International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org
Volume 6, Issue 3, May- June 2017 ISSN 2278-6856

Management Of Rainwater And Its Conjuctive Use In Kolli Hill Area Using Remote Sensing

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Abstract

It is very effective in providing water supply, disaster prevention, alternative water source, and does not create water right conflicts. Over the years, rainwater harvesting has emerged from the past limited small and large farm pond use, and expanded to providing water supply for widespread agricultural, industrial, and residential uses. Establishment of rules and regulations along with incentive programs is being implemented step-by-step to further promote rainwater harvesting. This paper describes first the current status of water resources in India. followed by a narrative of rainwater harvesting development trend. It also introduces the current status of rainwater harvesting and its application results. Finally, the future prospect as well as the present incentive programs will be introduced.Conjunctive use therefore functions as a buffer for periods of water scarcity. The idea of this management approach is to use surface water when the water table is high and change to groundwater when the water table is low. This technique might be especially important as a buffer function for mitigating impacts of climate change, such as increased heat and drought.

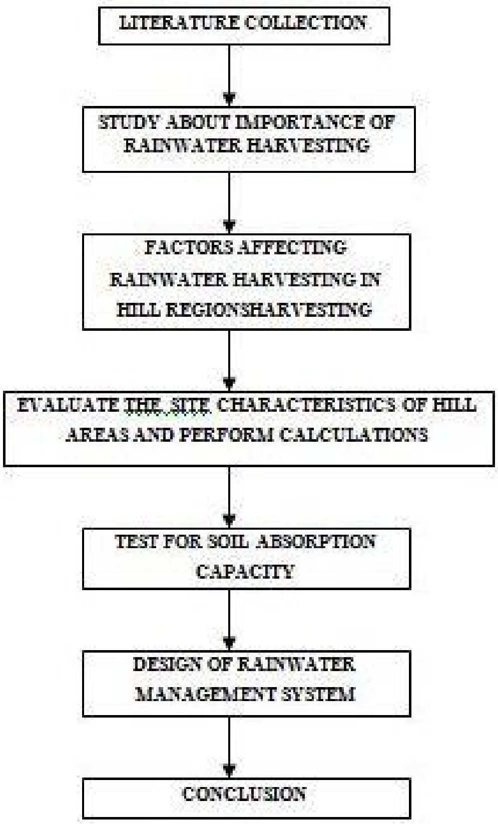
Keywords: Management, Rainwater, Conjuctive Use, Kolli Hill, Remote Sensing

1.INTRODUCTION

Rainwater harvesting is an ancient technique enjoying a revival in popularity due to the inherent quality of rainwater and interest in reducing consumption of treated water. Rainwater is valued for its purity and softness. It has a nearly neutral pH, and is free from disinfection by-products, salts, minerals, and other natural and man-made contaminants. Plants thrive under irrigation with stored rainwater. Appliances last longer when free from the corrosive or scale effects of hard water. Users with potable systems prefer the superior taste and cleansing properties of rainwater. Archeological evidence attests to the capture of rainwater as far back as 4,000 years ago, and the concept of rainwater harvesting in China may date back 6,000 years. Ruins of cisterns built as early as 2000 B.C. for storing runoff from hillsides for agricultural and domestic purposes are still standing in Israel. Rainfed area constitute about two-third of total 142 million hectares cultivated in the country. It is estimated that these areas contributes only 45 % to the total food grain production whereas irrigated area which account for one third of cultivated area contributes 55% to total food grain production. The productivity levels in irrigated areas has attained a level and there is little scope for further increase, so the opportunity lies in the development of rain fed areas. Rainfed agriculture is complex, diverse and risk prone and is characterized by low productivity and low input usage. Variability in rainfall results in wide variation and instability in yields. The farmers of rained areas generally face two major problems i.e uncertainty in the availability of water and soil degradation.

