Impact assessment of pseudo urbanization on the human health and its remediation using non-conventional technique

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Abstract

The current government of India program encouraging toilet facility in villages as well as schools will have a considerable importance with respect to water resource development and pseudo urbanization in rural areas of India. The "sulab shuachalay" has given different design of soak pits for rural masses in India. These soak pits have been copied by ordinary masons without following the proper standards like dimensions, amount of sewage water, inlet and its outlet, structures and disposal of discharge water has created the water quality issues. For this purpose, the tarai region area within India is selected due to the availability of required data set for this study. This region is identified with potential exposure of water contamination and is found vulnerable with respect to water pollution due to wrong design of soak pits. As a result, the nitrogen content in ground water have increased enormously and has resulted on the health issues like ulcer and cancer in the human bodies. The present study deals with the impact assessment of pseudo urbanization on the human health and its remediation using non-conventional technique like root zone system which also improves the esthetics of the surrounding areas within the settlements and villages of Terai region areas. On an average, it is expected that around 34-40 crore people are affected by this kind of soak-pit design effecting the lifestyle and health of residing populations in Terai region of India. Therefore, this subject area requires immediate remediation to reduce its impact over the ground water quality which is the main source of drinking water in this region.

Keywords: Settlement, Water, Urbanization, Human Health, Environment

1. Introduction

India lives in villages and the mode of life of people residing in villages is different from that of life in modern cities. The facilities provided to them relating to water and sanitation along with many other things are also not sufficient for better life. Earlier people in most part of Uttar Pradesh especially Balrampur district in case traditionally used their agriculture fields for the disposal of night soil.

However, now with the advent of modernization and improvement in their living standard these sectors have got the soak pits and septic tanks, which are mostly undesigned. It has lead to plethora of problems. The night soil pollutes ground water when it directly goes into the water table or through their overflow the sewage water is collected in the pond by virtue of which the polluted water of pond further pollutes ground water as recharge. People in these areas have mostly been using hand pumps for drinking water, which has not been changed for a long time. Since the ground water is polluted and hand pumps are installed at shallow level therefore, the chances of ground water contamination leading to the occurrence of many water borne diseases like, Cholera, Typhoid, Methemoglobinaemia i.e. Blue Baby Syndrome, Decentry, Jaundice, etc is high in these areas.

Therefore, it is necessary to make assessment and characterization of Groundwater contamination and its impact on groundwater quality and human health due to the possible spread of water borne diseases in Balrampur district of Uttar Pradesh. Apart from it there is also a need to find out some possible remedial measures and evolving sustainable strategies that can be applied to check the ground water contamination from improper design of Septic Tanks and spread of water borne diseases in the district. Findings of the study can also be used as a guideline in several other parts of India, which are facing similar problems.

The impact of septic tanks on groundwater quality and in turn the health hazards caused to human lives is one of the major problems India is facing in this 21st Century. The Balrampur district has septic tanks and soaks pits as the sanitary system. Leachate, an inevitable product from the septic tanks containing volatile organic compounds and other toxic constituents in absence of adequate protection measures poses threat to groundwater systems.

Balrampur district has engulfed by the symptoms of Nitrate effects. The nitrate content is high enough and hence water is unsuitable for drinking purposes. Nitrate is a potential health threat to infants causing Methemoglobinaemia. Chronic consumption may also cause some cancer. It also leads to reduced vitality, increased stillbirth and birth weight. There is an increased risk of bladder cancer. Poor sanitary condition may result in outbreak of many other water borne diseases, iodine and iron deficiency causes havoc in the areas of Balrampur district. Cases of Goiter and Hydroceal are also reported in large number.

Ground water is extremely critical to agricultural production but there are vast stretches of land affected by pollution of ground water due to the leachate from the septic tanks in the locality. These septic tanks have been constructed to treat the wastewater derived from human excreta. Ideally the wastewater should be able to decompose and its bacteria to be destroyed in theses septic tanks. But these septic tanks are being made randomly and in totally unplanned manner. Firstly their location, which is very critical, is being taken arbitrarily whereas the septic tank should always lie downstream of the flow of water so that no drawing of water is affected by it. Secondly there are too many numbers of septic tanks in a small area. Since normally the villages are agglomerations of houses clustered together with not very well worked out drainage network, there are too many latrines in a small stretch of land. Hence the gradual seepage from numerous septic tanks accumulates to become large in quantity and reaches the ground water aquifers. Also during heavy rains this process is further accelerated whereas most of the recharge of ground water happens during this period and if this, recharging water itself is polluted it will only give impurities to the aquifers. The cleansing property of the soil is also drastically reduced because the concentration of the leachates is much higher than the soil's carrying capacity. Also due to improper construction and design of septic tanks and inadequate quality control by the local administration the positive effects of septic tank are likely to be subdued by the negative ones on ground water. Also the old septic tanks, which need regular cleaning, are often neglected and they are let to overflow. Thanks to the Policy for Rural Sanitation under the Ministry of Rural development there are many schemes where subsidies and loans are grained to local farmers both through the central and state government. But what is lacking is post-project monitoring for execution, local level planning and evaluation of design of septic tanks according to local site conditions. So there is an urgency to check on all these issues so as to keep the Ground water pure. Also the availability of ground water is inadequate in the lean months.

2. Aims and Objectives

2.1. To study & analyse the land use pattern in Tarrai Region, Balrampur District with respect to spatial distribution.

2.2. To understand the planning & placement of sanitary amenities & community supporting infrastructure.

2.3. To study the impact of wastewater originating from septic tanks on the quality of ground water and the Assessment of ambient status of contamination and identification of potential sources and pathways of migration of pollutants.

