LANDSCAPE DESIGN ALTERNATIVES TO FACE WATER PROBLEMS IN EGYPT

[1]REHAM M. M. MOHIEELDIN, [2]HOSAM M. ABDEL AZIZ

[1]Associate Professor in the Architecture Department at the Modern Academy for Engineering and Technology,
[2]Assistant Professor in the Architecture Department at the Modern Academy for Engineering and Technology
E - mail: [1]Eng_rehammostafa@yahoo.com, [2]Hosamoftah@yahoo.com

Abstract - Egypt is facing a new decade with the expected shortage in its water supply due to the Ethiopian New Dam on the river Nile. News is filled with coming wars and the death of the Nile in Egypt. If this is true and with Egypt's current problems in managing its share of water, this will result in additional complications and one of them will affect the building sector in the form of the many residential compounds that compete with each other aesthetically and environmentally through the high percentage of natural landscape they include. Thus, this paper will try to provide practical alternatives for the main landscape elements in order to decrease the water consumption rate for plantation, while preserving the design aesthetics and benefits.

Index Terms - Landscape Design, Water Conservation, Sustainable Hardscape & Drought Tolerant Plants

I. INTRODUCTION

Water is the source of life for nations, and Egypt is no exception where the river Nile was and will always be its lifeline, providing it with all its needs from water. However, in recent years Egypt faced water sacristy due to mismanagement of its share in addition to other reasons [1]. This combined with Egypt expected decrease in its water share from the Nile due to the Ethiopian New Dam raise a red flag, where the new decade must be a decade of extreme water conservation for Egypt [2].

One of the main water consuming factors is the building sector, where in the past years there was a call for residential compounds with high percentage of greenery and landscape, usually not less than 60% of the total land area. These compounds faces now the high costs of their landscape water consumption that was raised by the government as means for conserving its decreasing water supply. Owners now are asking landscapers to change their designs in the projects' new phases to non-water consuming landscape alternatives regardless of their functionality or aesthetics values.

Thus this paper will provide a comparative study using a real case study, projecting its initial design with its high water costs in compare to a more sustainable design applicable to Egypt. However, while the new design will conserve water and decrease costs, it will also preserve the functional and aesthetical values of the design.

II. WATER CRISIS IN EGYPT

A. Current Reasons

Egypt is an arid country with limited rainfall; therefore, it depends mainly on the Nile River for its freshwater supply. However, there is still an annual deficiency of about 7 billion meters, with expectation from the United Nations that by the year 2025, Egypt might run out of water. Current water problems can be related to various reasons such as; rapid population growth, inefficient irrigations methods, abusing water resources, pollution, unbalanced water distribution [1].

B. Grand Ethiopian Renaissance Dam (GERD)

Another expected reason for increasing Egypt's water problems in the near future is the grand Ethiopian renaissance dam. Due to a colonial-era treaty, Egypt was granted around 90% share in the water of the Nile, 55.5 billion cubic meters, forbidding other countries along the Nile from taking even a drop without permission. Since 2010, major concerns aroused that a political influence shift is taking place when Ethiopia started constructing its new Dam on the Nile. The problem is not only the decrease in the total amount of water Egypt will receive due to this dam, but also that during the dry months not enough water will be released in the downstream [1]. Around 25% decrease in the Nile's water for up to seven years is expected in order to only fill the reservoir behind the dam [2].

This problem cannot be afforded by Egypt, thus the news is filled with talks of war over water and the death of the Nile for Egypt [3]. However, and until a conclusive political solution is found, serious actions must take place now in order to find holistic solutions for water conservation and to decrease the current consumption rates. The government started by raising the costs for water and forbidding or decreasing the area for planting some crops that require a large amount of water for irrigation, in spite of the objecting voices stating that these are not the best solutions for addressing this problem.

