ARTIFICIAL GROUND WATER RECHARGE AND CALCULATION OF CROP WATER REQUIRMENT

CHAPTER 1

1.1

INTRODUCTION :

Water is an essential and vital component for our life support system. In tropical regions ground water lays an important role with context to fluctuating and increasing contamination of surface water resources. Ground water has unique features which render it particularly suitable for public water sully. Ground water is widely distributed and can be frequently developed incrementally at points near the water demand, thus avoiding the need for large water storage, treatment and distribution system. In most of the instances, the extraction of excessive quantities of ground water has resulted in drying u of wells, damaged ecosystems, land subsidence, salt water intrusion and deletion of the resources. The rate of deletion of ground water levels and deterioration of ground water quality is of concern in major cities and towns of the country. Being a National Capital Territory, Delhi is facing multifaceted problems regarding water availability, quantity and quality.

This are is an attempt to focus on the methodology of Ground Water recharge by the rainwater harvesting which is very challenging issue for the environment otherwise water leads to flooding / public havoc. The feasibility & need for implementation of Ground water Recharge Scheme in the area was established through the detailed study & analysis of the factors governing the Ground Water Discharge & Recharge in the area: such a Ground water Level behavior, Ground water Quantity, Rainwater quantity, Rainfall Intensity & its distribution. The Ground Water & Rainwater potential, Aquifer Geometry & Characteristics and Ground Water requirement of the area also feasible for the implementation of ground water recharge. The Depth to Water level measured at different locations in the area was utilized to study the annual & re-oust Monsoon water level fluctuations. There after the impact of Rainwater Harvesting on the Ground Water Quantitative potential was established based on the mathematical calculations.

The various hydraulic effects are generated by artificial recharge as a result of the head, which is allied in the recharge area and the mass of the water, which is introduced into the aquifer through the recharge area, the piezometric effect and the volumetric effect results in a rise in the iezometric surface in the unconfined aquifers and a rise of the artesian reassure in the confined aquifers.

1.2

Artificial recharge :

Artificial recharge is the rocess by which ground water recharge is increased at a much faster rate than under natural ercolation conditions.The ractice of increasing the amount of water that enters an aquifer through hu man-controlled means is known as artificial recharge.

Artificial ground water recharge is commonly used in the following areas:

1. Areas where ground water levels are steadily declining.

2. Areas where a significant portion of the aquifer has already been desaturated.

3. Areas where ground water availability is insufficient during dry months.

4. Areas where salinity ingress occurs

The artificial recharge techniques connect the source water to the ground water reservoir. Artificial recharge in ground water reservoirs reduces two effects: (a) a rise in water level and (b) an increase in the total volume of the ground water reservoir

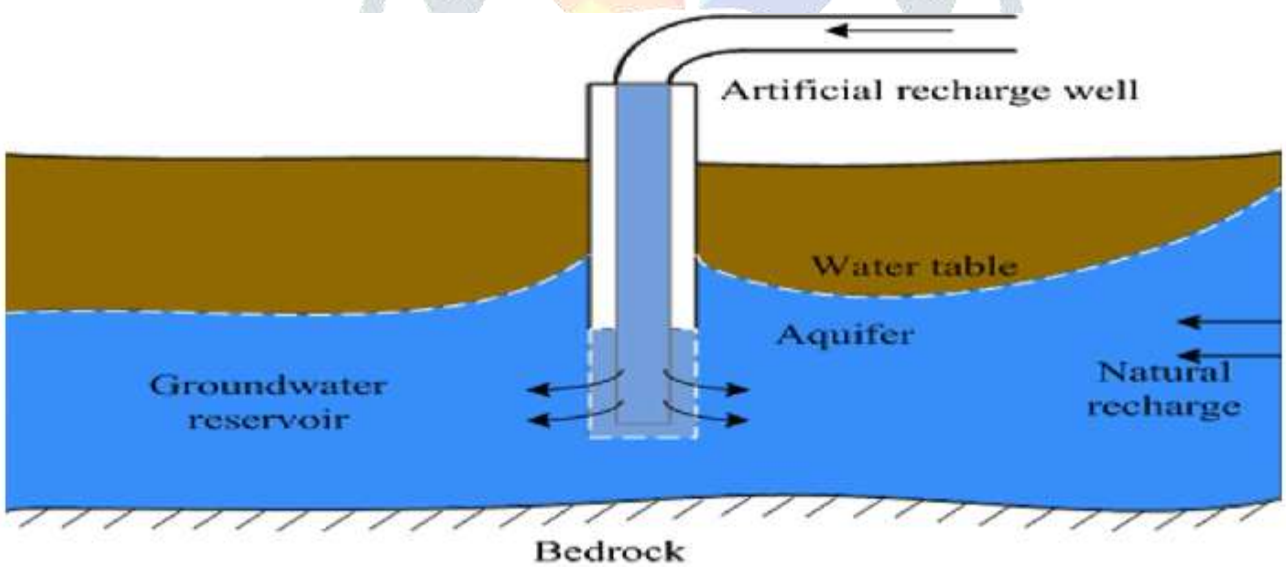

Figure-1 : Artificial Recharge

1.3

Groundwater :

Groundwater is the water found beneath the Earth's surface in the ore sacs of rocks and soils, as well as in the fractures of rock formations. When a unit of rock or an unconsolidated deposit can reduce usable amounts of water, it is referred to as an aquifer. The water table is the depth at which soil ore sacs or fractures and voids in rock become completely saturated with water.

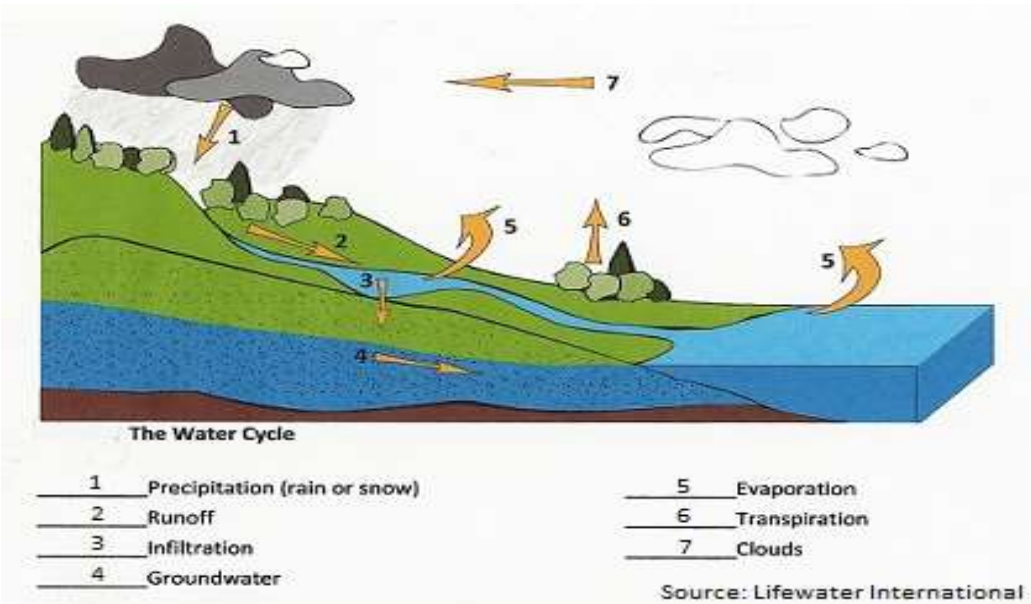

Figure-2: Groundwater storing process

1.4

ADVANTAGES AND DISADVANTAGES:

Artificial recharge has several potential advantages, namely:

1)The use of aquifers for water storage and distribution, as well as the removal of contaminants through natural cleansing recesses that occur when polluted rain and surface water infiltrate the soil and percolate down through various geological formations.

