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THE CONCEPT OF WATER CONSERVATION IN SUSTAINABLE BUILDING.

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Abstract

Water is necessary for the sustenance of human life, owing to the fact that this natural resource is rapidly exhausting, conservation is essential. Water conservation is the planned management of water to prevent waste, overuse and exploitation of the resource. This research aims to stress on the need for water conservation and highlights some several technologies and strategies available for implementing water efficiency practices and some methods that can be employed to reduce water consumption in a building. However, the three major key components of water conservation in green buildings are: Reduce indoor potable water use, reducing water consumption to save energy, Improve environmental well-being. The research sought to bring to limelight water conservation technologies which include: Rain water harvesting, Grey water recycling and Low-flow plumbing fixtures. By way of literature review, this research is to explore the approach and practical aspects that promote water conservation as an element of green building. Contemporary potable water management is not sustainable whereas we use potable water for non-domestic uses. The appropriate solution is to substitute potable water with rainwater for some purposes and this water source is considered sustainable because the accesses to fresh water have prolonged to be a source of worry in some parts of the world.

Keywords: Water conservation, Rainwater harvesting, Grey water recycling, Low-flow fixtures.

1. Introduction

Green building focuses on a building structure that is designed to be environmental-friendly and makes nominalist and effective use of natural resources. The aim of a green building is to achieve sustainability in buildings in terms of health, energy use, and other environmental issues. A Green building design largely emphasises on making effectual use of natural resources like water, energy, etc. Water is an essential element in human life; it can therefore be considered as fuel for humans. Water is necessary for the sustenance of human life, owing to the fact that this natural resource is rapidly exhausting, conservation is essential. Water conservation is therefore an important chunk of green buildings that entail curtailment of water usage and includes day-to-day demand management for better water usage. Water conservation can be defined as the planned management of water to avoid waste, overuse, and exploitation of the resource. It can also be defined as using our limited water supply efficiently and wisely. In today's world, many have the thought that the supply of water is abundant, but contrary to that thought – water is no longer a limitless resource in most countries**.** Water can be said to be the only commodity on earth for which there is no economical exchange. According to Kaposztasova et al, (2014), water is not a commercial product like any other but rather a heritage which must be protected, defended and treated as such. Water is paramount in human life, it is used for drinking, cooking, washing, and irrigating landscapes, farming, construction, and operation of buildings. The need for water is limitless because of its importance and as such cannot be overemphasized.

Water conservation measures in residential and commercial buildings can greatly reduce water waste, yielding lower sewage volumes, reduced energy use, and bring in financial benefits too, (GoSmartBricks.com). Reducing water consumption and protecting water quality are key objectives of sustainable design. Water conservation has often been the most overlooked aspects of a whole-building design strategy. Hence, the significance of water conservation strategies and technologies is to lessen the amount of potable water consumed in buildings. There are also significant energy cost savings associated with water efficiency measures, further illustrating that water conservation measures are an integral part of a facility's overall energy management plan. The access to fresh water has prolonged to be a source of worry in many parts of the world, water efficiency strategies in green building practices have become paramount to both new and existing construction efforts.

The planning for various water uses within a building is increasingly becoming a high priority. This is due to a number of reasons, namely that new and existing water resources are becoming increasingly scarce in a number of regions throughout the country; per capita water consumption is increasing annually; water and sewer rates have increased dramatically over the last decade (100–400%); and new water supply options are too costly or altogether unavailable, often resulting in stringent water use requirements in new construction applications, (Bourg, 2016).

1.1 Purpose of the Study

Concerning the sustainable approaches, design for water means that the fresh water – blue water does not have to be the first choice for a water source.

a. The purpose of this research is to analyse, particularly the methods in water conservation to be rated in green building design.
b. The study investigates green aspects; of self-contained factors ensembles measuring the green ship for buildings.
c. The study is to create a suitable mechanism that can establish the basic principles of sustainability in water policy and subsequently water management.

1.2 Aim and Objectives

The aim of this research is to save water by all means in any form and protect water quality.