2.4. To ascertain the kind of water borne diseases in the locality.

2.5. Detailed characterization of hydro geological framework of the study area through analysis of available information and detailed field inventory.

2.6. To Perform Hydro geological and geophysical study to identify potential contamination.

2.7. To assess the above issues and evolve techniques of effective wastewater treatment and design of septic tanks to improve quality of Ground water.

3. Methodology

The study area will be studied following the methodology given below:

a) The area will be studied both in the micro level and macro level.

b) The bore wells will be located between the soak pits and the hand pumps.

c) The hand borings will be done at a depth of water level, which is 30 feet. The sites for hand boring will be chosen in such a way that the hand pumps and septic tanks are surrounded by these borings.

d) The water samples will be collected from the shallow and deep hand pumps.

e) The parameters like pH, TDS, hardness, chloride and nitrate have to be analyzed to get an idea on the extent of contamination of groundwater from shallow and deep hand pumps.

4. District Details

4.1. Location

Balrampur district is one of the newly born districts of Uttar Pradesh and has been created after being separated from Gonda district. It marks the part of northern border area of the country and lies in the extremes of latitudes 27º 26' and 27º 50' North and longitudes 82º 11' and 82º 46' East extending from the Sharavasti on the west to that of Siddhartha Nagar in the east and Nepal border running throughout the north. On the east, the Anah river separates it from Nepal for some 35 km while the Siddhartha Nagar district forms the remaining portion of the boundary. To the south of it lies the Gonda district of which it was once a part. Basti marks its southeast boundary.

Figure 1 Location Map - Balrampur District (Dept. Civil Engineering, n.d.)

The total land area utilized for different purposes is shown in table. Balrampur district is having a total area of 3377 sq kms, having total population of 1,252,269 millions as per census 2001.

Table 1 Overall Setup of Balrampur District

S.No	Description	Area in Sq.Km	Population*
1	Total Block Area	2904.5	1,252,269
2.	Total Forested Land	205	778
3.	Total Rural	3102.5	1253047
4.	Total Urban	267.5	88242
5.	Total District	3377.0	1341289

4.2. Rainfall and Climate

Balrampur experiences a sub tropical monsoon type of climate, which is characterized by a seasonal rain, produced by the southwest and northeast monsoon. The direction of wind is generally from NW to SE in the NE monsoon season and from SE to NW in the SW monsoon season. The SW monsoon season from mid June to October is influenced by the humid winds of the oceanic origin and its main characteristics are cloudy weather, Temperature fluctuations, heavy rainfall high relative humidity Wind Velocity and Dust Storm etc. These all affect the soil characteristics, water availability and its quality as well.

4.3. Physiography and drainage

Physiographic observations show that the Balrampur is a plain sloping gradually from North to South or South to East, and its elevation in general is 105 metres above the mean sea level. However the level of the surface is interrupted by several ditches, jhils, canals, rivers and number of hilly areas. On the basis of drainage and structural variations the district of Balrampur as a whole can be divided into the following physical divisions.

Figure (Dept. Civil Engineering, n.d.2 Physical Division Map of Balrampur District)

4.3.1. Terai

4.3.2. Khaddar

4.3.3. Central Upland

4.4. Terai Region

In the north of Balrampur is the moist tract of Terai and extending southward from the forest at the foothills to the Rapti river and the villages immediately under the influence of the river on its south bank. It covers greater part of the district covering the areas of Haraiya Satgharwa, Tulsipur, Gainsari and Pachperwa etc blocks. As in all sub mountaineer tract, it lies low; water is very near the surface; and floods are frequent. In the north the innumerable torrents bring down boulders and debris from the hills and their broad beds are covered with shingle and sand; but further south swamps are frequent and the soil is a heavy clay admirably suited for the growth of the fine paddy.

The Slope of the district is from Northwest to Southeast and is not very marked. In the extreme north it is about 200 meter above the sea level and from this point it drops to 107 metres at Tulsipur and 108 meters at Balrampur .The central plateau is slightly higher than this in the northwest, the level at Kauria station being 112 m but towards the southeast it drops steadily.

5. Water Resources

All the rivers of the district flow from northwest to southeast and belong to two main systems that of Rapti in the north and the Ghagra in the south. Numerous tributaries feed each river, as they only serve to carry off the surface water during the rainy season of the year.

Figure 3 Drainage Map of Balrampur District (Dept. Civil Engineering, n.d.)

5.1. Rapti River

The river rises in the mountains of Nepal and after traversing the Sharavasti district enters the Balrampur on its western border near Mathura village. It flows in a very tortuous course through Balrampur block as far as the Utraula boundary and reaches the Siddhartha Nagar district at the material ghat. The banks are usually high but river is continuously changing its course. It only over flow its banks in very wet seasons but then instead of covering the submerged land with sand, it usually leaves behind a deposit of rich loam. The other rivers and streams of the district belong to the Ghagra systems and flows through the Uparhar and Tarhar.

5.2. Lakes

The district contains several lakes many of which are of considerable size and form a valuable source of water supply. In the Terai region they are generally formed by the action of the rivers in changing their beds. Such jhils were merely bends of a stream, which have become silted up at either side and elsewhere they generally consist of shallow depressions in the surface, in which the drainage water collects, while the larger groups of jhils sometimes represent ill-defined lines of drainage, which only develops into streams in years of heavy rainfall. In Terai there are innumerable swamps along both sides of the Rapti and throughout the low-lying rice tract.