2) The technology is arrogate and widely understood by both technologists and the general public.

3) Recharging the aquifer with highquality injected water can imrove the aquifer's

water quality.

4) Recharge can significantly increase an aquifer's long-term yield.

5) Recharge methods are environmentally aealing, especially in arid regions.

6) The majority of aquifer recharge systems are smile to operate.

Artificial Recharge has some disadvantages too, namely:

1)

In the absence of financial incentives, laws, or other regulations encouraging landowners to adequately main tain drainage wells, the wells may fall into disreair and eventually become sources of groundwater contamin ation.

2) There is a potential for contamination of the groundwater from injected surface-water run-off, especially from agricultural fields and road surfaces. In most cases, the surface-water run-off is not re-treated before injection.

3) Recharge can degrade the aquifer unless quality control of the injected water is adequate.

4) Unless significant volumes of water are injected in an aquifer, groundwater recharge may not be economically feasible.

Chapter 2 : Study area

1.5

What is rainfall?

Rain is a type of recitation, which is characterized by the return of water from the sky to the ground. Rain is the most common form of recitation, but there are others. When rain freezes, it is referred to as sleet or hail. Snow is formed when valor crystallizes before falling as fluffy flakes.

1.6

What is Runoff?

Runoff is the portion of the water cycle that flows over land as surface water rather than being absorbed into groundwater or evaporated. The United States Geological Survey (USGS) defines runoff as the portion of recitation, snow melt, or irrigation water that enters uncontrolled surface streams, rivers, drains, or sewers.

1.7

What Affects Runoff?

There are a variety of factors that affect runoff. Some of those include:

Amount of Rainfall

The amount of rainfall directly affects the amount of runoff. As expected, if more rainfall hits the ground, more rainfall will turn into runoff. The same can be said about snowmelt. If a large amount of snow melts in a short time period, there will be a large amount of runoff.

1.8

Permeability :

The ability of the ground surface to absorb water will affect how much surface runoff occurs. If you have ever oared water onto sand, you may have noticed it sinks into the sand almost instantaneously. On the other hand, if you our water on the street, the water will not sink but runoff to the gutter or a ditch.

1.9

Vegetation :

Vegetation needs water to survive, and a lant's root system is designed to absorb water from the soil. There is less runoff in highly vegetated areas because the water is used by the lants instead of flowing off the surface of the ground.

2.0

Slope :

The sloe of a surface is also important to the amount of runoff there will be. The steer a surface is, the faster it will flow down the slope. A flat surface will allow the water time to absorb.

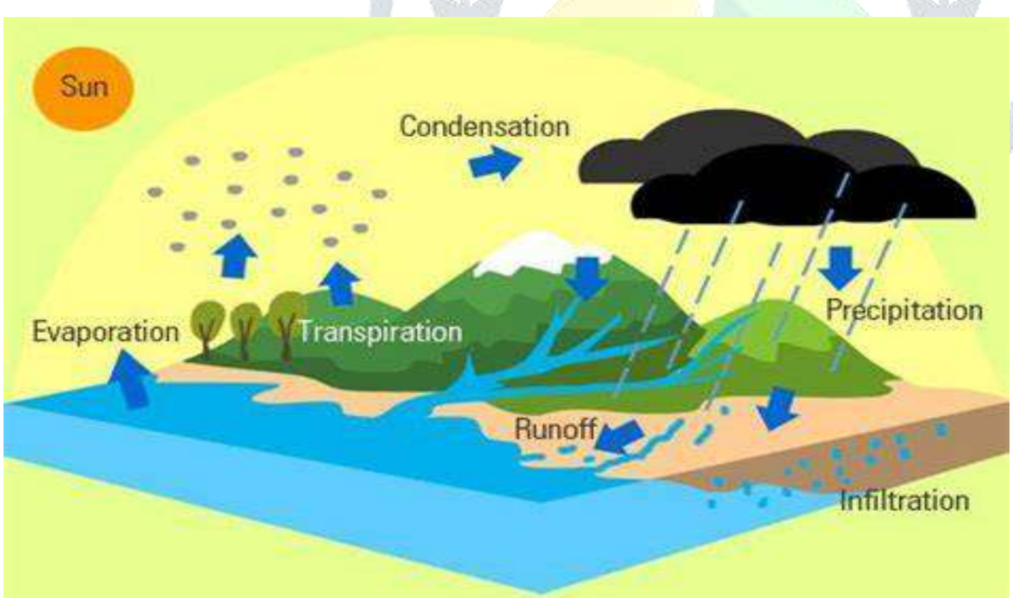

Figure-3: Slope

Groundwater Level Dynamics in Bengaluru City, India

For millions of role in India, groundwater is an important, decentralized source of drinking water. It provides nearly 85% of rural domestic water needs and 50% of urban water needs [1]. Because of accelerated growth, rising er casita water use, and the unreliability of imported surface water from distant sources, urban towns and cities are increasingly reliant on groundwater for water sully. Lerner describes how urbanization affects the groundwater cycle through changes to both the total water budget and pathways recharge in a review of urban recharge. The total imported water sully of many temperate European cities is comparable to the annual rainfall endowment, whereas water sully imports are greater than annual rainfall in many dense cities in arid areas.

Bengaluru

2.1

Materials and Methods :

city has a land area of 720 km2 and is located between latitudes 12450N and 13100N and longitudes 77250E and 77450E. (Figure 1). The city core is located at an elevation of 900 to 930 m alms (above mean sea level), on a divide with a roughly North–South axis, with the Arkavathi River drainage westward to the River Cauvery and the South near drainage eastward (Figure 2) The climate is semiarid, with an average rainfall of 820 mm er year, with September being the wettest month.

Close to 60 percent of the rainfall on average occurs during the southwest monsoon from June to September [27]. The retreating, northeast monsoon From October to December, it also brings rain. Although the dry season lasts from January to May, From March to May, convectional thunderstorms occur. January and February are typically the months that receive the most snow. There has been almost no rain.