Perhaps one of the most interesting aspects of rainwater harvesting is learning about the methods of capture, storage, and use of this natural resource at the place it occurs. This natural synergy excludes at least a portion of water use from the water distribution infrastructure: the centralized treatment facility, storage structures, pumps, mains, and laterals. Rainwater harvesting also includes land based systems with man-made landscape features to channel and concentrate rainwater in either storage basins or planted areas. When assessing the health risks of drinking rainwater, consider the path taken by the raindrop through a watershed into a reservoir, through public drinking water treatment and distribution systems to the end user. Being the universal solvent, water absorbs contaminants and minerals on its travels to the reservoir. While in residence in the reservoir, the water can come in contact with all kinds of foreign materials: oil, animal wastes, chemical and pharmaceutical wastes, organic compounds, industrial outflows, and trash. It is the job of the water treatment plant to remove harmful contaminants and to kill pathogens. Unfortunately, when chlorine is used for disinfection, it also degrades into disinfection by products, notably trihalomethanes, which may pose health risks. In contrast, the raindrop harvested on site will travel down a roof via a gutter to a storage tank. Before it can be used for drinking, it will be treated by a relatively simple process with equipment that occupies about 9 cubic feet of space. Rainwater management helps to maintain or restore natural water cycles and use rainwater as the resource that it is. The goal is to use rain gardens, green roofs, bio swales and other similar rainwater management methods to slow and clean the rainwater, either capturing it for use in irrigation or within buildings in 'purple pipe' or grey-water systems, or slowly diffusing it back to the natural water table. By managing rainwater more sustainably, we will:Have cleaner water that is discharged to our harbour and beaches, Reduce the peaks of runoff that can stress and overwhelm the existing storm water and increase our climate change resiliency, and Expand property owner's understanding of the local water cycle and their interactions with it.

2.METHODOLOGY



3. RAINWATER HARVESTING SYSTEM

Rain water harvesting modules were demonstrated in the watershed through participatory approach.

- Water harvesting from Base or Surface flow-The water source at Sanio contributed 20-25 thousand liter water per day under normal situation but the discharge increased to 85-90 thousand liter per day during rainy season .This large volume resulting from rainfall was not harvested properly and was going waste as surface flow. So, to harvest every drop of water, it was taken to tanks for storage and then supplied through pipe lines thus reducing all type of delivery losses. This module has benefited 55 families by irrigating 10 ha of land and, increasing productivity of Potato, Peas and Garlic by 25 %.The harvested water is also used for animals and domestic use.
- Runoff harvesting system at Dedag-The runoff, resulting from rain, seepage from hillock and discharge from spring, having peak discharge of 20-25 thousand liters per day, has been harvested, The water at this site is diverted to one side in a open channel and collected in two big tanks. This harvested water has benefited 20 families by providing irrigation to 4-5 ha of land and beside this, the farmers are also using this water for domestic purpose.
- Roof Water harvesting –The areas with no natural catchments have been demonstrated for roof water harvesting system. In this module roofs of three houses have been selected as catchments for the harvest of rain water and they are expected to contribute 2.75 lac liter water annually as roof water yield, which will benefit 6-7 families by providing irrigation to 2-3 ha of land after rainy season.
- In situ rain water harvesting-soil moisture conservation practices are main concept in this module and farmers are getting good result out of it.

3.1 Objectives Of Rainwater Harvesting

- To reduce loss from surface runoff
- To avoid flooding
- To meet the increasing demands of water
- To raise the water-table by recharging groundwater
- To reduce groundwater contamination
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3.2 Need For Rainwater Harvesting

- About 50% fresh water goes waste due to runoff.
- More than 1 billion people lack clean drinking water globally.
- Population increase is much faster than the increase in the amount of available fresh water.
- Per capita availability of fresh water will further decrease in the coming years.
- During summer and droughts, it will supplement the domestic water requirement.
- Climatic changes also lead to increase in precipitation, evaporation, transpiration, occurrence of storms and changes in biogeochemical processes affecting water quality.
- It is essential to reduce groundwater pollution and improve the quality of water.
- It is a better option for providing clean and safe water particularly for drinking and other domestic uses.