Figure 4 Occurrence of Lakes in District

6. Analysis

Water samples were collected from wells for chemical analysis to know about the quality of formation water. Assessment and characterization of Groundwater contamination and its impact on groundwater quality and human health in the district

6.1. Hydro chemical Analysis

6.1.1. **Ph** - On comparing the obtained results with the available standards it can be inferred that the pH of the water available in Balrampur area is within the prescribed limits. (Dept. Civil Engineering, n.d., p. 41)

6.1.2. **TDS** - TDS is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogencarbonate, chloride, sulfate, and nitrate anions. The presence of dissolved solids in water may affect its taste. The obtained results with the available standards shows that TDS in Balrampur area is within the prescribed limits. (Dept.
Civil Engineering, n.d., pp. 42-43)

6.1.3. **Hardness** is defined as the concentration of multivalent metallic cations in solution. Thus comparing the obtained results with the available standards it can be inferred that hardness of the tested water samples is within the prescribed limits. (Dept. Civil Engineering, n.d., p. 44)

6.1.4. **Chlorides** in reasonable concentrations are not harmful to humans. At concentrations above 250 mg/lthey give a salty taste to water. Human excreta, particularly the urine, contain chloride in an amount about equal to the chlorides consumed with food and water. This amount is averages about 6 gm of chloride per person per day and increases the amount of Cl- in municipal wastewater about 15 mg/l above that of the carriage water. Thus, wastewater effluents add considerable chlorides to receiving bodies. As per the obtained results its under the prescribed limit. (Dept. Civil Engineering, n.d., pp. 45-46)

6.1.5. **Nitrate** is a common nitrogenous compound due to natural processes of the nitrogen cycle, anthropogenic sources have greatly increased the nitrate concentration, particularly in groundwater. The largest anthropogenic sources are septic tanks, application of nitrogen-rich fertilizers and agricultural processes. Thus comparing the obtained results with the available standards it is found that the Nitrate in water available in Balrampur area is much higher than the prescribed limits.

This call for development of suitable remedial measures to overcome the problem of nitrate contamination. The most basic, unavoidable cause of nitrate contamination is that when biological materials decompose, most of the nitrogen in the materials ends up as nitrates. Nitrate is a very stable molecule and doesn't readily turn into anything else. It is also very soluble, and moves with the flow of water -- from the source into the groundwater, and eventually into an aquifer. Nitrate migrates easily into aquifers because it is highly mobile in soils. The movement of contaminants through soil to groundwater is affected by many variables, including properties of the contaminant itself, soil conditions and climatic factors. These combinations of factors make the likelihood of groundwater contamination a very sitespecific science. (Dept. Civil Engineering, n.d., pp. 47-48)

6.2. Hydrogeological study

6.2.1. **Occurrence of groundwater**

Ground water in the area occurs both under confined and water table condition. It occurs in the zones of saturation within the granular zones encountered below the land surface. The principle source of replenishment to the groundwater body is precipitation. South of the river Rapti the formation are sandy and suitable for construction of shallow and deep tube wells.

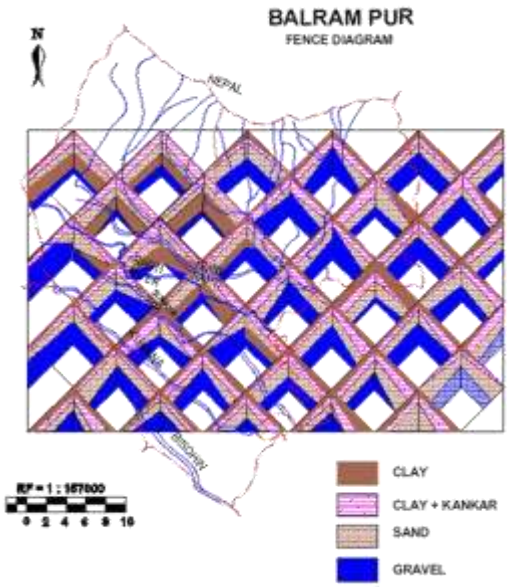


Figure 5 Fence Diagram Map of Balrampur District (Dept. Civil Engineering, n.d.)

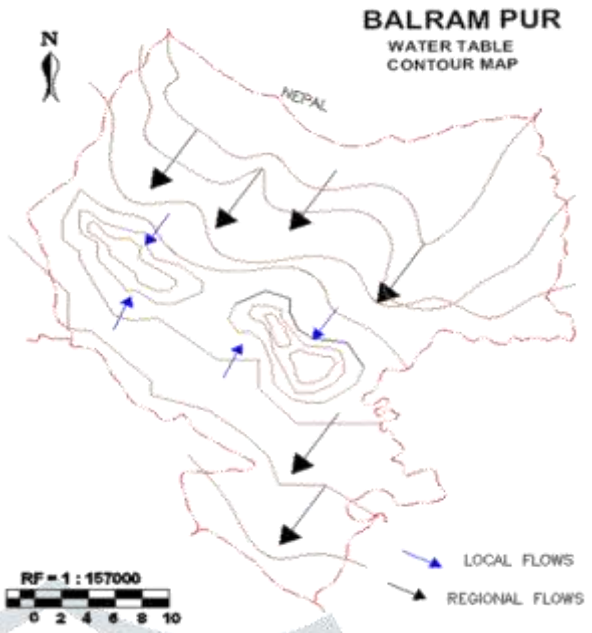


Figure 6 Water Table Contour Map of Balrampur District (Dept. Civil Engineering, n.d.)