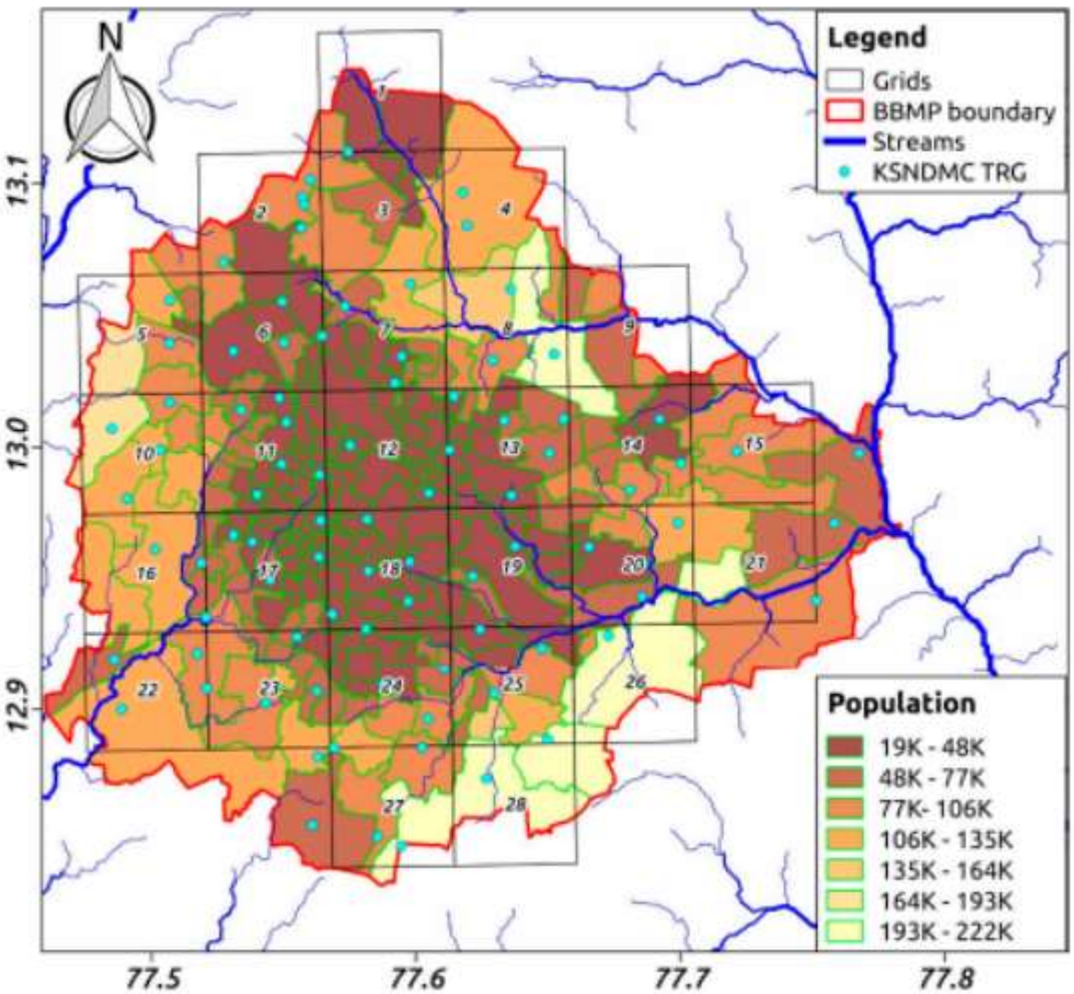

Figure-4: Spatial distribution of the population in Bengaluru city. The stream 5km*5km grid and telemetric rainfall gauge of KSNDMC are also shown. Number represents the grid. IDs

The first set was to compile a detailed database for the city. Between December 2015 and September 2017, groundwater table making was completed. Groundwater levels (GWL) were measured in a 700 km2 area using a monitoring network of 158 wells. 154 of the 158 wells had an unbroken record throughout the study period and were chosen for the analysis resented here. The monitoring network was established through a novel a roach in which existing wells (mostly municipal bore wells) were used as piezometers to measure groundwater levels. Mas were interpolated from the depth to GWL measurements using ordinary kriging. Kriging has been found to reform better than inverse distance weighting [28,29], and has been used in other studies in hard-rock aquifers in southern India . Variograms for each month were fitted using numerical optimization. Exponential variograms were found to fit the data well, and used to create interpolated mas of depth to groundwater (DGW) at a spatial grid of 100m.

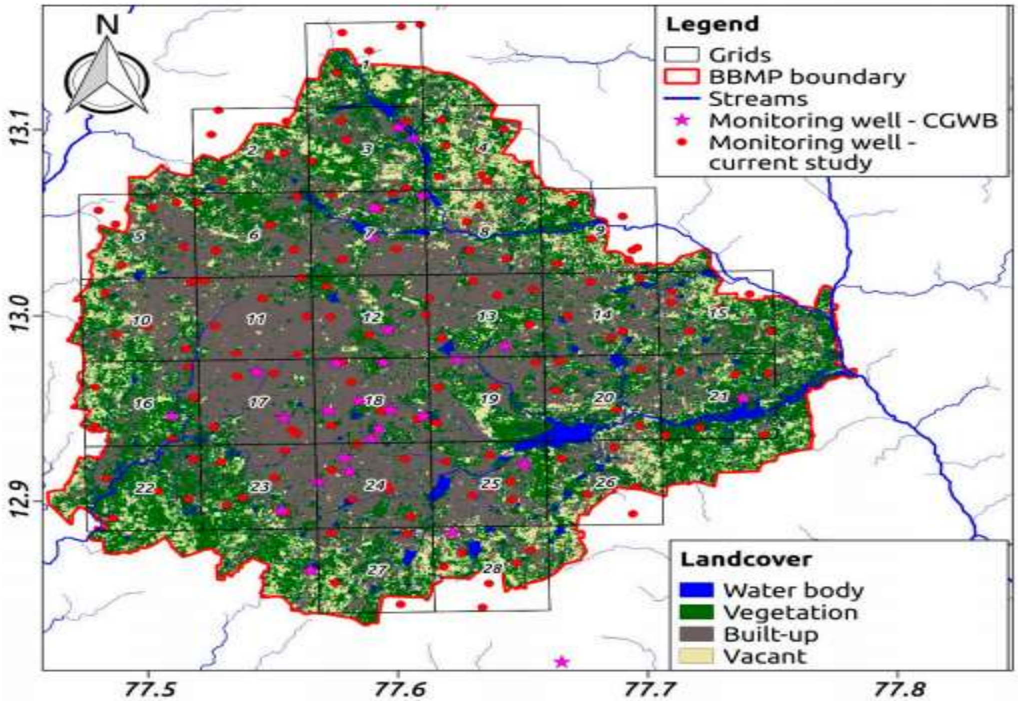

Figure-5: Spatial distribution of land cover and monitoring network. Numbers represent the 5km grid IDs. Landcover data are from 2011

2.2

Rainfall Data :

Annual rainfall for more than 100 years (1901–2012) is shown in Figure 5. During this period, the maximum, minimum and average annual rainfall were 1527, 393 and 880 mm, respectively. Daily rainfall data covering the study period were collected from about 150 stations maintained by the Karnataka State Natural Disaster Monitoring Cell (KSNDMC) for the period January 2015–October 2017. The spatial distribution of these KSNDMC rainfall gauges is shown in Figure 1. A lot of monthly rainfall averaged over these stations is shown in Figure 6. Total rainfall (January–December) for the years 2015, 2016 and 2017 (u to October 2017) was 1153, 716 and 1435 mm. The intra-year rainfall distribution during these three years has strong variability, and each year was quite different. In all three years, the southwest monsoon rainfall was much lower than normal. However, during 2015 and 2017, there were extreme rainfall events, while 2016 was a drought year. In 2015, the months of September–November reduced about 50% of the annual rainfall. In 2016, the months of May–July reduced about 70% of the annual rainfall. In 2017, the months of August–October reduced about 75% of the annual rainfall. The 2017 rainfall was close to the highest received rainfall in more than 100 years. These patterns of drought conditions and extreme rain events over the study period provided a natural orotundity to study the response and resilience of Bengaluru's groundwater system.

