the community, land, environment etc. is correctly understood and correlated.

Along with the river water pollution, Kanpur City is facing increasing problem of rising groundwater level in older areas of the city (*Bajaria Thana* area). The topography of the city shows that the said areas were never under the original town planning. The low land and the slope follow the natural course of the water flow towards the river Ganges. Hence, traditionally the said areas were not fit for habitation. Nevertheless, due to the increasing industrialization and population growth the people slowly occupied the same areas, which had low real estate value because of the above reasons. Presently the areas are densely populated and facing serious problem of rising underground water level due to the large-scale constructions blocking with

little facilities of sewage system, the natural flow of water causing water logging and clogging the sewerage system. Every monsoon these areas are facing serious health and property damages. The rising groundwater level is causing serious environmental degradations in the said areas.

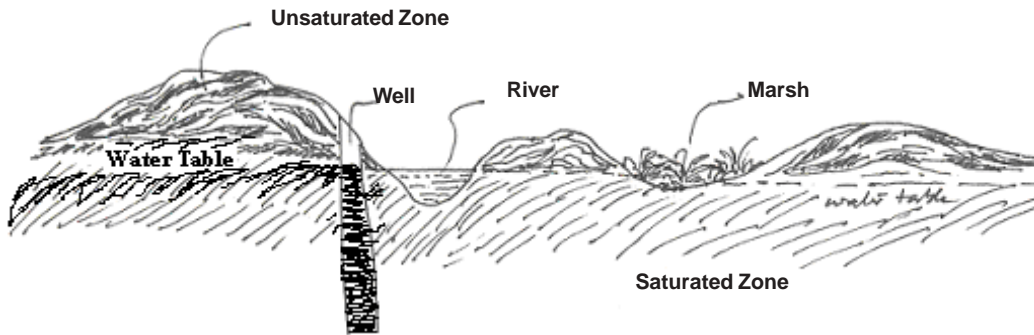
Hence, the author feels that less we interfere with the nature man has better chance of maintaining harmonious relationship with nature. Unfortunately, the democratic principle is guided by the philosophy of Utilitarianism. Under the utilitarian principle, usually the future does not bear enough responsibility. Because the more remote the consequences of our actions there are more uncertainties. The economic policies and planning in most of the cases give priority to short-term benefits. The elected public representatives have to produce the result within the limited period for the future political success. No environmental result can be achieved within a short period of time. Therefore, such projects are not in the priority list. Environmental projects are either neglected or not considered due to other political compulsions. Thus, even the seriousness of the rising groundwater level does not draw due attention compared to various immediate problems. More the project like rising groundwater level is delayed, the danger of correcting it becomes complicated and the environment is further deteriorated.

### CONCLUSION

The conflicting value system among environment, employment, and justice create enormous confusions and contradictions. Environmental Preservation, Employment Opportunity, and the Social Justice each with their own merit try to fulfill their goal and ambitions. Therefore, in order to make any environment related project, the values should be brought together at three levels- philosophical and ethical, policy decisions, and political strategy. The complexity of such system and governance can never be solved through engineering expertise. The author feels that, in most of the cases at the time of any failure of a project, the technical failure seems to get the maximum attention. The failure in discharging the duty of good citizenship and the duty of the governance seems to shed their responsibilities. No project, which involves human beings, can depend on only technical expertise or technical knowledge. In most cases

problem related to human being is directly or indirectly found to be a creation of mankind only. Decreasing rainfall due to deforestation is a creation of human beings. Polluting the air due to the emission of fossil fuel is creation of mankind. Therefore, any environment related project because of human beings requires solution from human being only. Therefore, in order to find a solution in man created problem, it requires to be examined by the 'participatory governance' of various organizations. The maintenance of the city health would largely depend on the civic authority. However, without having the full cooperation and participation from the community, no project can be successful. The policy makers have to make a strategy to induct a well-coordinated multidisciplinary committee comprising experts from the cross-section of the society. Technical experts are to be supported by the economists, management experts, social scientists, community level organizations, their representatives, and the government administrations. The three fundamental components of the social structure, -policymaking body, government agency, and the public have to coordinate and cooperate in every major step in order to make it successful. The author feels, the technical experts require fullest cooperation from the above sectors. Understanding the serious problem of rising groundwater level requires collective cooperative attitude otherwise no technical solution can achieve the success.