6.2.2. **Movement of groundwater**

Water level data of key wells collected during the pre monsoon season were analyzed and altitude of the water table was plotted with reference to the mean sea level was worked out. The reduced levels of the water tables were plotted to prepare the water table contour map. It shows that the general direction of the groundwater movement is from north to south in the northern part of Rapti and from northwest to southeast, excepting some localized variations, in the southern part of Rapti area. The elevation of the water table ranges from 149.53 m the northwest corner at Bankatwa NHS, Block Haraiya Satgharwa to 92.52 mamsl at Sadullah Nagar, Block Rehra Bazaar in the southern part of the area. There is a fall of water level elevation from north to south of 57.01 m. In Balrampur district the river Rapti in general is recharged from the groundwater hence it is effluent in the nature. River Kuwana also receives water from ground so it is also effluent in the nature. The steepness of the water table contours in the northern part of the Rapti River indicates low permeability of the aquifer indicating that the sediments are finer and the hydraulic gradient is 6.5 m/km. In the southern part of the Rapti the formations are highly permeable. The gradient calculates for southern part of Rapti is 0.15 m/km.

6.3. Septic tanks and pollution of ground water

Septic systems are used to treat and dispose of sanitary waste. They are a significant source of ground water contamination leading to waterborne disease outbreaks and other adverse health effects.

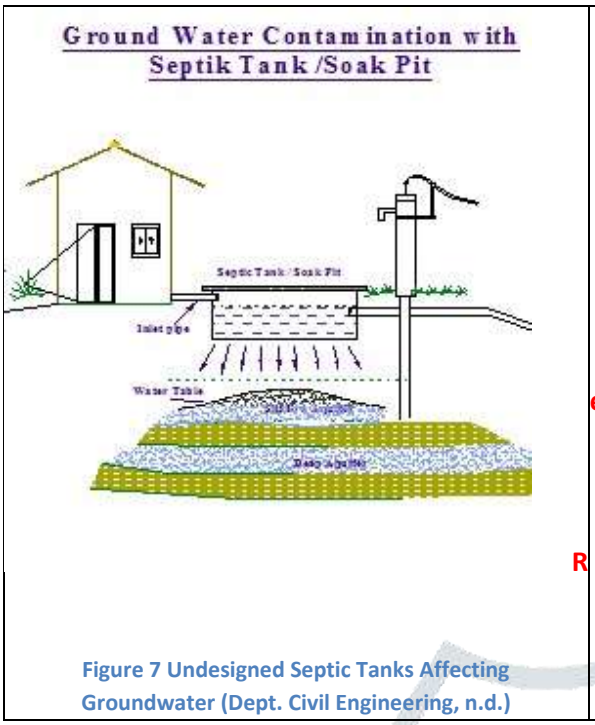


Figure 7 Undesigned Septic Tanks Affecting Groundwater (Dept. Civil Engineering, n.d.)

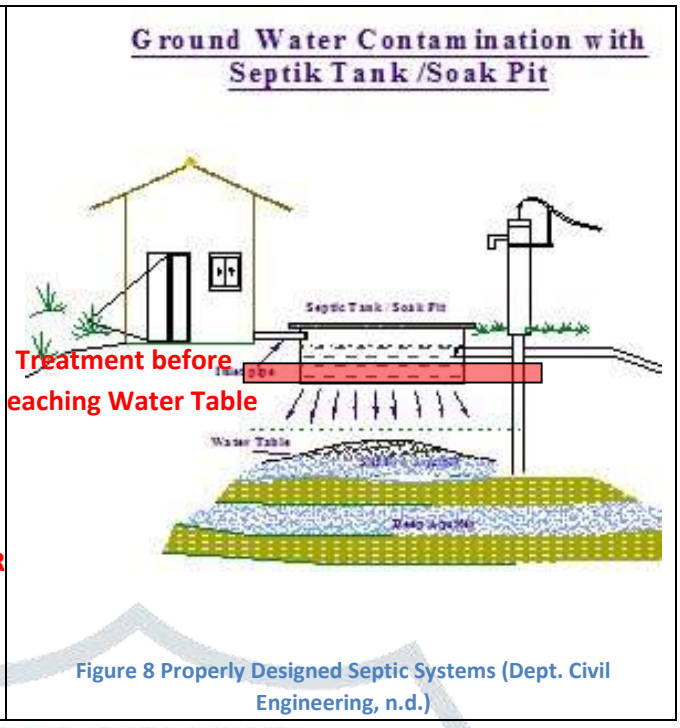


Figure 8 Properly Designed Septic Systems (Dept. Civil Engineering, n.d.)

Improperly used or operated septic systems are the significant source of ground water contamination that lead to waterborne disease outbreaks and other adverse health effects. The "bacteria, protozoa, and viruses found in sanitary wastewater cause numerous diseases, including gastrointestinal illness, cholera, hepatitis A, and typhoid" **(EPA, 2001)**. In order to pose minor threat to drinking water sources, these sanitary systems are required to be properly sited, designed, constructed, and operated.

6.4. Prevalent water-borne diseases due to ground water Pollution

Water-borne diseases are infectious diseases spread primarily through contaminated water. Though these diseases are spread either directly or through flies or filth, water is the chief medium for spread of these diseases and hence they are termed as water-borne diseases.

Most intestinal (enteric) diseases are infectious and are transmitted through faecal waste. Pathogens – which include virus, bacteria, protozoa, and parasitic worms – are disease-producing agents found in the faeces of infected persons. These diseases are more prevalent in areas with poor sanitary conditions. These pathogens travel through water sources and interfuses directly through persons handling food and water. Hepatitis, cholera, dysentery, and typhoid are the more common waterborne diseases that affect large populations in the tropical regions.

It is a well-known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that mi Nitrogen, primarily from urine, faces, food waste, and cleaning compounds, is present in sanitary wastewater. Consumption of nitrates can cause Methemoglobinaemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, Methemoglobinaemia can be fatal for affected infants. Due to this health risk, a drinking water maximum contaminant level (MCL) of 10 milligrams per litre (mg/l) or parts per million (ppm) has been set for nitrate measured as nitrogen (EPA, 2001).