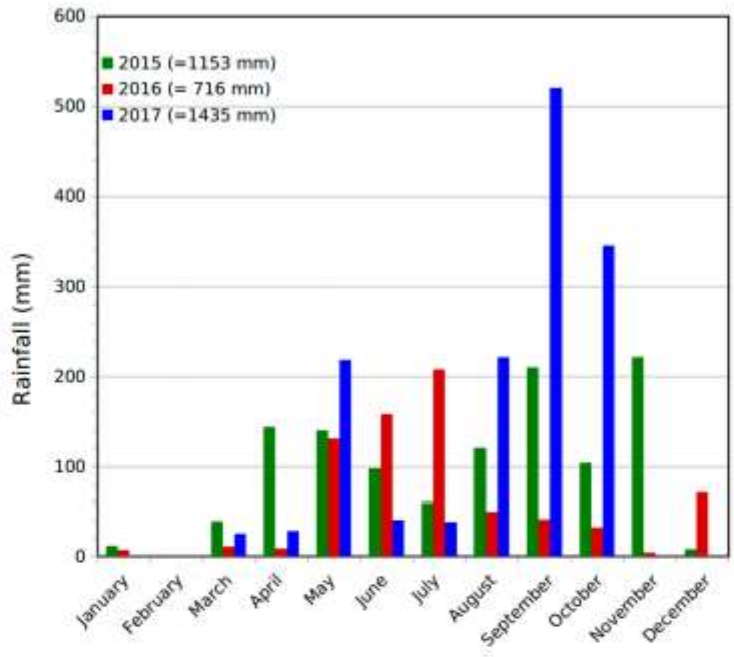

Figure-6: Monthly rainfall patters in Bengaluru city during January 2015-October 2017

chapter 3 Methodology

3.1 Methods of Ground water recharge

3.1 Techniques :

- Direct methods
  - Surface method
  - Subsurface method
- Indirect Methods
  - Induced recharge method
  - Aquifer Modification method

3.2 Direct methods

(Surface method) :

- percolation on tank
- Flooding
- Stream augmentation
- Ditch and furrow system
- Contour bund

(Subsurface method) :

- Recharge wells
- Dug well
- Recharge pits and shafts

3.3 **Surface method:**

- percolation on tank:

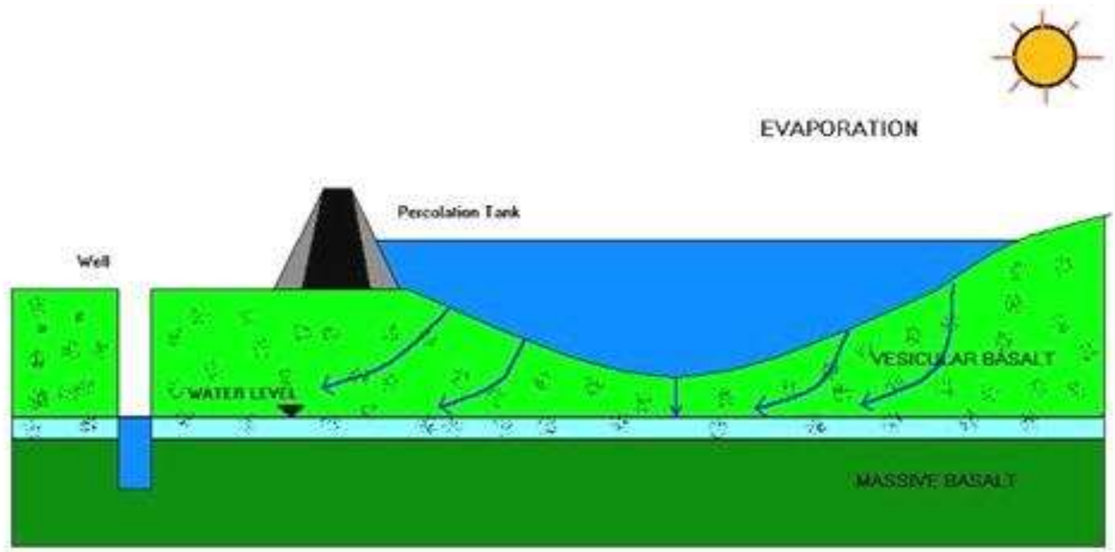

Figure 7. percolation tanks – A method for ground water recharging

Earthen dams are constructed on suitable sites for storing adequate surface water. Tank area should be selected such a way that the sufficient amount of water infiltrate through the bed of the tank and reach the G.W table. This method is amicable on alluvial area and hard rock area. And it is useful for providing continuous recharge after monsoon. Size of tank depends on the percolation capacity of strata.

- Flooding:

Figure 8. Groundwater recharge by flooding

This method can use where the region having thin vegetarian cover and sand soil cover. Water distributed over the region by distribution system. A flood zone is a lace where water can be spread out in a thin layer.

Stream augmentation:

Figure 9. Groundwater recharge by stream augmentation

By erecting a series of check dam across a natural stream or river , seepage from the stream or river is artificially increased. Check dams distribute the water over a wider area, resulting in increased groundwater recharge. The check dam locations should be chosen so that there is enough permeable bed or weathered bed available for easy recharging of the stored water.

Ditch and furrow system:

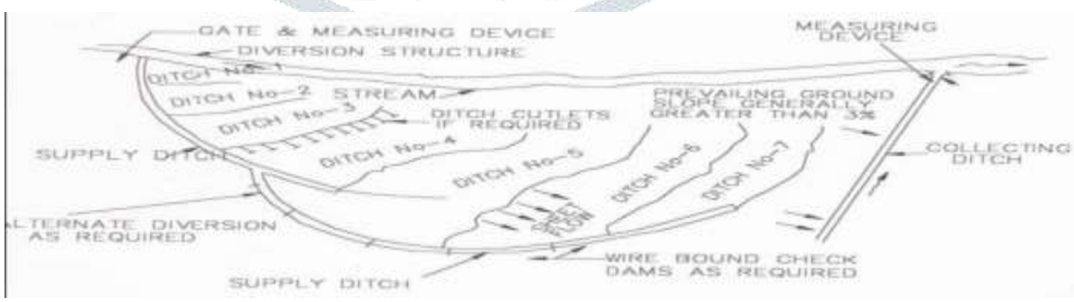

Figure 10. Ditch and furrow system for groundwater recharge

To transport the water from the source, a system of closely sacked flat bottom ditches or furrows is used. This system allows the water to percolate deer into the earth. The permeability of the soil determines the ditch sacking. More densely sacked ditches or furrows should be provided for less permeable soil.

- **Contour bund:**

Figure 11. Contour bund for farming by groundwater

In a hilly region, a contour bund is a small embankment built along the contour to reserve surface runoff for a longer period of time. This scheme is used in areas with low rainfall and strong internal subsurface drainage.