III. RESIDENTIAL COMPOUNDS IN EGYPT

After irrigation which consumes around 86% of Egypt water [4], the built environment, especially the residential sector, is considered one of the main water consuming factors in Egypt. In recent years, there was an increase in the demand for the residential compounds, as a result to the High living standards requirements [5], which meant additional burden on the water resources due to the compound's landscape large areas. A great solution for this would have been using grey water and seasonal rainfall water for landscape irrigation. However, grey water is not really used in Egypt, may be because the current trials for grey water leaves it with a little smell that does not satisfy the needs of the compounds' high standard. As for rainfall, clients tend to believe that the initial costs will be higher and for a limited time of usage during the year.

Today, the residential compounds in Egypt are estimated to be more than 150 compounds all over Egypt [6] and more than 30 top rated compounds are in New Cairo alone [7]. Thus, the research selected New Cairo and one of its compounds to be its case study.

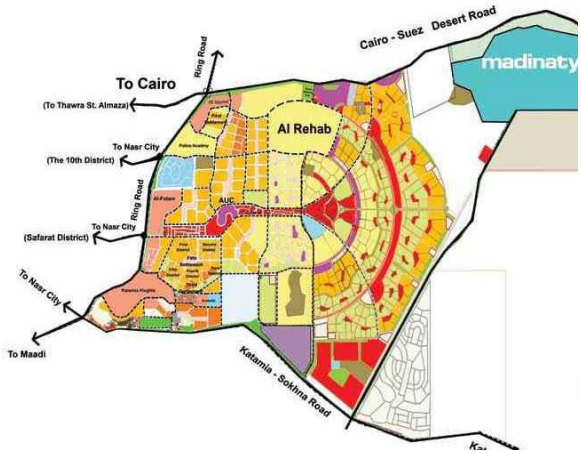


Fig. (1): New Cairo Map and its compounds distribution [8].



Fig. (2): Various photos illustrating different top rated residential compounds in New Cairo and their landscape design showing the large use of grass [9].

IV. WATER CONSERVATION STRATEGIES FOR LANDSCAPING

Now in Egypt, clients' link residential compounds beautiful landscape with a significant higher costs, while normal people link it to consuming water that is not available. In general, landscape design and plant selection depends basically on three factors; function, aesthetics & maintenance [10]. While there is a huge need now to reduce water consumption rate for landscaping, there is an equal need to do that while preserving the aforementioned three factors. There are many strategies that could be used to achieve this, such as [11];

- Improving the soil by cultivating it to increase its ability to retain moisture.
- Using suitable, upgraded and efficient irrigation system for the adequate use of water such as low-flow irrigation.
- Planting in the right place according to the need for sun or shade and gathering plants that request the same amount of water in the same place.
- Controlling the weeds because they steal water.
- Watering deeply so roots can grow downwards and find any available groundwater.
- Planting mulch around the plants in order to conserve the moisture in the soil.
- Decreasing the lawn grasses areas or finding alternatives to greenery since it requires an enormous amount of water.

It's possible to design landscape that's both water conserving and good looking. While the aforementioned strategies will conserve water, there are two main strategies that will preserve the aesthetics of the design and they are achieved through [11];

- Using bright colors through a combination of flowering and plenty of lush foliage plants.
- Playing with foliage texture and bold shapes.

The next part will focus on demonstrating two main alternative strategies that can be used in replacing the greenery and the grass. They are replacing greenery with hardscape or using drought tolerant plants.

A. Replacing Greenery with Hardscape

Hardscape is all non-plant elements in the landscape like walls, patios, steps, benches, decks, sculptures, paths, flagstone walkways, terraces, boulders, plazas and more. These elements are part of the landscape design which can create visually appealing outdoor spaces and act as an alternative to water consuming grass. Hardscape can also be used to direct the rainwater flow to water the plants [12]. Paving paths with gravel, porous concrete, decomposed granite or spaced flagstones are great alternatives for grass to conserve water. Permeable paving materials do not

need irrigation and add beauty in addition to structure to the landscape, allowing rainwater and irrigation water to pass through them [11].



Fig. (3): Hardcsape design using sustainable materials such as gravel and stones with high visual effects [13].



Fig. (4): Another Hardscape design using wood and gravel for the walkways, with different visual effects [14], [15].