Table 1 per capita availability of water

YEAR	KILO LITRE PER CAPITA PER YEAR
1950	5177
2000	1820
2025	1400(likely population 130crores)

2050	1140(likely population 160crores)

3.3 Rainwater Harvesting Technology

Rainwater harvesting is the method of storing rainwater and thereby increasing the recharge of groundwater. As India since the very beginning was primarily an agricultural country, the need to harness water was felt. This is also due to fact that rainfall in our country occurs only for two to three months; therefore, water needs to be conserved for its use throughout the year. Even the ancient civilizations like Harappa, Mohenjo-Daro, etc. provide excellent examples of water harvesting through a network of tanks and reservoirs. Some of the old forts like Jaigarh Fort near Jaipur and Fatehpur Sikri near Agra, also provide good examples of water storage through rainwater harvesting.

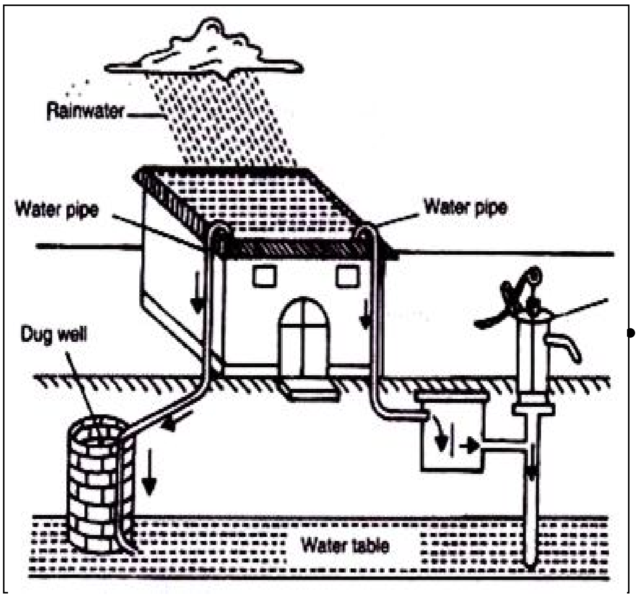

Figure 1 Rainwater harvesting

Several techniques are in practice to recharge groundwater. One method is to manage rainwater in such a way that it is used at the source. If as much water as possible is collected and stored, it can be used after the rainy season is over. This method has been traditionally practiced in dry areas. Simple local techniques such as ponds and earthen embankments can help in the harvesting and storage of rainwater. Rural and urban water use, restoration of streams for recreation, fresh water fisheries and natural ecosystems, etc. need rainwater harvesting. Local practices for rainwater harvesting can provide sufficient amount of water. One hectare of land in an arid region with 100 mm rainfall annually could yield one million litres of water per year through rainwater harvesting.

Deep wells may provide a source of clean water, but it is possible only in the rural areas. Traditional systems could become more efficient if scientific attempts are combined to enhance their productivity. Other methods are refilling of dug-wells, recharging of hand pumps, construction of percolation pits, trenches in the agricultural fields, bunds and check-dams etc. The above practices have been used since long in India. Now there are advanced techniques of water harvesting systems such as canals, tanks, embankments and wells. In hilly areas, rainwater harvesting has been practiced in rooftops and springs with the help of bamboo pipes. In arid and semi-and regions, wells and step-wells were constructed to tap groundwater. Construction of tanks has been a very popular method in recent years to conserve rainwater. Rainwater harvesting treatment is very important in the areas where pollution is alarming. It is now possible to use nano-filtration for the removal of hardness, natural organic materials, pesticides, bacteria, viruses, salinity, nitrates, arsenic and other pollutants. Weather and water policy should be integrated and may be streamlined to promote rainwater harvesting in the water stretched regions of the world. In the urban areas, water resources are fast depleting due to population increase and unrestricted use of water.