3.4 **Subsurface method:**

- **Recharge wells:**

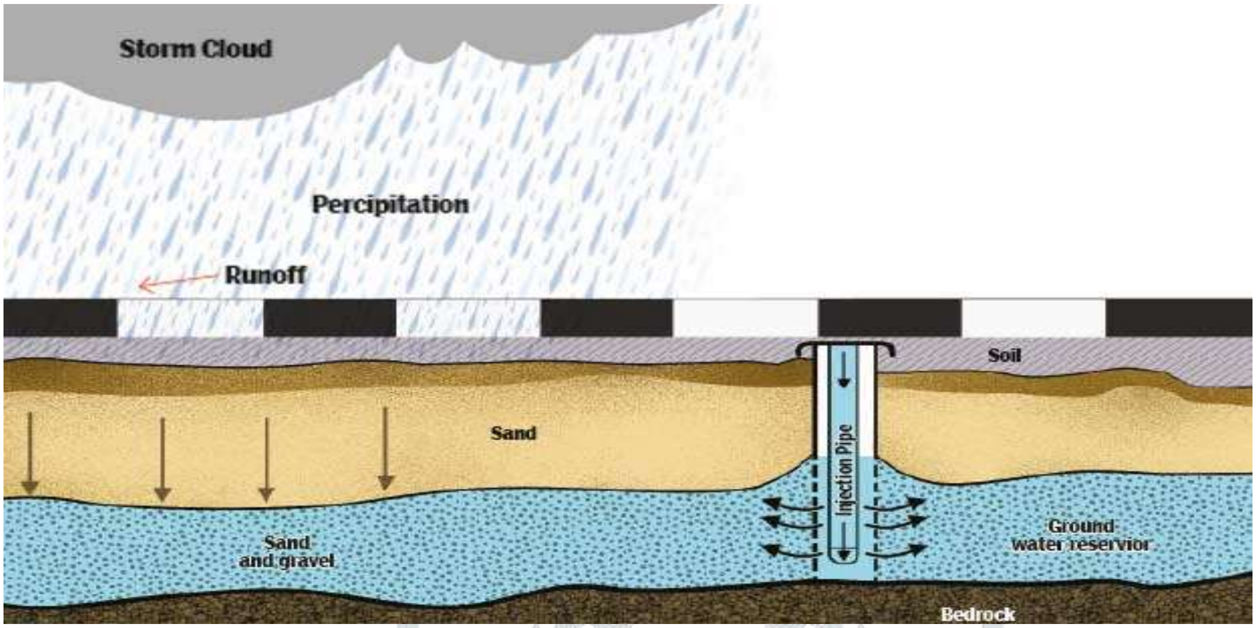

Figure 12. Recharge wells for rainwater harvesting

Water is recharged directly into the aquifer using recharge wells. uming wells are similar to recharge wells. This method can be used to recharge a single well or a grou of wells. This form is more exensive than the other and necessitates boredom.

Dug wells:

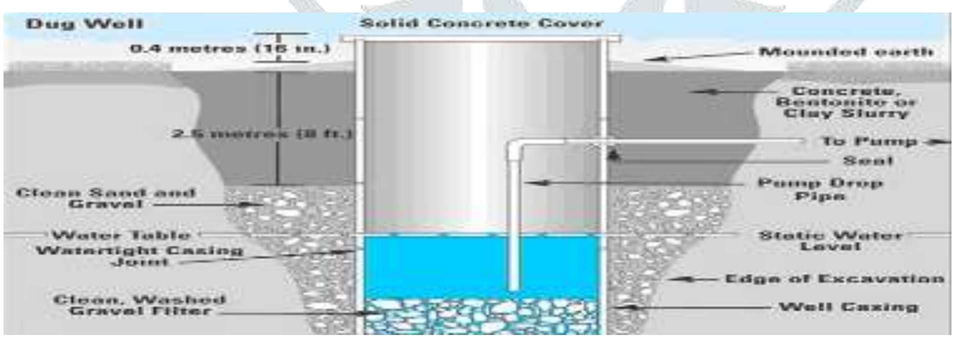

Figure 13. Dug well

Thousands of drilled wells have either gone dry due to significant declines in water levels in both alluvial and hard rock regions. Groundwater can be recharged using these dug wells. To prevent entrapment of bubble s in the aquifer, water for recharge should be directed through a ice to the well's bottom.

- **Recharge pits and shafts:**

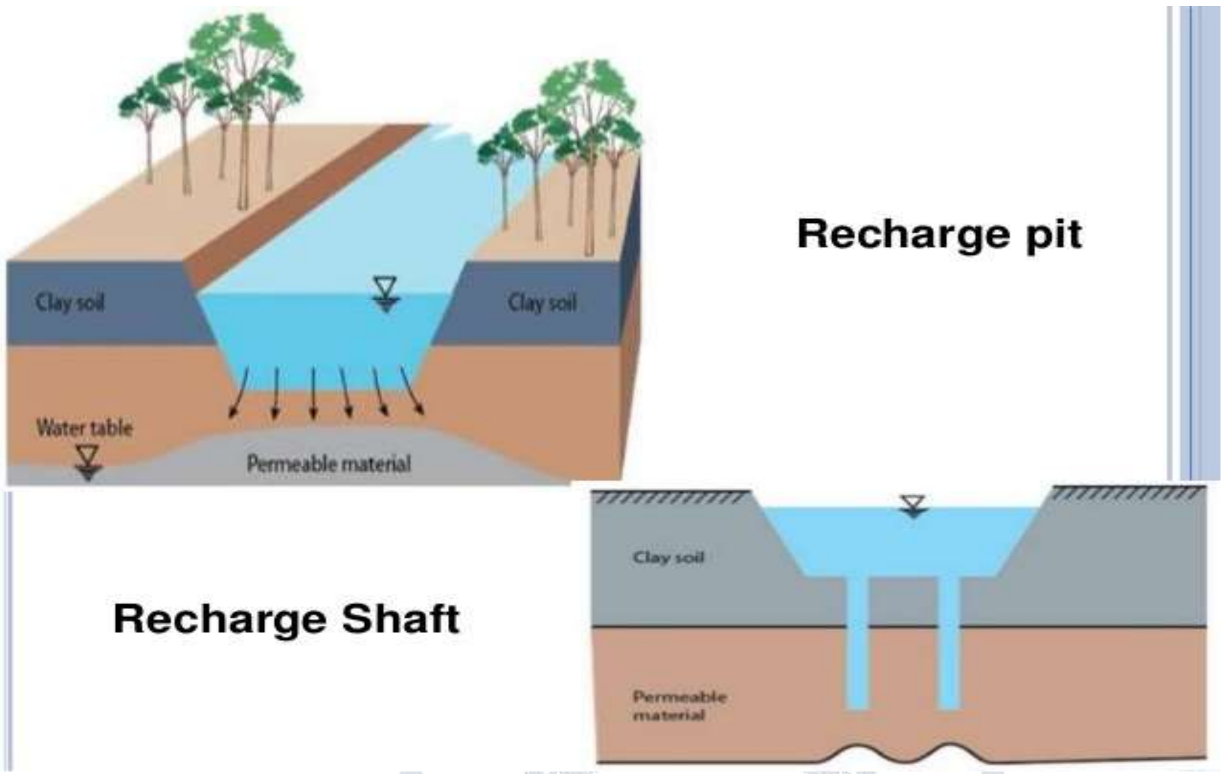

Figure 14.: Recharge pit and shaft

There are various dimensions of recharge it. A layer of less permeable soil exists most of the time, particularly in agricultural fields. So, since surface flooding methods of recharge are ineffective, a recharge it can be excavated that is dee enough to reach the less permeable strata. Recharge shafts, like recharge its, are used to recharge water into an unconfined aquifer with a water table far below the land surface and a poorly impermeable strata at the surface. The recharge shaft is similar to the recharge its, but the recharge shaft has a much smaller cross section than the recharge its.

3.5 **Indirect methods:**

- **Induced recharge method:**

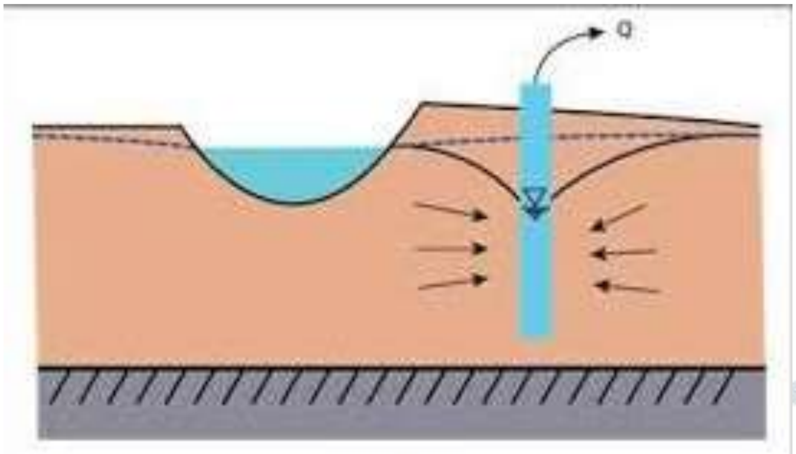

Figure 15. Induced recharge method

The aquifer is hydraulically attached to surface water sources such as a stream, river, or lake, and water is drained from there. umming creates a reverse gradient, allowing water from the surface water sully to penetrate the aquifer, allowing the aquifer to be recharged. This method is useful, particularly when the surface water quality is low. The impurities in surface water are removed by filtration via soil strata. As a result the water quality in the wells is much superior to that of the surface water.