In other to achieve the stipulated aim, the following objectives highlighted the several technologies and strategies available for implementing water conservation practices.

a. To stress on the need for water conservation
b. To ensure the protection of the existing sources of fresh water which is most essential for avoiding the crisis of water in the future.
c. To protect natural water bodies thereby protecting aquatic wildlife
d. To avoid water wastage by conserving water by all means.
e. To research on the quantity and quality of water

1.3 Scope of the Project

The scope of this research is analysed by using the following criteria: water fixtures, water recycling, alternative water resources, rain water harvesting, and water efficiency landscaping.

1.4 Methodology

The study presented in this paper, traces a case study research method were carried out to provide information on various water conservation strategies employed at a number of residential and commercial facilities. Water conservation measures in residential and commercial buildings can greatly reduce water waste

1. General overview on applying the concept of water conservation in green building.
2. Defining considerations for water conservation.
3. Defining the benefits of applying criteria for green building strategies that could maximize water conservation.
4. Describing case study potentials in terms of water conservation aspects.

2. Literature Review

Water is a clear; colourless, odourless, tasteless liquid that freezes into ice below 0ºC and boils above 100 ºC. It is composed of hydrogen and oxygen existing in gaseous, liquid and solid states that is essential to all known forms of life. Water as an essential element in human life and often referred as the source of life - can be captured, stored, filtered, and reused. It provides a valuable resource to be celebrated in the process of green building design. Global water usage continues to increase at 2x the rate of population growth (GoSmartBricks.com). Bargiacchi, (2021) stated that although 71% of earth is covered in water, it is still a scarce resource: 97% of earth’s water is saltwater, which is not suitable for drinking and domestic uses. More than half of the available 3% freshwater is locked in glaciers, underground or in the atmosphere.

Water Conservation and Water Efficiency are terms often used synonymously, but differ in their positive meaning. According to GoSmartBricks .com **Water Conservation –** Implies curtailment of water usage and includes day-to-day demand management for better water usage while **Water Efficiency –** In simple terms, means responsible use of fresh water and reducing the overall usage of water and minimizing wastewater.

Water efficiency is the planned management of water to prevent waste, overuse, and exploitation of the resource. Effective water efficiency planning seeks to "do more with less" without sacrificing comfort or performance. Water efficiency planning is a resource management practice that incorporates analysis of costs and uses of water; specification of water-saving solutions; installation of water-saving measures; and verification of savings to maximize the cost-effective use of water resources, Bourg (2016). It also points toward using improved practices and technologies which deliver equal or better life service with reduced water consumption. This water savings potential is enormous with relatively low-cost expenditures.

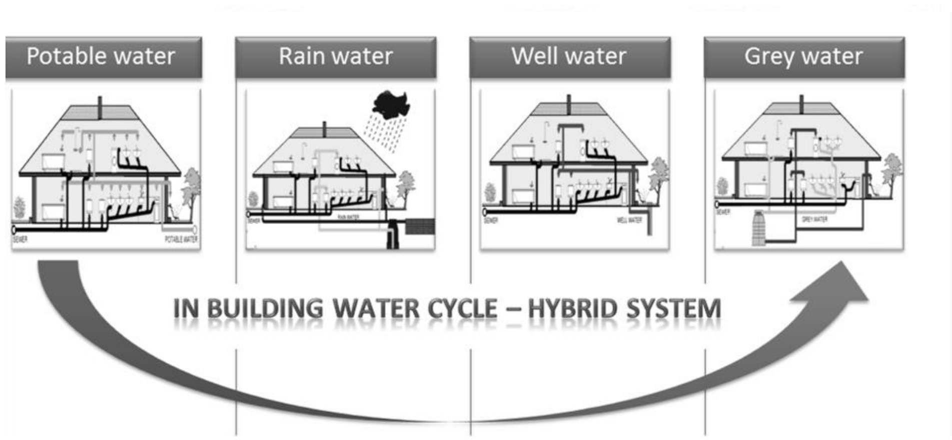

Fig.8: Hybrid system of in-building water cycle.
Source: Kaposztasova et al. (2014)