The majority of waterborne microorganisms that cause human disease come from animal and human faecal wastes. These contain a wide variety of viruses, bacteria, and protozoa.

Groundwater has historically been assumed to be safe without treatment to kill microorganisms. Layers of soil act as a natural filter, removing microbes and other particles as water seeps through. While soil acts as a natural filter, it isn't 100% foolproof. Since Balrampur district has engulfed by the symptoms of Nitrate effects. The nitrate content is high enough and hence water is unsuitable for drinking purposes.

Nitrate is a potential health threat to infants causing Methemoglobinaemia. Chronic consumption may also cause some cancer. It also leads to reduced vitality, increased stillbirth and birth weight. There is an increased risk of bladder cancer. Poor sanitary condition may result in outbreak of other water borne diseases as shown in Table.

Table 2 Water Borne Diseases Caused By Microbial Organisms (saciwaters, n.d.)

Water Borne Diseases Caused By Microbial Organisms	
Cause	Water Borne Disease
Bacterial Infection	Typhoid, Cholera, Paratyphoid fever, Bacillary Dysentry
Viral Infection	Infectious Hepatitis (jaundice), Poliomyelitis
Protozoal Infections	Amoebic Dysentery

7. Land use Pattern of Rural India in Tarrai Region

In earlier times the rural Indian settlements were centric in planning with a drinking water sources situated at centre surrounded by residential units & other facilities and towards the outer periphery exists the agricultural land, which was used for sanitary waste disposals. With that sort of structuring the sanitary waste existed in first place at agricultural open lands which allows its decay overtime and its conversion into manure. Therefore, instead of getting land filled or wasted, it was getting utilised as manure. There was no concept of enclosed sanitary units within residential houses of lower strata people however the high class which includes zaminadars & landlords to have enclosed sanitary units in their houses but the sanitary waste used to be collected from their & then disposed off into agricultural field pits where it was converted into manure. Therfore, it was getting treated and mainly disposed off properly without affecting the water table.

And the process of percolation was catered by soil itself. Good soil facilitates treatment and disposal of sanitary wastewater. Soil profiles made of sand, silt and clay worked well. If there is too much clay in the soil, the waste may percolate poorly. If the soil contains too much sand and large particles, wastewater may pass through to the groundwater without being treated by soil microbes. But even then it was imposing less risk on ground water table.

Over the time the rural settlement in India has undergone advancement in population & subsequent urbanisation. The rural settlement in India has largely become over exploited in terms of natural resources with high density of population burdening the existing infrastructure. More over the changing lifestyle has also altered the way people were utilising their natural resources.

7.1. Old Land use Pattern

As per the old Pattern of rural settlement in India, the settlement is based on water source known as pond or Talab or small water body which caters to the daily water requirement of the surrounding population. Making the placement of residential units concentrated next to the water body. Further with the inclusion of sanitary facility within every dwelling unit, as part of practise soak pits started getting used and later septic tanks comes in fashion. But owing to the poor workman ship and unawareness of local labours, the design standards for construction of septic tanks is not followed.

The practise has worsened the scenario by introducing sanitary waste percolation directly into ground water table, which is the carrier of many diseases.