- **Aquifer modification method:**

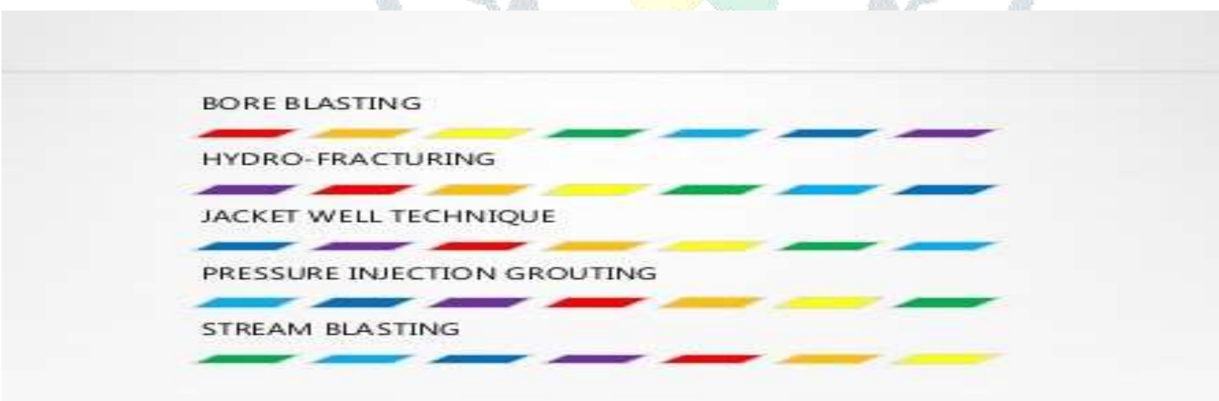

Figure 16. Aquifer modification method

This is used to alter the properties of an aquifer so that it can retain and transmit more water. More recharge occurs after use, both in natural and artificial environments.

Chapter 4 : Result and Discussion

Ground water recharge in different states in India

4.1 Ground water recharge in Bangalore, India

In Bangalore they followed different techniques to recharge the groundwater. We just focus here about rain water harvesting and how they collect water from the rain to recharge groundwater. Recharge wells can serve two critical functions: first, they can help monitor and prevent flooding, and second, they can help ensure that rainwater percolates into groundwater. Recharge wells, direct bore well recharge, check dams (found in rural areas), and other “artificial recharge structures” can all help to recharge groundwater. However, the “recharge well” will be the subject of this guide because it is most suitable in an urban setting, takes u little sake, and can be retrofitted or incorporated into real estate growth. Furthermore, the recharge well is well-suited to Bangalore's geology.

The following are the key components of a groundwater recharge rainwater harvesting system:

Rainwater collection area: Any avid or unpaved surface, such as a rooftop or a lot of land, may be used to collect rainwater (garden, driveway etc). Since the water is being recharged and the soil serves when a filter as it percolates into the atmosphere, catchments for recharge do not need to be "suer clean." Garden areas, avid areas, assure, and rooftops are all good catchment areas.

- Chemically contaminated catchments, on the other hand, should be avoided. Fertilizers and pesticides should be used with caution in gardens and farmlands.
- Conveyance: Rainwater is conveyed by downiest or gutters on rooftops. In the case of lots, water is carried by underground channels/ies. Storm water drains in layouts, campuses, and wide apartments hold runoff from various land use catchments (Eg: arks, roads, other avid areas, gardens and excess rooftop runoffs). As a result, storm water drains are an effective conveyance mechanism for recharge.
- Filtration
- Recharge well

There are a variety of ways to retrofit/integrate recharge wells into real estate growth. Based on the catchment area, rate of rainwater runoff, and enetration into the soil, the form and number of recharge wells can be calculated for any catchment. The lot's toograhy should also be analyzed to identify valley oints, which receive the most rainwater runoff and are therefore suitable locations for recharge wells. When flooding in valleys is a concern, however, recharge wells from the ridge down to the valley can be incororated.

Figure 17. Rainwater collection area

Refer to this guide on developing a direct use RWH (Rain Water Harvesting) system, which includes both storage and direct use of water, for RWH systems that include both storage and recharge components. In a Direct Use RWHM, you can channel overflow from the storage barrel or sum for recharge. Overflowing water, as well as rainwater falling on your lot, can be used to restore the groundwater.

- **Filtration:**

Water is used down to the permeable region, which is made u of weathered soil, by the recharge well. Fine filtration is not needed since the earth itself acts as a filter. Filtration is only needed to remove larger debris as well as silt (which will silt u the recharge well). As a result, the filter's configuration is determined by the catchment and the type of debris captured there. Silt and leaf debris can need to be managed in gardens and farmland. Solid waste, such as plastic bags, is an essential type of debris that must be managed in avid areas. For large debris, an in-drain filter – usually a grating/concrete jail – combined with a silt tar can be an effective solution. Filtration is not needed for recharge wells connected to clean rooftop areas or that catch overflow from tanks / sums.

Figure 18.Filtration

- **Construction a recharge well:**

The following are some of the tasks involved in digging a recharge well:

- ❖ Soil excavation: Manually drilling the well to the desired depth is known as soil excavation. Digging is halted until the water table is reached. Hard rock or water seepage from the well's side walls may make it difficult to dig a well. After manually removing or umming out the water in the case of seepage, digging can resume. Since seepage may lead to the collapse of side walls, work should proceed after ensuring the safety of the staff.

- ❖ Doming excavated soil: Be reared–this is difficult and costly, especially in urban areas where there is little demand for this soil. U to a depth of five feet, soil is only ideal for filling, not landing. While you can try to find a nearby lace for doming soil, it may still be costly.

- ❖ purchasing, shying, and installing RCC rings inside the well: After the well has been dug, RCC rings are stacked one on to of the other inside the well. The RCC rings' external diameter should be 6-8 inches smaller than the well's diameter. The well's bottom is left unlined and the gap between the rings is not lustered, allowing well water to see out from all sides.

❖ Doming of excavated soil: Be reared – this is difficult and expensive especially in the core areas of cities as there is no demand for this soil. Soil u to the depth of five feet is suitable only for filling, and not farming. You should try to identify a nearby location for doming soil, but it may still cost money.

❖ Covering the well with a manhole: To avoid accidents, the well's mouth should be sealed with a decent quality grilled or perforated RCC slab. Manholes may be installed in the RCC slab to enable maintenance access to the well. Rainwater inflow and outflow in the well can also be observed through eyeholes installed on the slab. A safety grill can also be mounted 2-3 feet below the slab to ensure safety in the event that the slab gives way.