3.4 Rainwater Management Performance Standards

The Hill areas Rainwater management program, as described in our project, imposes requirements for new and redevelopment projects to manage Rainwater runoff for volume, water quality treatment, and peak flow rate. The specific Rainwater management requirements for a given project are determined by:

- The amount of land disturbed

Whether the project is a new project or a redevelopment project Which major watershed the project is located in.

3.5. Rainwater Management Methods

3.5.1 Rain Barrels And Cisterns

Rain barrels and cisterns can be used to collect rainwater for reuse. The larger the storage system is, the more water can be used and kept out of the stormwater system. The water collected is non-potable, but can be used to water gardens and lawns or indoors in toilets and urinals. In Victoria, most of the rain falls in the spring and autumn, but the watering needs are highest in the summer so it is beneficial to have a larger storage capacity if the stored water is to be used for irrigation of landscape or garden areas.

Rain Barrels: A rain barrel is a specialized container, connected to the downspout from a building that is designed to collect and store rainwater for reuse. Rain barrels are only eligible for incentives for low density residential properties (one to four units) under the Rainwater Rewards Program.

Cisterns: Cisterns or holding tanks collect rainwater and have a larger storage capacity than rain barrels. They can be elevated above ground, placed at ground level or buried underground. Cisterns can be connected to an irrigation system or 'purple pipe' system for indoor use. Locate rain barrels on a flat surface next to or near roof downspouts. Only collect roof water for reuse. Do not reuse water from parking or pedestrian areas, surface water runoff, or bodies of standing water. Roof material can impact the end use of the water collected in your rain barrel or cistern. Currently, no water quality standards for roofing types exist, and few roofing products carry water quality test information. Individual roof products vary. It is important to be mindful that any chemical treatment of a roof, such as moss inhibitors, could be harmful to plants.

3.5.2 Infiltration Chambers

Infiltration chambers are underground tanks or chambers with permeable bottoms that are designed to slowly release water into the ground over time. They primarily act to slowly return rainwater to the natural water table. This water is not reused. Infiltration chambers may not be located below buildings.Infiltration chambers are best used to infiltrate roof runoff, which is generally cleaner than ground surface runoff. Inflow to the infiltration chamber is generally through a sump to pre-clean the rainwater before entering the infiltration chamber, reducing the maintenance and extending the lifespan of the system. This may be a standard household sump or a larger sump for a nonresidential site.Inflow may also be through a lawn basin, which is a grate-topped sump located in a grassed area.The perforated under drain pipe below the surface must be connected to the municipal stormwater system. Infiltration chambers are easier to fit within a site than rain gardens or bioswales as they do not take up surface area, however, they tend to require a larger footprint than rain gardens and are more expensive to construct.

3.5.3 Rain Gardens

A rain garden is a shallow depression that uses soil and plants to manage runoff from hard areas such as roofs, parking lots and driveways. Rain gardens mimic nature by absorbing and filtering stormwater runoff. A rain garden fills up with water and forms a temporary “pond” of stormwater. It naturally filters out the pollutants in the stormwater as the water soaks down through the soil of the rain garden. The plants and a layer of absorbent soil can hold and evaporate a significant amount of rainwater as well as allow the stored water to slowly seep into the ground. A rain garden can enhance the look of a home or business as it is a landscape feature as well as a rainwater management method.

3.5.4 Permeable Paving

Permeable paving is hard surfacing specifically designed to allow rain to flow through the surface and into the soil below. To increase the volume of runoff that can be directed to the pavers, they can be installed with a drainage pipe and rock reservoir underneath. Permeable paving can be used instead of standard asphalt and concrete for surfacing sidewalks, patios, driveways, or parking areas. It can add character to your site while maintaining access and durability for vehicles and foot traffic.

3.5.5 Bioswales

Bioswales are sloped channels that are designed to clean and slow the runoff coming from a roof or driveway. There are a number of different types of bioswales, including grassed channels, dry swales and wet swales. They all use absorbent soil and plants to absorb, filter and infiltrate runoff. As with rain gardens bioswale plantings often include native plants or plants that are drought resistant and can also handle large amounts of water. A bioswale helps to move stormwater from one area to another, while also slowing and cleaning the stormwater.