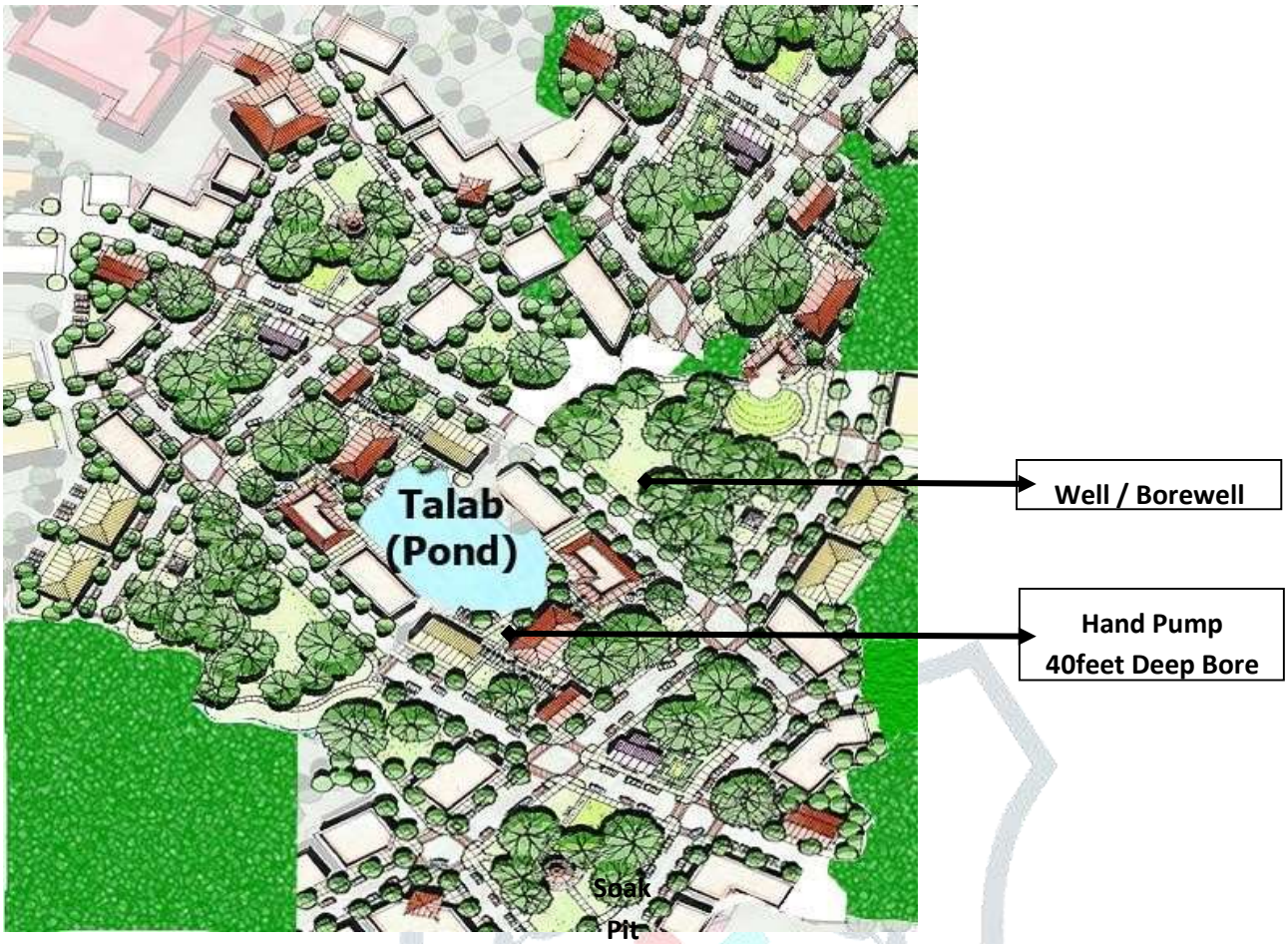


Figure 9 Old Pattern of Rural Settlement with Water Pond (Author, n.d.)

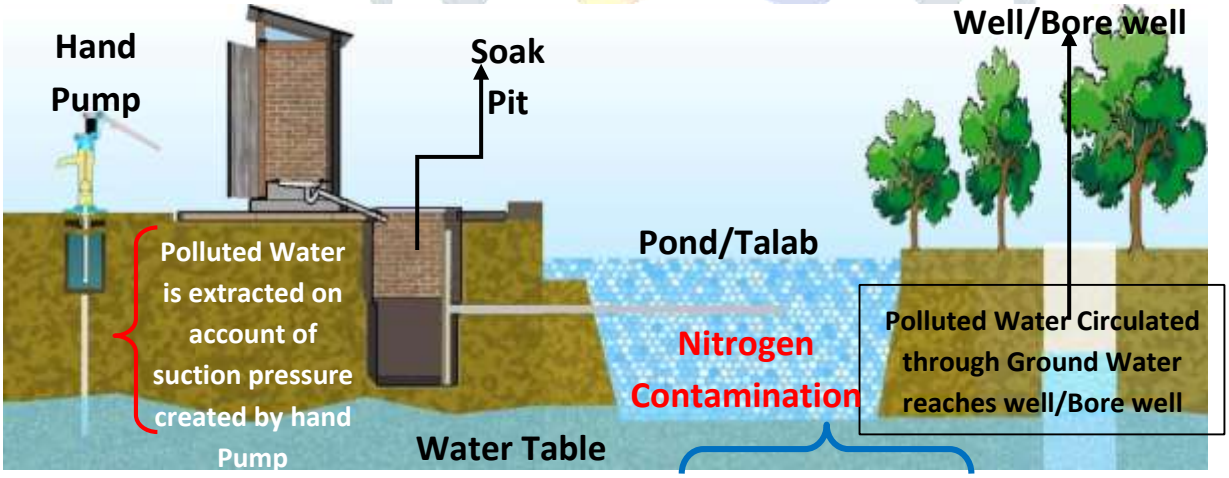


Figure 10 Section showing Ground water Contamination (Author, n.d.)

The percolating contaminated water from septic tanks has raised the level of Nitrate and microbial organisms in underground water reservoir. Shallow aquifer has been affected up to 40-70 feet, but deeper parts of them are still safe. Ground water present in deep aquifers is still not affected and can be used for drinking purposes. Abnormal behavior of groundwater quality in urbanized and populated area of the district was recognized. The impact of septic tank was very much visualized in the rural areas of Balrampur as well, people of the area are always suffering from water-borne diseases especially Jaundice, Methemoglobinaemia, Decentry, Typhoid etc.

In a typical rural setup infrastructures including a hand pump & water well are essentially available near the central water body or water pond. The sources of water for these are rain water & ground water for bore well or water well

used for drinking water. The pond or Talab used for water needs other than drinking is again sourced mainly by ground water & rain water. But since the entire infrastructure is based on ground water and since the source of water is getting infected by untreated sanitary waste percolating straight into it. Therefore remedial measures are required at the design level so that proper interventions could be proposed to make sceptic systems function properly while minimizing groundwater contamination.

7.2. New Land use Pattern

In order to reduce ground water contamination Proper design and use is important. Septic systems are designed to treat and dispose of a specific volume and type of wastewater in the conditions found at the site. The system must not be overloaded, hazardous chemicals or large amounts of grease should not be disposed in septic systems. For example, Kitchen grease should be placed in the garbage, not the septic tank. Good practices in septic planning and design are crucial to achieve effective septic system.

Since long, waste disposal system appears to be inadequate/improper resulting in nitrate contamination in ground water. This is now high time to take special attention to rectify the mistakes and to develop proper sewerage system immediately.

On account of macro level planning the settlements should be planned with assigned locations for latrines, septic tanks & open drains or unlined drains with appropriate considerations towards the natural slope of the region. So as they are constructed only in the downstream side of water flow to avoid contamination. Otherwise in event of water withdrawal the contamination will get extracted due to the suction pressure in hand pumps, etc.