The illustration (Fig. 2) shows the characteristic of the underground water flow. The natural underground water level corresponds to the water level of the river that maintains the underground water level. In case of any disruption in the underground flow would naturally cause to disruption in the flow and create rising or drying the level. Once the underground water level starts raising it would naturally convert its absorbent capacity (unsaturated zone) to saturated zone. Therefore, maintaining the natural underground water flow is an essential concern for the city planners. The author feels that whenever human being is involved environment related project they tend to undermine the long-term affect on environment. It is therefore, much better to hold the project for every possible cross-examination before the implementation than execute out of compulsions. Because, the damage that may cause to the environment may not be repairable at all. The biotic of the land may alter



Subsurface Groundwater

Fig. 2. Groundwater flow

its compositions and produce that were never expected.

Case Study I: Metro Transit System, Kolkata, India

The prolong transport problem of Kolkata drew attention of the city planners, State Government and the Central Government. It was

realized that due to the geographical location of the river and the roads accounted for only 4.2% of the surface area compare to 25% Delhi and even 30% in other cities in India. In 1969, the Metropolitan Transport Project was set and the detailed studies to construct a Mass Rapid Transit System (Fig. 3) were completed in 1971. Five rapid transit lines totaling a route length of 97.5 km was envisaged. The immediate need was to construct the busy North- South connection between Dum Dum Station (North) to Tollygunge Station in (South). The length of 16.45 km running between north and south covers a significant portion parallel to the river Hoogly in the West of the city Kolkata. The thirteen stations between Kalighat Station (south) to Shyambazar Station (north) covers almost three fourth of the total length of the north-south track runs parallel to the river. The heavy underground tunnel construction stands as a solid wall between the main metropolitan city and the river. The city has grown parallel to the river Hoogly in the west and the natural slope of the underground water is from east toward the river. Therefore, the moment such construction took place the underground water flow was disrupted. The old underground sewerage system for years is not function efficiently during the monsoon season that creates water logging in many of the north part of the city low land areas. The sewage system that was planned more than hundred years ago for the city population has increased in ten folds. On the top of it after the construction of the underground metro transit, the natural underground water flow is being heavily disrupted. Similar problem is being sited across the world. The parallel route of the track along



Fig. 2a. Metro transit system, Calcutta (Source: UrbanRail.Net by Robert Schwandl, p.18)

the river might have solved the problem of the mass transportation running through the busy populated areas but created another major problem that is affecting the health of the people and causing property damage. Technical decision of the route, public demand and the political compulsions were part of the planning process. Public demand and the political decisions many times take the front seats neglecting the technical difficulties. In such decisions, it may produce short-term solutions but in long run, it may have adverse environmental effect. Because of such stretch of metro track in Kolkata, the city is constantly facing the menace of the rising groundwater level. Thus, the damages of the building constructions, collapsing the old structures (mostly in north), and the waterborne diseases have become a regular feature in Kolkata.