The Green Building Design course introduces methods of rainwater harvesting, grey water systems and living pools (BCKL, 2009). One of the objectives of using alternative water resources is to support adequate water quality use for different purposes. It is the fact that we use expensive and valuable potable water for flushing toilets, even though it doesn't need to be water with such quality. This is for instance right place where to substitute potable water with one of the alternative water resources. Other examples are irrigation, washing and maintenance, washing vehicles or heating. Rain and stormwater harvesting contribute to the integrated management of urban water cycle. It has direct impact on volume and quality of stormwater runoff than reduction in flows to wastewater treatment plants and it of course conserves drinking water. Climate changes impose important challenges to the water sector. Potential effects on the urban water cycle involve the aggravation of existing conditions as well as occurrence of new hazards or risk factors. Risk management has its place in science and our everyday life as well. Water management in general comprises wide range of problems especially in recent years we see increasing need to dispose rainwater on decentralized way. That is the reason why we are interested in this topic and why we would like to increase awareness on this topic in our conditions. This paper does not deal with the RWH system in details but presents the semi quantitative approach methodology verified by mathematical method - analytical hierarchy process (AHP).

Fig.1: Sustainable Water Management for Green Growth (Source: Vos, 2017)

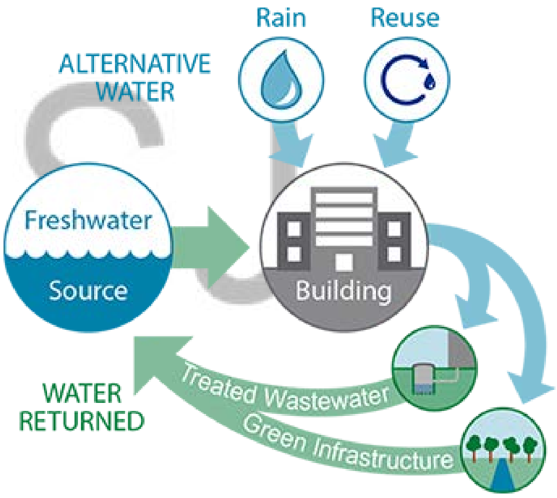

Fig.2: Protect and Conserve Water (Source: WBDG2021)

2.1 Types of water

There are many types of water as defined by Kinkade-Levarios, (2007).

1. *Atmospheric water* – rain and fog
2. *Blue water* – water from lakes, rivers
3. *Green water* – soil moisture
4. *Stormwater* – rainwater that has hit the ground
5. *Grey wate*r (light, dark) – waste water from laundry, bathtub, shower, basin

6. *Alternate water* – water that has been used previously
7. *Black water* – water from toilets and kitchen sinks
8. *Reclaim water* – water that has gone through a sewer treatment process and has been filtered and processed for reuse in various ways.

2.2 Key Components of Water Conservation in Green Buildings

The three key components of water efficiency in green buildings according to the USGBC (U.S. Green Building Council) are:

a. Reduce Indoor Potable Water Use
b. Reducing Water Consumption to Save Energy
c. Improve Environmental Well-Being

2.3 Water Conservation Strategies and Technologies

The conservation strategies and technologies entangled in a green building ettle at reducing the amount of potable water consumed in buildings. In recent time there are several water conservation strategies which comprise a low cost of implementation with a quick payback.

2.4 Water Conservation Strategies

Several strategies are being used for the conservation of water in green building today considering its necessity. There has been a number of strategies been employed to reduce the amount of portable water consumed at a facility. In general terms, these methods include:

i. System optimization (i.e., efficient water systems design, leak detection, and repair);
ii. Water conservation measures; and
iii. Water reuse/recycling systems.

More specifically, there is a wide range of technologies and measures that can be employed within the water conservation strategies to save water and associated energy consumption. These include:

i. Water-efficient plumbing fixtures (ultra-low-flow toilets and urinals, waterless urinals, low-flow and censored sinks, low-flow showerheads, and water-efficient dishwashers and washing machines)

ii. Irrigation and landscaping measures (water-efficient irrigation systems, irrigation control systems, low-flow sprinkler heads, water-efficient scheduling practices, and Xeriscape)

iii. Water recycling or reuse measures (Gray water and process recycling systems), and

iv. Methods to reduce water use in HVAC systems.