B. Using Drought Tolerant Plants

Grass is considered the largest water consumer element in the landscape, requiring a high maintenance level as well [16]. Using drought tolerant plants instead of normal greenery or grass has a good financial and ecological sense. It requires less water and utilizes every drop without compromising the natural beauty of the landscape design with various environmental and biological benefits. In addition to conserving water, drought plants can reduce or almost eliminate the need for chemical fertilizers, which creates a healthier environment and lower the maintenance costs [17]. Drought tolerant plants consist of groundcovers, shrubs and trees which can be visually appealing throughout being colorful in addition to being enticing to birds [18], thus creating their own aesthetics.



Fig. (5): Euphorbia milii is one of the most water saving Shrubs [19].



Fig. (6): Poinciana Regia is one of the most water saving trees and used a lot in the landscape in Egypt [20].

Additional alternatives that are applicable to the Egyptian climate and market will be demonstrated in the case study below, in addition to discussing the amount of water and money they can conserve.

V. LAW-WATER LANDSCAPE DESIGN (CASE STUDY)

In this part, the research will demonstrate a practical application to the aforementioned strategies throughout using a real case study. First it will illustrate the project with its initial design, and then it will provide a more sustainable alternative that can succeed in all the required goals, while comparing between the two designs water consumption and monthly landscape costs. Thus, Leena Springs residential Compound in new Cairo, Cairo, Egypt was selected. The residential compound is located in the northern 90 street in new Cairo. It consists of several residential villas and apartments. The study area is called Zone (A) which consists of a number of villas, with total ground area of 6000 m^2 for landscape alone.



Fig. (7): Leena Compound location in New Cairo [21].



Fig. (8): An Overview of the Site, Zone (A) By: Researchers

The weather in this area is considered hot arid with high temperature especially in the summer. This consumes large amounts of water for evaporation in addition to irrigation. Generally, the case study was selected to demonstrate the use of large areas of greenery (grass) which is around 70 % of the landscape total area in Zone (A) of the project, with total area 4200 m^2, as shown in Figures (9), (10) & (11). This required a high water consumption rate, for irrigation about 80 m^3 of water daily, with an approximately total monthly cost 7600 L.E. (June 2018).



Fig. (9): The initial landscape design where there are large areas of grass and water feature By: Researchers



Fig. (10): The lake area where the initial design decreased its depth to be 40 cm in order to reduce its water consumption rate By: Researchers



Fig. (11): Various site photos to show the use of large areas of grass in the initial design, in addition to illustrating the desired visual effects By: Researchers

The research is proposing a new design alternative using the aforementioned strategies to reduce the water consumption rate. Since the initial design considered the lake area and its consumption rate in its design, this proposal will focus on creating alternatives for the large area of grass.

The proposal divided the original grass area into three zones. Two of them will turn to be sustainable hardscape with two different patterns and the third will use a ground cover alternative to the grass. The aim of this was not only to decrease the freshwater consumption rate but to also maintain nice aesthetical visual effects for the users and owners of the

residential units, and thus not affecting the quality of life the compound target.

The following figure gives an overall view to the new design, where the pink and yellow colors are used to indicate the Hardscape two different zones. The green hatched color is used to indicate the drought tolerant new ground cover areas.