4.2 Ground water recharge in Bhubaneswar (Khurda district), India

In this lace (Khurda district) the techniques are different to collect the ground water recharge. Techniques are given below :

- **Dug wells :**

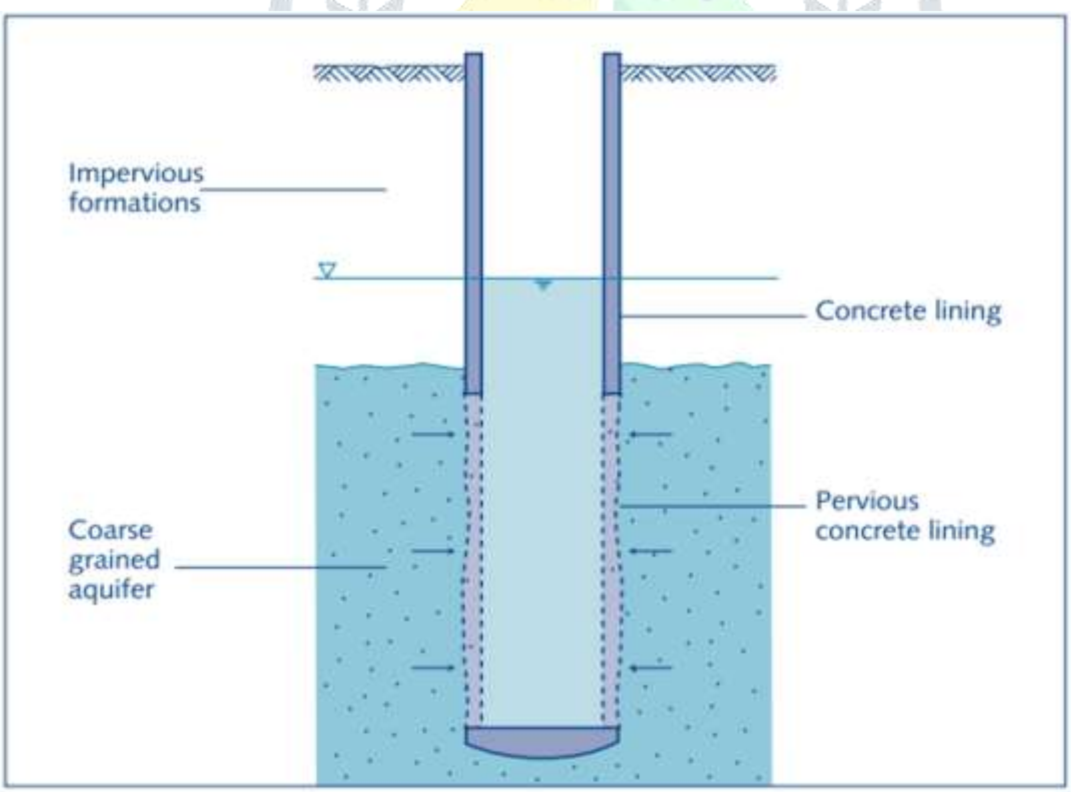

Figure19. Dug wells

The most ocular ground water abstraction structures in the district are dug wells. Underlain by crystalline formations, dug wells are possible in submerged sediment zones, valley fills, and flood lain. The irrigation water determines the dug well’s configuration. Crop requirements, depth to water level, saturated zone thickness, and seasonal water level fluctuations are all factors to consider. Dug wells should be 10 to 12 meters dee in hard and semi-consolidated sediments, and 8 to 10 meters dee in unconsolidated sediments. The diameter of drilled wells should be between 4 and 6 meters. Wells in unconsolidated formations can roduce u to 50 m3 er day, while wells in other formations can roduce about 40 m3 er day. To revent interference, kee the ga between any two dug wells at least 100 meters.

- **Filter joint tube wells :**

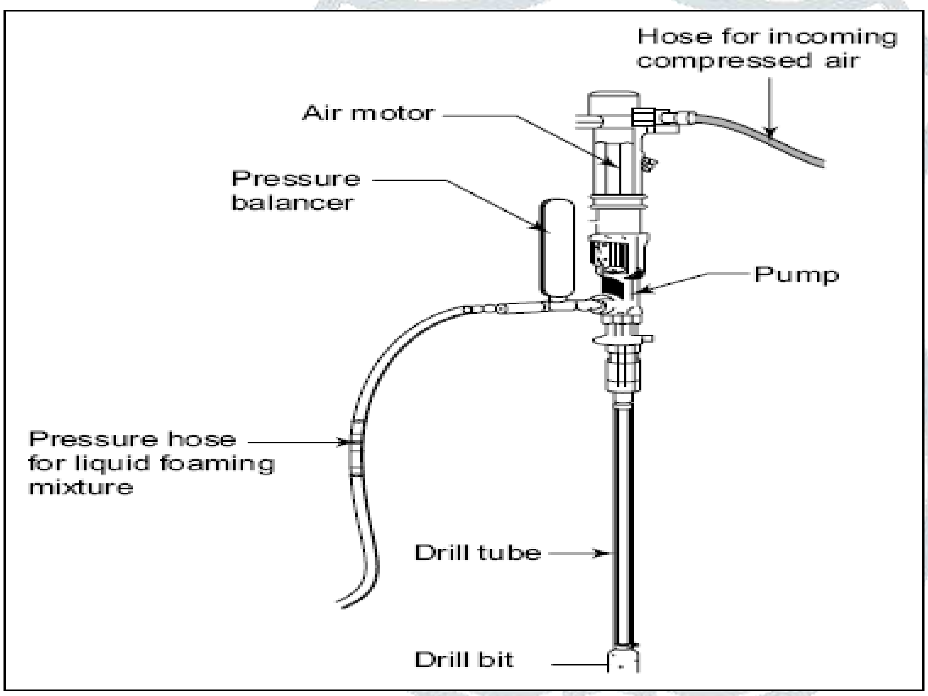

Figure 20. Filter joint tube wells

These wells can be drilled in unconsolidated formations, which are mostly found in the district's eastern portion. The depth could range from 15 to 30 meters, with a diameter of 10X5 cm or al through 5 cm and two H centrifugal ums mounted. The yield of these wells is usually very high. To prevent intrusion, keep the distance between any two structures at least 150 meters.

- **Shallow tube wells :**

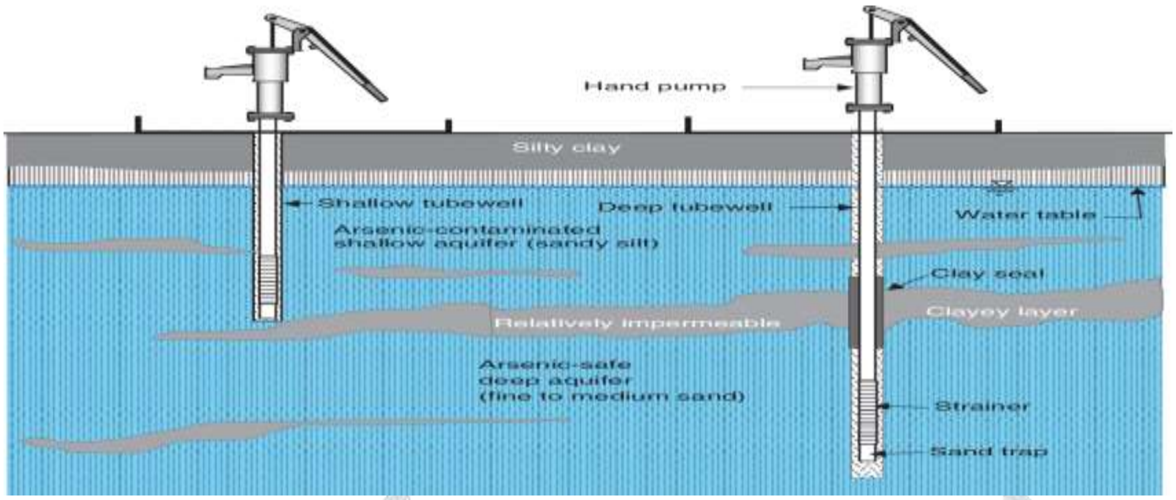

Figure-21.