3.5.6 Green Roofs

A green roof is a specially designed garden that has been planted on top of a waterproof membrane on a roof. Green roofs slow rainwater runoff from the roof, while absorbing and evaporating some of the rainwater. Green roofs also provide many secondary benefits, including space for gardening, and insulation which can reduce heating costs and cooling costs for the building and extending the life of the waterproof roof membrane.

- Green roofs are easiest to design for new construction but may also be retrofitted. A structural engineer must verify that the building structure and roof structure can support the saturated weight of the green roof.
- Building insurance may be a concern for a green roof. Any property owner considering a green roof should contact their insurer to discuss it before initiating any design.
- Some green roof manufacturers and installers provide a warranty for the materials and/or installation. Such warranties allow only specifically approved installers to work on the green roof.
- Green roof plantings require care and watering until they are established, generally the first 1 to 2 years post installation. Access and irrigation to the roof must be available for this.
- Aesthetic value of a green roof is much more significant when the green roof can be seen from taller neighbouring buildings or other vantage points.
- If the structure can support it, intensive green roof plantings and resident or public access can provide much-needed green space and garden space in the dense urban environment.

4.DRAINAGE IN HILL AREAS

Drainage of a hilly urban area needs to be planned for future giving due emphasis to its expansion pattern. Depending on origin of the residential development and culture of the community, expansion in the hills may take place in two distinct patterns. When people, traditionally living in plains of river valley, starts residing in the hills because of non-availability of affordable land in the plains, then urbanization expands towards hill starting from the plain area. If such expansions take place in an unplanned manner through indiscriminate cutting of the hills it induces several problems in the drainage. Toe cutting made in the process of unplanned expansion adversely affects the slope stability and the retaining wall constructed as remedial measures may in turn adversely affect the subsurface drainage if sufficient weep holes are not provided or if the permeability aspect of the retaining wall is not addressed properly. This increases the slope instability during rainy season. Similarly the exposition of land surface because of vertical and horizontal cutting aggravates the surface erosion process by many folds. Deposition of such eroded sediment inflicts serious problem in the drainage system in the area located downstream of it.

Roads will affect the natural surface and subsurface drainage pattern of a watershed or individual hill slope. Road drainage design has as its basic objective the reduction and/or elimination of energy generated by flowing water., increases exponentially as its velocity increases. Therefore, water must not be allowed to develop sufficient volume or velocity so as to cause excessive wear along ditches, below culverts, or along exposed running surfaces, cuts, or fills. Provision for adequate drainage is of paramount importance in road design and cannot be overemphasized. The presence of excess water or moisture within the roadway will adversely affect the engineering properties of the materials with which it was constructed. Cut or fill failures, road surface erosion, and weakened subgrades followed by a mass failure are all products of inadequate or poorly designed drainage. As has been stated previously, many drainage problems can be avoided in the location and design of the road: Drainage design is most appropriately included in alignment and gradient planning.
Hill slope geomorphology and hydrologic factors are important considerations in the location, design, and construction of a road. Slope morphology impacts road drainage and ultimately road stability. Important factors are slope shape (uniform, convex, concave), slope gradient, slope length, stream drainage characteristics (e.g., braided, dendritic), depth to bedrock, bedrock characteristics (e.g., fractured, hardness, bedding), and soil texture and permeability. Slope shape gives an indication of surface and subsurface water concentration or dispersion. Convex slopes (e.g., wide ridges) will tend to disperse water as it moves downhill. Straight slopes concentrate water on the lower slopes and contribute to the buildup of hydrostatic pressure. Concave slopes typically exhibit swales and draws. Water in these areas is concentrated at the lowest point on the slope and therefore represent the least desirable location for a road.