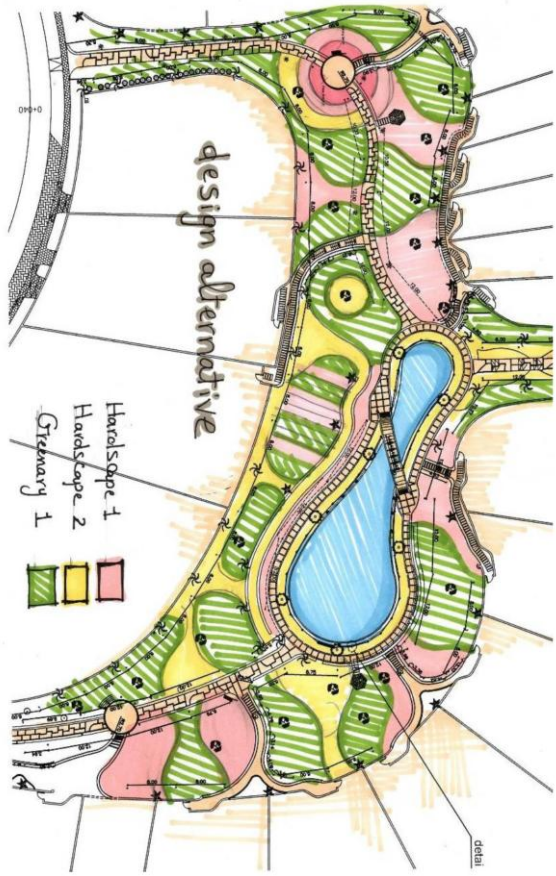


Fig. (12): The research proposed landscape design alternative
By: Researchers

As shown in Fig. (12), the ordinary grass used in the landscape was replaced with sustainable hardscape areas for around approximately 50% of the total landscape area, which simultaneously means a decrease by 50% in the water total consumption rate for irrigation. A sample to Hardscape (1) and (2) are illustrated in figures (13) and (14).

Additionally, the proposal used drought tolerant ground covers with a similar visual effect to the grass which is Wedelia (sphagneticola trilobata) and Carpobrotus edulis, but with 50% lesser water consumption rate than the normal grass. This use of drought-tolerant plants also decreases the negative impacts on the environment [17]. The only disadvantage of the proposed ground cover illustrated in figures (15) and (16), is that they are not walk able. These two solutions succeeded in decreasing the total water consumption rate by around 75% of the current rate. Since the original daily water consumption was $80m^3$, the expected new consumption rate will be around 20 m^3. This also means that the expected monthly total costs will decrease to be around 1900 L.E.



Fig. (13): Example to hardscape (1) that will use sustainable materials such as gravel, sand and colored stones [22].



Fig. (14): Example to hardscape (2) that will use different colored stones, tree bark and colored sand [23].



Fig. (15): The Wedelia (sphagneticola trilobata) used as grass alternative in the new design. It is a tough plant with an extremely low maintenance rate and the ability to prevent erosion [24], [25].



Fig. (16): The Carpobrotus Edulis is another alternative; it is an invasive species that spread out in the Mediterranean coast [26], [27].

CONCLUSION

The water problems that are facing the world and Egypt specially are increasing. Fresh water supply is scarce, while the demands are increasing and additional obstacles arise. After irrigation, the new residential compounds Landscape in Egypt is considered one of the main freshwater consumers. Thus some strategies were developed to decrease the landscape fresh water consumption rate while still maintaining its aesthetic and functional quality.

Throughout the practical application and by using a case study, the research proved that water consumption rate for residential compounds landscape irrigation can be decreased. The study succeeded in reducing it by around 75% throughout using two main design strategies, and they are changing grass areas to hardscape or use non tolerant drought plants. This was achieved without affecting the functional, aesthetical and visual needs of users.

RECOMMENDATIONS

There are many recommendations in order to conserve freshwater consumption in Egypt, and the first one will be teaching users and clients the real and main factors wrongly consuming water. While focusing on the available alternatives, without affecting the human needs and landscape function.

Moreover, further studies can be conducted on the use of none tolerant drought plants and ground covers to be used in Egypt to face the water sacristy. This can be combined with using advanced irrigation systems that can reduce water consumption and evaporation rates.

Another, study should involve the difference in the initial costs between grass and its alternatives; the hardscape and drought plants, in relation to their running costs.

Finally two main strategies must start taking place on a wider scale; which is using graywater and collecting rainwater for landscape irrigation to decrease loads on fresh water.

REFERENCES

[1] A., Dakkak, "Egypt's Water Crisis – Recipe for Disaster", EcoMENA Org., Echoing Sustainability in MENA, Middle East, July 2017. Website: https://www.ecomena.org/egypt-water/ (Dated on 7/7/2018)

[2] S., Raphelson, "In Africa, War Over Water Looms As Ethiopia Nears Completion Of Nile River Dam", here & now compass, NPR Inc., Washington, USA, 2018. Website: https://www.npr.org/2018/02/27/589240174/in-africa-war-over-water-looms-as-ethiopia-nears-completion-of-nile-river-dam (Dated on 7/7/2018)