Rainwater during monsoon period can be fruitfully utilized for recharging ground water by various techniques. This will not only augment the ground water resources but also dilute and flush the polluted area gradually.

At micro scale, as a remedial measure impervious lining of each septic tank should be proposed at individual dwelling unit scale and the incorporation of root zone system should be proposed at community as well as individual scale.

Further the gas extracted locally from root zone system can also be used for local lighting purpose. This will help in illumination during night hours as many of the Indian villages are still having short supply of electricity. Therfore, this system can be used as an alternative source for energy at local level.

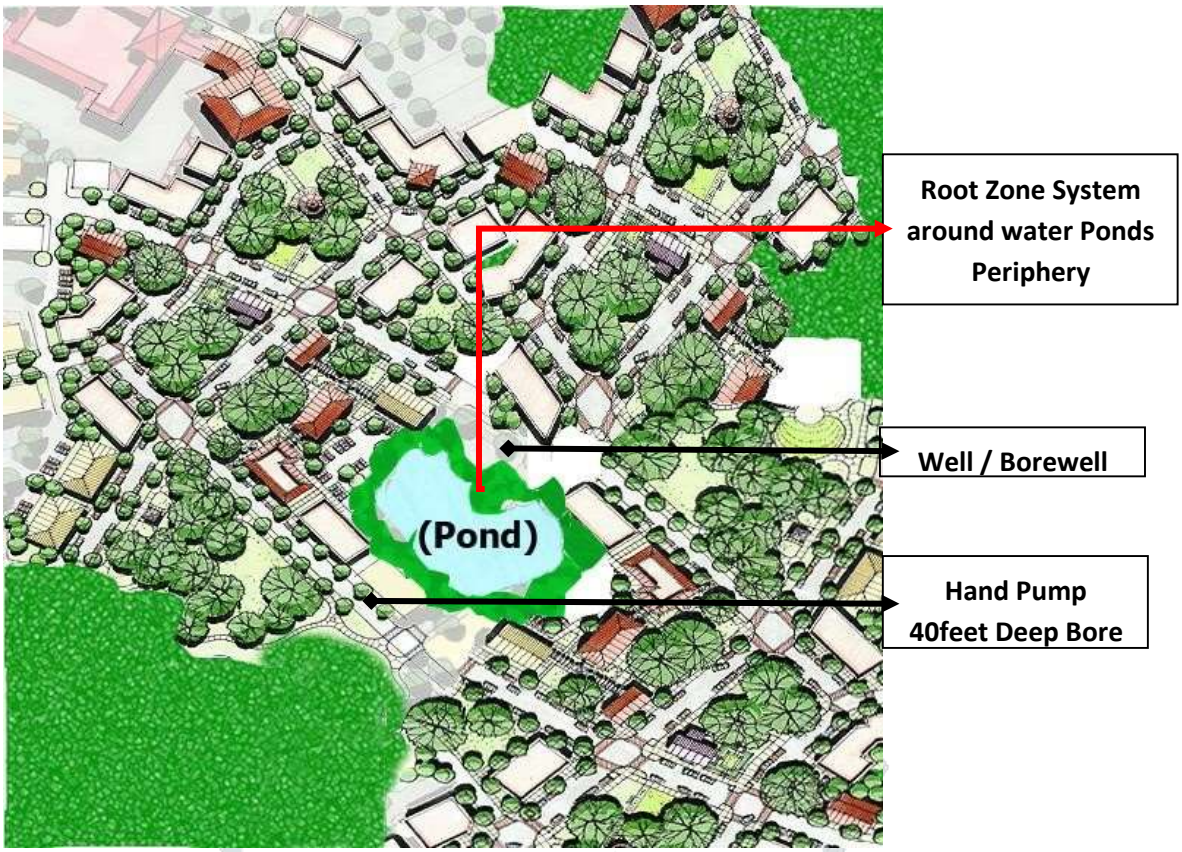
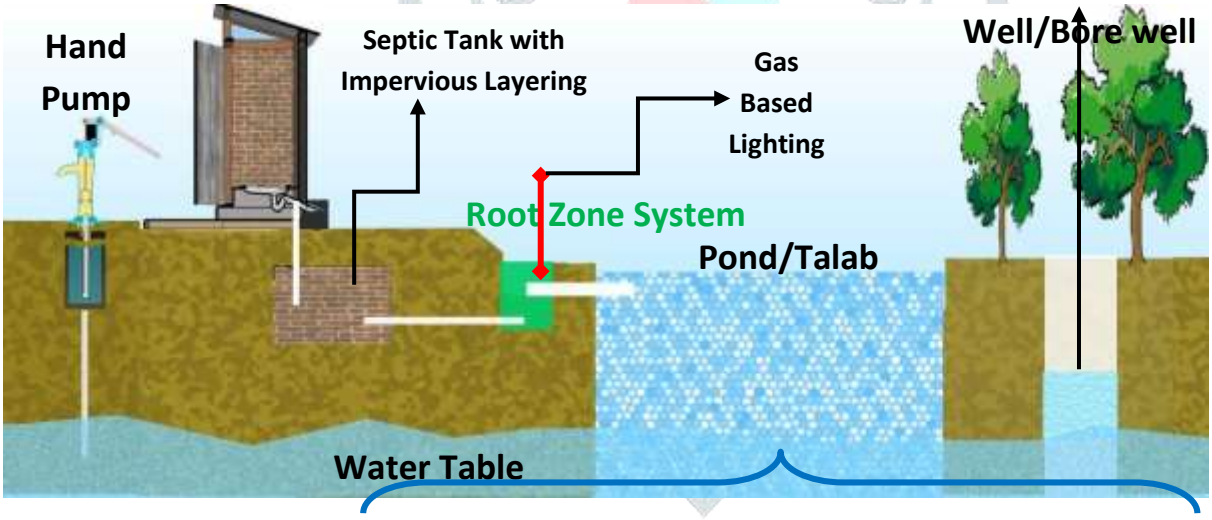


Figure 11 New Pattern of Rural Settlement with Root Zone System & Water Pond (Author, n.d.)