2.5 Water Conservation Technologies

Water Efficient technologies in buildings are imperative these days. With so much water getting wasted and overused, high volume of fresh water is getting drawn out resulting to depletion. Hence, water efficient technologies play a great role in conserving potable and non-potable water and eventually save the already scarce freshwater resources. Water conservation technologies include: rainwater harvesting, grey water recycling, low-flow fixtures, sensors etc. This technique emphasizes the value of decreasing demands for fresh water and reducing the generation of waste water through optimized landscaping, integrated rainwater catchments, gray water recycling, and wastewater treatment systems. Water - often referred as the source of life can be captured, stored, filtered and reused. Green architecture is more effective with the inspiration of ecological surrounding to conserve water and decrease water consumption or wastage through water-saving plumbing fixtures. It is part of the approaches in green architecture which encourage the thorough use of water. This green architecture approach makes certain that water is harvested, used, purified and re-used during the entire period of construction and simultaneously the architectural design ensures that in the entire life cycle of the building not only supports efficient water use but also preserves the quality of surrounding water systems and makes use of water recycling mechanisms through the following:

2.5.1 Rain water harvesting

The formation of precipitation is the first form of water in the natural hydrological cycle, hence rain is considered as condensed water falling from the cloud. Rainwater harvesting is a technology in which a building collects, store and utilize rainwater. The eaves of the building consist of water collectors that deliver rainwater falling on the roof top to the storage tank. Mishra, (2009) stated that, rainwater harvesting is the collection and storage of rain for reuse on-site rather than allowing it to run off. However, once the rain hits the ground it is no longer referred as rain, but as stormwater.

Therefore, it is the active collection and distribution of rainwater which rather than going to the sewage is put into use in daily life. Rainwater is collected from rooftops or any hard surface such as stone, concrete patios and asphalts parking lots and is been transported into a reservoir with filtration techniques. Once this harvested rainwater is purified, it can be used for various purposes such as cultivation, horticulture, irrigation, toilet flushing and other domestic uses. Rainwater harvesting is a common practice in the Eastern part of Nigeria, (Anambra, Enugu, Ebonyi) etc. due to their low water table and lower rate of rainfall.

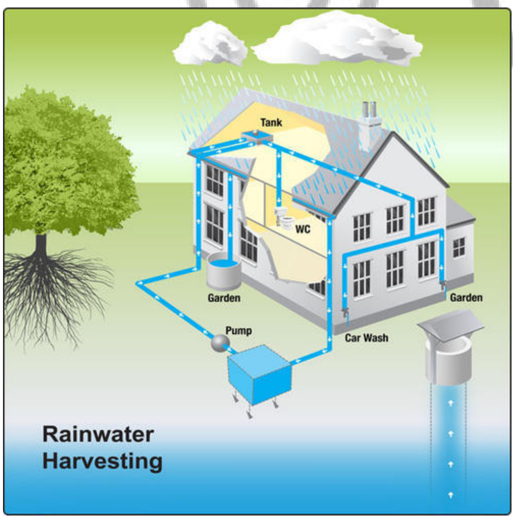

Fig.3: Rainwater harvesting (Source: https://5.imimg.com)

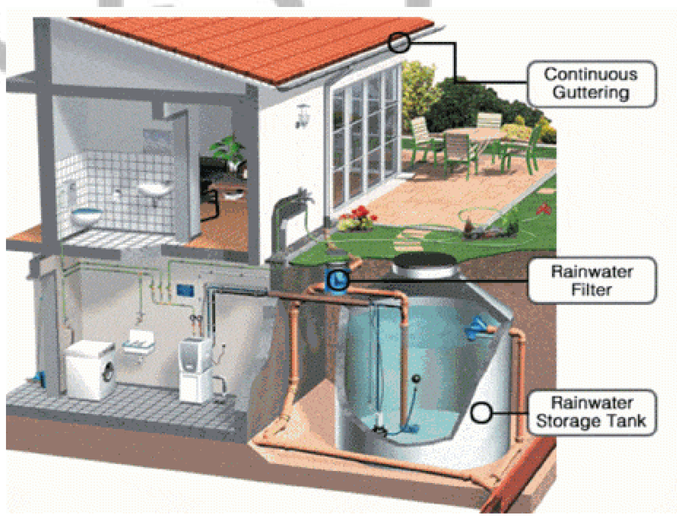

Fig.4: Rainwater harvesting technique for green-building (Source: www.theconstructor.org)

Rainwater harvesting captures precipitations and uses it as close as possible to where it falls. Rainwater harvesting supports sustainability in stormwater management which in principle means managing storm water as a resource and as close to the source as possible. Stormwater management has been changing throughout years and it was caused by extensive urbanization which changed storm water runoff and infiltration patterns. Stormwater runoff is largely caused by rain falling on asphalt or roofs and storms.