[3] Foreign Stuff, "Death of the Nile: Egypt fears Ethiopian dam will cut into its water supply", The Telegraph News, U.K., October 2017. Website: https://www.telegraph.co.uk/news/2017/10/02/death-nile-egypt-fearsethiopian-dam-will-cut-water-supply/ (Dated on 7/7/2018)

[4] M. A. Ibrahim, et al, "Water Management in Existing Residential Building in Egypt (Grey-Water System)", International Journal of Scientific & Engineering Research, Volume 3, Issue 8, August 2012, 1 ISSN 2229-5518. Website: https://www.ijser.org/researchpaper/Water-Management-in-Existing-Residential-Building-in-Egypt-GreyWater-System.pdf (Dated on 1/7/2018)

[5] N. V. Jagannathan, A. S. Mohamed, & A. Kremer, "Water in the Arab World - Management Perspectives and Innovations", Middle East and North Africa Region, The World Bank, Washington, USA, Pp. 37-57,119-129, 2009.

[6] Website:https://www.yellowpages.com.eg/en/category/residential-compounds/p8 (Dated on 20/7/2018)

[7] Website:https://www.propertyfinder.eg/blog/find-the-top-23-compounds-in-new-cairo/ (Dated on 20/7/2018)

[8] Website: http://www.madinaty.com/en/project.aspx (Dated on 20/7/2018)

[9] Website:https://www.propertyfinder.eg/blog/find-the-top-23-compounds-in-new-cairo/ (Dated on 20/7/2018)

[10] UC Master Gardener Program, "Designing with Drought-Tolerant Plants", University of California, Agriculture and Natural Resources, USA, September 2015.

[11] Sunset Editors, "Easy Water-Wise Gardening – Advice and Design Ideas for the 21st Century", Sunset Publishing Corporation, 2009.

[12] Land Mark, "Hardscape Design for Water and Maintenance reduction", Land Mark Design Inc. Website: http://www.landmarkdesigninc.com/hardscape-design-water-maintenance-reduction/ (Dated on 7/7/2018)

[13] Website:https://onekindesign.com/2016/04/15/40-brilliant-ideas-stone-pathways-in-garden/ (Dated on 20/7/2018)

[14] Website:https://www.pinterest.ie/pin/521784306799138037/ (Dated on 20/7/2018)

[15] Website:https://www.pinterest.com/mtdragon/backdoor-steps/ (Dated on 20/7/2018)

[16] C., Bowman, "Drought-Tolerant Landscaping Ideas for a Modern Low-Water Garden", Decorating Ideas, March 2016.

[17] R., Bernet, et al, "Native and Drought Tolerant Plants", ESLP, 2010.

[18] Sea Grant California, "Drought Tolerant Plants", University of California, August 2009.

[19] http://www.llifle.com/Encyclopedia/SUCCULENTS/Family/Euphorbiaceae/23360/Euphorbia_milii (Dated on 20/7/2018)

[20] https://bn.wikipedia.org/wiki/%E0%A6%9A%E0%A6%BF%E0%A6%A4%E0%A7%8D%E0%A6%B0:Tree_with_pods_%26_flowers_I_IMG_8689.jpg (Dated on 26/7/2018)

[21] Website:Google Maps (Dated on 20/7/2018)

[22] Website:https://www.pinterest.co.uk/pin/537124693047836976/ (Dated on 25/7/2018)

[23] Website:https://www.pinterest.co.uk/pin/283515739020820411/ (Dated on 20/7/2018)

[24] Website:https://www.gardeningknowhow.com/ornamental/groundcover/wedelia/wedelia-groundcover-plants.htm (Dated on 20/7/2018)

[25] Website:http://tropical.theferns.info/image.php?id=Sphagnet icola+trilobata#plantimages/9/2/928db037d78b91dd3fafb77a51823554d5315243.jpg (Dated on 22/7/2018)

[26] Website: https://plantright.org/invasive/carpobrotus-edulis/ (Dated on 20/7/2018)

[27] Website:https://davesgarden.com/guides/pf/showimage/401665/#b (Dated on 20/7/2018)

★★★