The tube wells are feasible in the district's unconsolidated deposits in the east. The tube wells' deth can be limited to 50 meters. The um should be 5 H and the diameter should be 15cm. The estimated yield ranges between 12 and 15 ls. The distance between the linesShould be held at a distance of at least 300 meters.

- **Medium dee tube wells :**

Figure 22. Medium tube well

Tube wells are feasible in the eastern art of the block, which includes Baliatna and arts of Balianta. The tube wells' deth can be limited to 100 meters. The diameter should be 25X20 cm, and a um with a horsepower of 10 or more should be mounted. U to 30 ls is required as a yield. At least 500m of sacking should be maintained.

- **Borewells:**

Figure 23. Borewell

In the Athagarh formation, bore wells are possible. The depth of the wells may be limited to 100 meters. The average redacted yield is 5 to 7 ls. The distance between the sots should not be less than 150 meters.

4.3 Ground water recharge in Ahmedabad

The raid growth of Ahmedabad's urban areas over the last four decades has laced considerable strain on the city's natural environment. To meet domestic and industrial demands, groundwater draft has been increased, leaving much of the unconfined aquifer zone dry. At times, shallow depths of groundwater are brackish (athak BD et al 1971). Groundwater contamination has made some shallow aquifers unsuitable for domestic use as the urbanization recess has regressed (andey AK 1993, CGWB 2000). All of this regress has resulted in the mining of dee confined aquifers, which has resulted in a dramatic drop in piezometric level below 60 to 80 m in some areas.

Techniques to recharge water:

Natural recharge to the groundwater system is hammered by the urbanization recess (UNESCO-IAH 2003). Simultaneously, rising ovulation adds to the drawdown caused by declining groundwater sullies, resulting in a raid drop in water levels in urban areas. Groundwater sullies are segmented by rainwater harvesting combined with an adequate recharge structure (CGWB, 2007). AMC began ground water recharge work in low-lying areas by constructing percolation wells to improve groundwater recharge. The Ahmedabad Urban Development Authority (AUDA) made ‘Rain Water Harvesting' (RWH) mandatory for all buildings above

1,500 square meters in 2002. One percolation well is needed for a covered area of more than 1,500 sq m to ensure ground water recharge. Another well must be constructed for every additional 4,000 sq m of cover area. However, when compared to total residential complexes, the number of RWH structures built in residential areas is very small. Furthermore, due to inadequate maintenance of the recharge structures, various percolation wells constructed by AMC and AUDA do not reduce the desired revulsion to urbanization, the land was mostly used for agricultural uruses. There are over 50 natural lakes in the area, all of which are fed by natural drains that drain the surrounding area (AUDA 2008). The hydrological environment has deteriorated as a result of urban development and land use changes. Due to urban development, natural drains that used to lead to lakes have become obstructed or silted. Many areas were inundated during the rainy season as a result of the drains being blocked, while the lakes were derived of their share of runoff water. In the end, this resulted in less groundwater recharge.

According to the Ministry of Environment and Forest's land for the protection of large urban and rural lakes, AUDA has improved the drainage to Vastraur lakes by constructing storm water drainage and restoring and renovating the storage sake. Flooding in urban areas is relieved to some degree by the quick diversion of storm water during the monsoon. Furthermore, groundwater levels in the region have improved as a result of increased recharge to the groundwater from the lake bed as well as through uprose-built infiltration wells. The hydrograph revealed rising trends in piezometers near such bodies of water.

While the lakes that are already linked are being used to recharge the ground water level by natural seepage from the lake's bottom and also through uprose-built recharge wells at arrogate locations in and around the lakes, AUDA is rousing to increase their capacities and link the lakes with the Narmada Canal to make them perennial. Excess water that flows into the Sabarmati river or the Gota Gadavi canal can be used for irrigation (AUDA 2008).

Chapter 5 : Conclusions/summary

Groundwater restoration with reclaimed water would be a cost-effective and practical solution to the ajaro Valley's raid groundwater deletion and saltwater intrusion. Reurosed Water is a dependable and renewable source of local water that should be valued. a useful resource Groundwater recharge is a great way to reuse reclaimed water because it has a lot of benefits. natural storage (which enables drought mitigation or withdrawal when water demand is high) It can be used for soil treatment (with surface spreading), as well as directly revenging intrusion of seawater (with a direct injection barrier).

The ajero Valley should use the lessons learned from surface spreading and direct injection case studies to guide the feasibility study and implementation of a recycled water recharge reject. Indirect injection case studies revealed that injection well clogging is unavoidable and can be prevented. If not anticipated or handled in a timely manner, it can be very expensive. When a reject is built, however, these costs can be reduced if clogging is avoided and wells are easily accessible for cleaning. The most common technical problem in the surface spreading case studies was clogging.

Infiltration basin clogging, which occurs when solids accumulate on the surface of the basin and reduces infiltration rates, can be easily remedied with routine maintenance (i.e., basin drying and scaring). The role of public opinion, which needs community engagement to resolve, and implementation sets, such as how to conduct a feasibility study and ensure compliance with water quality regulations, were also considered and lessons learned from the case studies. The ajaro Valley will benefit from a dual reject of direct injection and surface spreading. This would allow a direct injection barrier to be built along the coastal intrusion zone, with surface spreading inland to complement agricultural and municipal sullies. Defending on the seasonal irrigation demand, the dual reject could handle different volumes of water. Although a steady flow of water is sent to the injection barrier (for operational reasons), the excess is either used for irrigation or surface spreading, depending on demand. For the time being, the ajaro Valley Water Management Agency has agreed to concentrate on surface water capture, restoration, and above-ground storage, and would revisit artificial recharge in the future (around 2025) if current rejects do not carry the basin into sustainable yield (ajaro Valley Water Management Agency, 2014). These lower-cost rejects were prioritized by the ajaro Valley Water Management Agency over higher-cost rejects.

ajaro Valley Water Management Agency (2014) describes recycled water recharge as a complex and costly reject. However, given the recent drought, some of the strategies outlined in the Basin Management land Update will need to be reconsidered, as surface water resources cannot be regarded as reliable sources of consistent output. A clear evaluation of the currently planned rejects is also essential (surface water capture, conservation and above ground storage) shows that these projects are rejected to yield just over 10,000 acre-feet, obviously not meeting the 22,000 to 46,000 acre-feet (depending on different factors) sustainable yield difference (ajaro Valley Water Management Agency, 2014; City of Watsonville, 2010). Recycled water recharge will us the basin far closer to achieving sustainable yield, with the ability to increase basin recharge by 5,000 acre-feet er year and improve the basin's infrastructure. The hydrostatic seawater barrier raises the long-term yield. Groundwater recharge with recycled water is a local, renewable, drought-resistant water source that could help the ajaro Valley deal with seawater intrusion and groundwater deletion. However, planning and obtaining permits for recycled water recharge projects can take u to ten years, and construction time is also needed. and ut it into action (Sanitation Districts of Los Angeles County, 2011). This suggests that the time has come to begin rearing for groundwater recharge using recycled water.

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