A. Methods of Rainwater Harvesting

Rainwater can be harvested through the following the methods.

i. Surface Runoff Harvesting: This is a method which rainwater flows away as surface runoff. This surface runoff can be caught and used for recharging aquifers by adopting appropriate methods. Landscape can also be contoured to retain the stormwater runoff.

ii. Rooftop Rainwater Harvesting: It is a system of collecting rainwater from the roof of the building. It can either be stored in a storage facility or diverted to an artificial recharge system.

B. Components of Rainwater Harvesting System

The common components of a rainwater harvesting system are

i. **Catchments:** This is the area which directly receives the rainfall and provides water to the system. This area can be a paved surface of a building or an unpaved area like a lawn or open ground. Corrugated sheets can also be used for water harvesting. reinforced cement concrete (RCC)

ii. **Coarse Mesh:** This is installed to prevent the passage of debris from the catchments.

iii. **Transportation:** Gutters are stationed to collect and transport rainwater from the sloping roof to the storage tank through drain lines which transport rainwater from the catchment area to the harvesting system. Conduit materials are made of polyvinyl chloride (PVC) or galvanized iron (GI).

iv. **First-flushing**: A valve device which ensures flushing out of relatively larger amount of pollutants from the storage tank been transported from the air and catchment surface.

v. **Recharge structures:** Harvested rainwater can also be used for charging the groundwater aquifers through suitable various structures to ensure the percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are:

recharging of bore wells, recharging of dug wells, recharge pits, recharge trenches, soakaways or recharge shafts and percolation tanks.

2.5.2 Grey water recycling

This refers to water sourced from kitchen, laundry, showers, basins and bathroom drains, that hasn't come in contact with sewage. A grey water recycling system reclaims this water and uses it. Grey water may contain urine and feces from nappy washing and showering, as well as kitchen scraps, soil, hair, detergents, cleaning products, personal-care products, sunscreens, fats and oils. Domestic wastewater (excluding fecal matter and urine) from bathrooms, basins, showers is called light grey water - LGW. Contaminated or difficult –to-handle grey water, such as solids-laden, kitchen sink water or from laundry is called dark grey water, (Kaposztasova et al, 2014). It provides a valuable resource to be celebrated in the process of green building design.

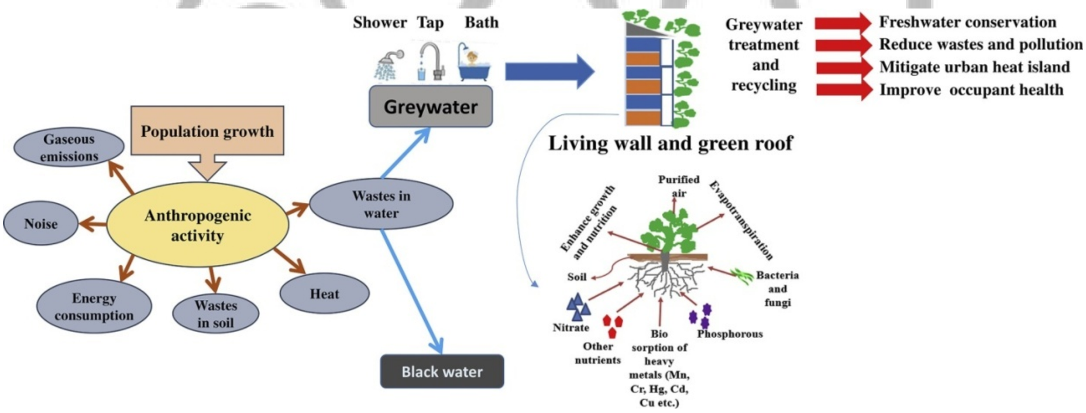

Fig.5: Greywater Recycling in Buildings Using Living Walls
(Source: Pradhan et al, 2019)