Hydrologic factors to consider in locating roads are number of stream crossings, side slope, and moisture regime. For example, at the lowest point on the slope, only one or two stream crossings may be required. Likewise, side slopes generally are not as steep, thereby reducing the amount of excavation. However, side cast fills and drainage requirements will need careful attention since water collected from upper positions on the slope will concentrate in the lower positions. In general, roads built on the upper one-third of a slope have better soil moisture conditions and, therefore, tend to be more stable than roads built on lower positions on the slope.

Natural drainage characteristics of a hill slope, as a rule, should not be changed. Culverts should be placed at grade and in line with the centerline of the channel. Failure to do this often results in excessive erosion of soils above and below the culvert. Also, debris cannot pass freely through the culvert causing plugging and oftentimes complete destruction of the road prism. Headwater streams are of particular concern (point A, Figure 60) since it is common to perceive that measurable flows cannot be generated from the moisture collection area above the crossings. However, little or no drainage on road crossings in these areas is notorious for causing major slide and debris torrents, especially if they are located on convex slope breaks. Increased risks of road failures are created at points A and B. At point A, water will pond above the road fill or flow downslope through the roadside ditch to point B. Ponding at A may cause weakening and/or erosion of the subgrade . If the culvert on Stream 1 plugs, water and debris will flow to point A and from A to B. Hence, the culvert at B is handling discharge from all three streams. If designed to minimum specifications, it is unlikely that either the ditch or the culvert at B will be able to efficiently discharge flow and debris from all three streams resulting in overflow and possible failure of the road at point B.Rapid urbanization has led to a considerable stress on the environment. Lack of judicious planning has given rise to a number of problems and their ill-effects experienced have been considerably profound. Some of the hazards that have surfaced over the recent times primarily because of the inadequate drainage system are stated below.

- Flooding,
- water logging
- Hill slope Erosion
- Landslide and Subsidence
- Traffic problem
- Health hazard

A road drainage system must satisfy two main criteria if it is to be effective throughout its design life:

- It must allow for a minimum of disturbance of the natural drainage pattern.
- It must drain surface and subsurface water away from the roadway and dissipate it in a way that prevents excessive collection of water in unstable areas and subsequent downstream erosion.
- The design of drainage structures is based on the sciences of hydrology and hydraulics-the former deals with the occurrence and form of water in the natural environment (precipitation, streamflow, soil moisture, etc.) while the latter deals with the engineering properties of fluids in motion.

4.1 Estimating Runoff

Any drainage installation is sized according to the probability of occurrence of an expected peak discharge during the design life of the installation. This, of course, is related to the intensity and duration of rainfall events occurring not only in the direct vicinity of the structure, but also upstream of the structure. In snow zones, peak discharge may be the result of an intense warming period causing rapid melting of the snowpack. In addition to considering intensity and duration of a peak rainfall event, the frequency, or how often the design maximum may be expected to occur, is also a consideration and is most often based on the life of the road, traffic, and consequences of failure. Primary highways often incorporate frequency periods of 50 to 100 years, secondary roads 25 years, and low volume forest roads 10 to 25 years Of the water that reaches the ground in the form of rain, some will percolate into the soil to be stored until it is taken up by plants or transported through pores as subsurface flow, some will evaporate back into the atmosphere, and the rest will contribute to overland flow or runoff. Stream flow consists of stored soil moisture which is supplied to the stream at a more or less constant rate throughout the year in the form of subsurface or groundwater flow plus water which is contributed to the channel more rapidly as the drainage net expands into ephemeral channels to incorporate excess rainfall during a major storm event. The proportion of rainfall that eventually becomes stream flow is dependent on the following factors:

1. **The size of the drainage area.** The larger the area, the greater the volume of runoff. An estimate of basin area is needed in order to use runoff formulas and charts.
2. **Topography.** Runoff volume generally increases with steepness of slope. Average slope, basin elevation, and aspect, although not often called for in most runoff formulas and charts, may provide helpful clues in refining a design.
3. **Soil.** Runoff varies with soil characteristics, particularly permeability and infiltration capacity. The infiltration rate of a dry soil, by nature of its intrinsic permeability, will steadily decrease with time as it becomes wetted, given a constant rainfall rate.