Waste Water from Septic Tank is first treated through Root Zone System before entering Pond, reducing contamination of wate r sources

Figure 12 Section Showing Root Zone System (Author, n.d.)

7.3. Application of root zone treatment system

The term 'Root Zone' encompasses the life interactions of various species of bacteria, the roots of reed plants, soil, sun and water. They are also known as constructed wetlands or sub-surface flow systems. In this system, these plants conduct oxygen through their stems into their root systems and create favourable conditions for the growth of bacteria. The wastewater flows through the root zone in a horizontal or vertical way where the organic pollutants are decomposed biochemically by the bacteria present in the rhizosphere of root plants. The filter media are selected carefully to provide favourable conditions for both plants & bacterial growth and to avoid clogging. Organic pollutants are removed drastically from wastewater and are reduced to their elemental forms.

7.3.1. **General design criteria**

The Root Zone Treatment installations are constructed according to the desired level of purification, the concentration of pollutants and hydraulic & organic loadings.

Table 3 General Design Criteria for Root Zone Treatment System

S.No.	Type	Horizontal Bed (M^2/day)	Vertical Bed (M^2/day)
1.	Organic loading	10-30 gm BOD	20-40 gm BOD
2.	Hydraulic loading	40-100 litre	50-130 litre

7.3.2. **Selection of Plant Species**

Following list of species can be used in root zone system: a) Phragmites australis (reed)

b) Phragmites Karka (reed)
c) Arundo donax (Mediterranean reed)
d) Typha latifolia (cattail)
e) Typha angustifolia (cattail)
f) Iris pseudacorus
g) Schoenopletus lacustris (bulrush)
h) Scirpus Lacustris

For horizontal RZTS all helophytes can be used which are deep-rooted and oxygenate the rhizosphere through the roots. For vertical systems, the plant selection is less critical, because the oxygen input is enhanced by the intermittent surface application.

7.3.3. A**dvantage of root zone treatment systems**

It's a decentralized wastewater treatment facility. Removal of bacteria and parasite is very effective, recycling and reuse of wastewater for secondary purposes (toilets, gardening) can be done effectively, especially in the water-scarce region. It requires low construction, operational and maintenance cost. Besides routine checks, only harvesting of the reeds is required once in 3-5 years. The reeds can also be used for commercial purposes.

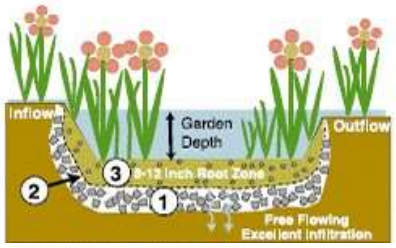


Figure 13 Application of Root Zone Treatment (Norlite, n.d.)

8. Conclusion and Recommendation

The major portion of water supply in villages comes from groundwater. From depth to water level data, the occurrence of shallow aquifers is confirmed in the region. The quality of groundwater is a very important issue in villages. The quality of groundwater is not taken as a serious issue in these areas and as a result the untreated groundwater is the root cause for some of the major health hazards in the villages. The present study area is a case of urbanization of village due to betterment of socio-economic condition of the masses. People opted for improperly designed septic tanks and soak pits over a very small area. The septic tanks are not always constructed in the downstream of the flow of water, as result when water is withdrawn there is a chance of contamination of the groundwater and sewer materials. This has a direct impact on the groundwater quality. Contamination is accelerated during monsoon. This is the main source of nitrate contamination in the area. The older septic tanks are not cleaned regularly and they are left to overflow. The concentration of nitrate in groundwater is higher than the permissible limit. Methemoglobinaemia in infants and cancer in adults are the effects of this concentration. (Sengupta, 2014)

The individual and the community can help minimize water pollution. By simple housekeeping and management practices the amount of waste generated can be minimized. Understanding the processes that control movement of contaminants is necessary for developing any successful strategy to protect groundwater from contamination levels that pose significant health risks.

The following remedial measures should be adopted.

- The replacements of designed Septic tank instead of soak pits are recommended in order to avoid Nitrate contamination in the ground water, which will further save the fresh drinking water.
- The comprehensive sewage collection system from septic tank to root zone system maybe designed which will further treat the Nitrate effected water. Alternately the root zone system may directly be connected from toilet to root zone system through the proper design of pipelines.
- The Root zone system maybe developed along the village pond area the pond will behave like an oxidation pond and maybe designed as constructed wetland from where the water may be supplied for irrigation or agricultural purpose. In this way the sustainable development vs better agriculture quality of water maybe generated through this process. The human health hazards like ulcer & intestinal cancer may be avoided which is becoming a big threat in the Terrain region.
- The agriculture lands maybe irrigated through the surplus water of the pond which will be rich in phosphorus, nitrogen and organic carbon and will further be useful for organic production of the harvest and protect the agricultural land in terrain region from the abuse of ill-impact of fertilizers. Similarly a hand full amount of manuring will also be produced through the root zone system in this way the revenue maybe generated for panchayat in the village areas.
- The gas based lighting system using methane filament will also be helpful for local area lighting such as chaupal, etc.
- The panchayat raj system in India maybe awarded this type of job in order to make it effective through participatory management amongst the individuals & panchayat raj.

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