#### **CASE STUDY II: BHAKRA NANGAL DAM, PUNJAB, INDIA**

Punjab is a little big state of India: little because the state occupies only 1.5 per cent of the geographical area of the country and big because around two-third of the food grains procured annually in the country come from this state. Canal irrigation water that became available through the Bhakra Nangal Canal System became one of the most successful stories of India's green revolution. Simultaneously, availability of electric supply through Bhakra Hydel Project encouraged the installation of tube-wells on consolidated holdings that provided assured irrigation supplementing the canal water supply. The Bhakra Nangal project is the most prestigious hydroelectric project of India, which harnesses the waters of river Sutlej. The Bhakra Nangal project not only provides electric power to Punjab, Haryana, and Rajasthan but also to common pool consumers like the Nangal fertilizer factory, the Delhi Electric Supply undertaking, to Himachal Pradesh and to Jammu and Kashmir. Bhakra Nangal complex provided 20.3 percent of the total power for the state. Bhakra Dam (225.5.m high), stores Gross-9621 m<sup>3</sup> volume of water, while Nangal Dam to feed Nangal Hydel Channel with a capacity of 12,500 Cs. (354cm<sup>3</sup>).

The magnitude of the *Bhakra Nangal* Dam in Punjab, India, has become the symbol of progress in agriculture and engineering in the early 50s right after the independence of India.

The need of water for irrigation in otherwise the dry state of Punjab became a great challenge. The urgency and the excitement of the success overlooked some of the aspects related to the future problem in underground water level due to the construction of the dam and the nature of canals. In the recent years, *Bhakra Nangal* Dam is causing serious environmental problem and damages to the properties. The underground water level is rising and has caused damage in the machine rooms in the basement. Punjab being a dry climate state had never faced the problem of rising underground water level. Nevertheless, due to the soft earth canal bed the seepage of water inside the soil has caused two problems. First, the canals are not able to hold the water-body and second, the seeping water has raised the underground water level. Without having a concrete bed the canals have created two problems. First, it cannot hold the water supply after the monsoon seasons. Second, the supply of water starts seeping through the soil. The underground machine rooms in the dam are being affected and the flow of canal water has reduced. However, the long-term affects were not perceived and today the increasing salinity is causing serious problem in maintenance of the underground machines. While conceiving the project and implementing it perhaps nobody could imagine even that rising groundwater level could create problem in a dry area like Punjab. It appears that number of canals in other developing countries is facing similar problems. By creating canals and dams for water supply to distance places for farming, might have brought prosperity for the time being but in the end the entire purpose is getting defeated. Along with the new irrigation system through canals, it has also slowly changed the biotic condition of the local areas. The mega Hydel and Irrigation projects have considerably being affected by these problems. The expected life of the project is shortened. The technical excellences of projects are suffering due to unforeseen future hazards. The landscape may have produced more green than its earlier view but slowly the rate of food production and the power generation are in the downfall. Immediate success and glory may not be the real story when it comes to environment related projects.

#### **REFERENCES**

Barbour, Ian G.: *Technology, Environment, and Human*

- Values*. Praeger Pub., New York (1980).
- Custodio, E. and Gurguá, A. (Eds.): *Groundwater Economics Symposium*. (Proceedings), United Nations Symposium held in Barcelona, Spain (Developments in Water Science, 39), (1989).
- Elliot, R. and Gare, A. (Eds.): *Environmental Philosophy*, The Pennsylvania State University Press, Pennsylvania (1983).
- Krutch, Joseph W. : Wilderness as tonic .pp. 241-247. In: *Ecological Crisis: Readings for Survival*. Glen A. Love and Rhoda M. Love (Eds.). Harcourt Brace Jovanovich, Inc., New York (1970).
- Leopold, Aldo: *The Sand County Almanac*. Ballantine Books, New York (1982).
- Price, Michael: *Introducing Groundwater*. Chapman & Hall, London (1994).
- Ray, Amit: Conflict in value Systems in Urban Planning and Design. pp. 319-330. *International Conference on Urban Regional Environmental Planning and Informatics to Planning in an Era of Transition* (proceedings), Athens, Greece, Oct. (1997).
- Rapoport, Amos: *House Form and Culture*. Prentice-Hall Inc, New Jersey (1969).
- Rapoport, Amos: *History and Precedent in Environmental Design*. Plenum Publication, New York (1990).
- Singer, Peter: *Animal Liberation a New Ethics for Our Treatment of Animals*. Avon Books, New York (1977).