4.2 Subsurface Drainage

When groundwater cannot be effectively removed or intercepted by surface drainage, subsurface drainage techniques are required. As discussed in previous sections of this workbook, if water is not removed from subgrade or pavement structures it may create instability, reduce load bearing capacity, increase the danger of frost action and create a safety hazard by freezing of the traveled surface. Field investigations carried out during the route reconnaissance and design stages may not always reveal subdrainage problems. These less obvious problems can be effectively dealt with during construction. Field investigations should be carried out during the wet season and may include soil and/or geologic studies, borings or trenches to locate groundwater, inspections of natural and cut slopes in the local area, and measurement of discharge when possible. Sites with potential slope stability problems should be more thoroughly evaluated.

When groundwater tables approach the ground surface, such as in low, swampy areas, the gradeline should be placed high enough to keep water from being drawn up into the fill by capillary action. Whenever possible, well graded granular materials, such as coarse sand, should be used for fill construction. For a detailed discussion of grading requirements for filter materials the reader is referred to the Earth Manual published by the U.S. Department of the Interior (1974).

Three types of subdrainage systems are commonly used:
(1) **Pipe underdrains.** This system consists of perforated pipe placed at the bottom of a narrow trench and backfilled with a filter material such as coarse sand. It is generally used along the toes of cut or fill slopes. The trench should be below the groundwater surface and dug into a lower, more inpervious soil layer to intercept groundwater. The drains may be made of metal, concrete, clay, asbestos-cement, or bituminous fiber and should be 15 centimeters (6 inches) in diameter or larger.

(2) **Drilled drains.** This system consists of perforated metal pipes placed in holes drilled into cut or fill slopes after construction.
(3) **French drains.** This system consists of trenches backfilled with porous material, such as very coarse sand or gravel. This type of drain is apt to become clogged with fines and is not recommended.
A major difficulty in selecting a drainage system is the lack of adequate performance data for various drainage methods. A good knowledge of seasonal groundwater fluctuations, variation in lateral and vertical permeability, and the ratio of vertical to lateral permeability are critical. Long term monitoring of drainage performance is important in determining appropriate prescriptions for future installations. For example, perforated drains are commonly prescribed but often will not function properly as a result of clogging of pores with fines or from geochemical reactions leading to the formation of precipitates. Several methods may be used to prevent plugging depending on soil characteristics and material availability. The first is to enclose the perforated pipe with geotextile fabric. Second, surround the pipe with an open graded aggregate material, which in turn is surrounded by a fabric. The use of fabric eliminates the need for an inverted filter consisting of various sized gravel and sand layers. Third, if fabric is not available, surround the pipe with a graded aggregate filter. Although the cost of installing such a drainage system is high, it may effectively reduce final road costs by decreasing the depth of base rock needed, thereby reducing subgrade widths and associated costs for clearing, excavating, and maintenance.

4.3 Factors Affecting Drainage

4.3.1Houses Built At The Bottom Of A Hill

Beware of houses built at the bottom of a hill! This is another common drainage problem. Our experience in analyzing common drainage problems has alerted us to this issue. Water drains downhill. Being downhill of your neighbors does not have to be a problem but so often it is. When purchasing a home which sits at a lower elevation than the surrounding homes, have a qualified water damage expert inspect the storm water drainage. We look for potential problems that may exist which can later cause you water problems and damage to your property. When buying a home, it is so easy to get involved in the layout of the kitchen and how the master bedroom functions, that the exterior of the house and yard are given little consideration. Improper grading of yards rank near the top of the list of common drainage problems. When we point this out to homeowners, they often think their situation is hopeless. Well, it is not. The storm water needs to be collected and routed away from the property to a suitable outlet. Our water damage experts have had years of experience solving storm water drainage problems.