According to Art Ludwig in Create an Oasis out of Grey water, only about 6% of the water we use is for drinking. The use of potable water for irrigation or sewage is not necessary. The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing or by using water for washing of the cars. Waste-water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads. Grey water can be used for flushing toilets, land irrigation, and other external usage. Point of use water treatment and heating improves both water quality and energy efficiency while reducing the amount of water in circulation. The use of non-sewage and grey water for on-site use such as site-irrigation will minimize demands on the local aquifer (Stephen & Harrell, 2008). This system of recycling ensures optimum utilisation of our limited water supply.

Treatment of grey water:

The following are the processes involved in the treatment of grey water:

i. Filtering
ii. Settlement of solids
iii. Flotation and separation of lighter solids
iv. Aerobic or anaerobic digestion
v. Chemical or UV disinfection

2.5.3 Low-Flow Plumbing Fixtures

Low-flow plumbing fixtures such as faucets, shower heads, and toilets have become an increasingly common feature in green homes today, and for good reason. Large quantities of water are been conserved with the use of these plumbing Low-Flow fixtures which are designed to operate with less water. Furthermore, toilet flush was designed to function using 7 gallons per flush, but these days they can efficiently operate using only 1.3 gallons this clearly means water savings of over 80 percent.

With increased technological development and consciousness on water conservation, a variety of water efficient plumbing options are available for this purpose. Water efficient taps which include taps with sensors that automatically turn off. Shower heads with water saving technology reduce the rate of water flow, through the spray pattern of the shower. Due to this knowledge on water conservation, there is water efficient toilets which are low flow, they use less water assisted with high pressure. This ensures a clean flush with almost half the amount of water used. High water pressure causes a lot of water wastage. Installing water pressure reducing valves in all the plumbing systems regulates the water flow to a predetermined level. These fixtures are usually easy to install. They also pay back their investment by saving enough water within a year.

Fig.6: Save water with low-flow plumbing fixtures.
Source: Ballanco, (2017).

Fig.7: Installation of low -flow features
Source: www.easecotipscom.

3. Benefits for Water Conservation

We can sum up the benefits of water conservation as below.

a. Protect ecosystems (this philosophy cares for all living and non-living such as soil, water, and air to the entire ecosystem because all species require water for survival)

b. Endless domestic uses (The need for water cannot be over emphasized, water is needed for drinking, cooking, washing, bathing, watering plants, etc.)

c. Food availability (to sustain a basic quality of life, it is impossible to grow any crops, fruits or vegetable without water)

d. Reduces energy (Green buildings make use of evaporative cooling systems to save energy)

e. Monetary Saving (basic water conservation measures lower water bills)

f. Recharges groundwater instead of depleting it

g. Grey water nutrients support plant growth – irrigation

h. Grey water reduces the load on septic tanks and drain fields

i. Support sustainability

4. Conclusion and Recommendations

Conclusion

Water conservation techniques in residential building are designated for fostering the awareness the importance of water usage efficiency. The water conservation approaches in the buildings is targeted to have points in greenship rating system as follows: water fixtures, alternative water resources and rainwater harvesting. Concern over the sustainability of drinking water supplies for new developments has increased over the last decade. Water is the fuel of all living and non-living on earth, as such it is a necessity. It is crucial to always recall how finite the water supply is. Absence of water conservation can result to extinction of multiple species including humans. Conclusively, it is our responsibility to learn about and implement water conservation.

Recommendation

The construction industries should be aware of the need for water conservation and are then make provisions for harvesting rainwater to increase the underground water table. Provisions have to be made for the recycling process of water thus helping conserve precious water and reuse it in an efficient way. Architects and engineers have to specify rainwater harvesting systems to collect rainwater, store it and then use it for gardening, toilet flushing and other nondomestic uses, thereby decreasing the demand for potable water from the mains supply. Architectural design should consciously ensure the application of various water conservation measures.

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