Each situation is different. No two sites are the same. We look for the most economical solutions that will solve the problem. The proper slope is vitally important. The grading contractor removes the dirt to construct the foundation. The concrete foundation contractor pours the foundation. The grading contractor backfills the foundation excavation with soil. Rarely does a contractor properly compact the soil used for the backfill.Over time the loose soil settles and creates a sunken area adjacent to the foundation. The low area holds water and the water seeps into the ground and enters the basement through cracks in the foundation wall, a most common drainage problem. The shrubbery around homes makes it difficult to detect the settlement around the foundation. Also, plants and mulch placed around shrubs can prevent water from draining away from the foundation.Water allowed to pool adjacent to your foundation will seep into the soil around your foundation. The saturated soil can reduce the structural integrity of the soil under the foundation.If one or more areas under your foundation become saturated, differential settlement can occur. The uneven settling of your foundation will cause cracks in brick, doors that will not close properly and windows that are difficult to open and close.

4.3.2 Climate

As the major transport of solutes through the soil is by the movement of water, climate plays a major role in determining drainage water quality. In humid tropics and temperate regions, the dominant movement of water through the soil is vertically downwards. Solutes, which are brought onto the soil by farmers or are naturally present in the upper soil layers, are leached into deeper soil layers and groundwater. Conversely, in arid climates where evaporation largely exceeds precipitation the dominant water movement through the soil is vertically upwards except during rainfall or irrigation events. Therefore, the chemical composition of deeper soil layers influences the quality of the shallow groundwater and the composition of the soil moisture in the rootzone. Climate and temperature also play a role in the rate of weathering and chemical processes.

4.3.3 Cropping Patterns

Cropping patterns play an important role in the quality of drainage water in a number of respects. First, crops extract water from the rootzone resulting in an evapoconcentration of salts and other solutes in the soil solution. Where the solubility product of minerals is exceeded through evapoconcentration, minerals precipitate out. This changes the composition of the soil solution and thus influences the chemical quality of subsurface drainage waters. Second, crop residues add organic matter to the soil profile. Organic matter in the soil increases the adsorptive capacity for metals and other solutes. Furthermore, organic matter enhances the soil structure, which increases the water holding capacity of the soil. The organic matter also serves as a carbon source for soil microbes involved in transformations such as denitrification, sulphate reduction and methane production in submerged soils. Third, plants extract nutrients through their rooting system and some plants have the capacity to accumulate large amounts of certain salts and toxic elements. Fourth, as not all crops have the same salt tolerance the type of crop largely determines the maximum salt concentration in the rootzone and the amount of water needed to maintain a favourable salt balance in the rootzone.

4.3.4 Land Slope

Sloping land permits water to run off the field by gravity, while flat land has wetness problems unless there is good natural or artificial drainage. Even with adequate slope, however, corn land can still have drainage problems due to side hill seepage. Land on floodplains may be subject to periodic flooding and require special attention to enhance surface water removal.

5.CONCLUSION

The evolution to more planned conjunctive use and management of rainwater resources offers great potential for increasing water-supply security and efficiency for both irrigated agriculture and urban water-supply in the developing world. It will be especially important for climate change adaptation on large alluvial plains, which are often major centres of population and economic development. There are a range of settings within which conjunctive use management can occur and there do not appear to be any situations where conjunctive use management should not be practiced; Planned conjunctive use management is far better than spontaneous conjunctive use;

- During monsoon, majority of the command remains waterlogged & it is required that groundwater withdrawal during non-monsoon period be increased so that groundwater reservoir will have sufficient capacity to accommodate monsoon recharge.

- Increasing storage through a combination of groundwater & Rain water ,large & small surface water facilities.
- Judicious allocation of water.
- Vigilant monitoring to avoid over irrigation.
- Creating public awareness.
- Necessity of public participation.
- Poverty reduction in irrigation areas is closely linked to water supply efficiency and hence to conjunctive use management.

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