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Combining Sustainable Food Production with Historic Preservation in Egypt

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Abstract:
Background: Egyptian Conservators, Preservationists, Historic and Cultural experts, Archaeologists, and other related professionals, must attempt to provide sustainable solutions in preserving Egypt's numerous historic structures. One way to accomplish this is by enlisting other disciplines and ideas in the effort of sustainable historic preservation. Many Egyptian historic structures suffer from the effects of groundwater. Efforts have been successfully undertaken to resolve this circumstance in several instances, however; there are too many cases that require immediate attention. Funding is a major problem in this case but solving the groundwater problem can be enhanced with sustainable solutions that can bring in funds with an agricultural hydroponics system in a cooperative structure. The preserved historic structure can also obtain funds via attracting tourist to the preserved sites.

This paper is a result of personal experience with groundwater and conservation of historic structures in combination with engineering and construction expertise. The solutions offered fits the Egyptian construct and offers solutions that solve many constraints in Egyptian society.

Keywords: Groundwater, Hydroponics, Solar, Community Cooperative, Sustainability

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I. Introduction

High groundwater creates a problem in many areas of the world. It is occasionally found on the surface where stagnant water houses algae and undesirable aquatic plants that is subject to odors and concentrated types of microorganisms. It is also detrimental to structures, especially stone or concrete assemblies. In particular, ancient stone structures like those found in Egypt are particularly susceptible to the effects of groundwater and excessive soil moisture. The United States Agency for International Development (USAID) has financially supported several large groundwater lowering projects in Egypt in order to preserve the reliefs and structural soundness of these historic edifices. In the case of Egypt, the large quantities of groundwater captured is discharged into the Nile River or nearby canals. This seems to be the only solution when applied to large areas encompassing ancient temples, catacombs and Islamic monuments.

II. Groundwater

Groundwater effects on structures

Although the groundwater is clean as the soil composite filters most particulates, without treatment or filtration, many situations will yield non-potable water. The problem is exasperated when near agricultural and industrial zones where the runoff can contaminate the groundwater.Many areas around agricultural activities contain high groundwater due to the flooding of the fields required by some crops. This scenario is not limited to the suburban areas but also urban areas especially around highly populated neighborhoods. Many historic structures are located in urban areas in Egypt and many are located in areas with high agricultural activities. Through capillary action, the groundwater rises through the stone and presents a condition where sections of exposed stone become moist from water below the surface. Upon reaching the outer surface of the stone, in many cases, the moisture evaporates and salt crystallization occurs that weaken, distort and eventually remove outer layers of the stone matrix. Excessive salt in the stone matrix also chemically weakens the stone's natural cementation. This problem is particularly destructive to text and images carved into the stone. When this condition happens, the tangible historic records are lost forever and structural integrity is jeopardized.

Fig. 1: Experiment on the effects of groundwater on sandstone sample showing surface salt crystallization (left) and potable water with little effect (right)

There are many areas in Egypt where the historic structures are smaller. This provides the opportunity to install an isolated groundwater lowering method that will protect the structure against the effects of continued high groundwater, high moisture, and subsequent damage. The model centers on isolation of the structure from the surrounding area with the use of impermeable material such as PVC type sheets and natural clay substance usually in the form of bentonite that is abundant in Egypt. This is done to reduce the effect of other surrounding structures from the impacts of lowering the groundwater such as potential settlement and large expensive pumping systems. The depth of the capillary break isolation trench is determined so the groundwater will still be permitted to flow at a depth that will not affect the structure (see Figure 2). Inside the isolated area, other low cost drains or pumping methods can be installed to keep the groundwater at a predetermined depth. At this stage, conservation and restoration activity can take place, preserving the heritage site for the future. The isolated area leaves smaller amounts of groundwater available to be used for other possibilities. It must be noted that sites are different in their geology and makeup. Water testing and an adequate geophysical study is what determines the best method. Other factors to consider include the costing of long term maintenance of pumps verses low maintenance such as isolation trenches. Risk analysis should be part of the planning phase. Pumps may be cost effective in the short run, but if not maintained and breakdowns occur, sustainability of the system may be subject to failure.

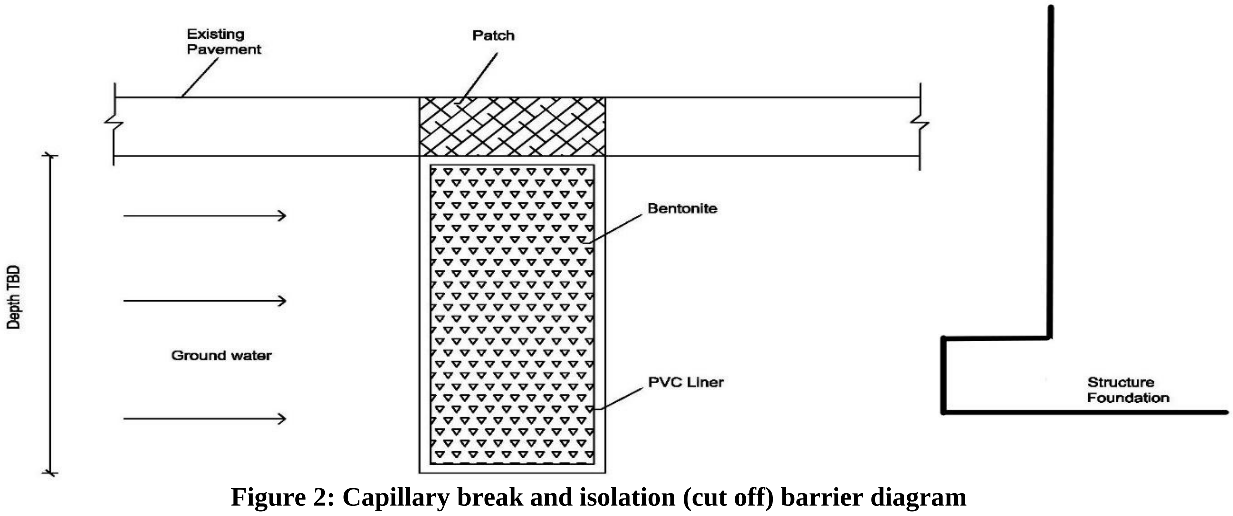

Figure 2: Capillary break and isolation (cut off) barrier diagram

III. Sustainability

Sustainable Options

The preservation of a historic structure also leaves opportunities to address other issues associated with Egypt. Unemployment is a major factor especially with youth and women. A hydroponics system can be set up to use the groundwater instead of discharging in local sewers or rivers/canals. It also utilized water more efficiently than traditional watering of a field. This system would work well with the preservation factor and at the same time address one of the major problems facing Egypt. A private or village cooperative enterprise growing high-grade produce is a sustainable employment formula for domestic use or for obtaining premium prices when exporting to outside customers. To use the groundwater, either a filter/reverse osmosis system can be used or a tolerant produce could be grown based on the composition of the existing water. It has been determined that Egypt will have shortages of water in the future.Egypt is facing an annual water deficit of around seven billion cubic meters and the country could run out of water by 2025 [1]. The Nile River is the main source of life for the Egyptians since it constitutes more than 97% of Egypt's renewable water resources. Egypt faces great challenges with regard to water resources due to its fixed share of the Nile water, and scarcity of rainfall, groundwater and desalination capacities. Climate change causes an additional challenge for water availability and accessibility in Egypt. The Nile Basin upstream developments especially the Grand Ethiopian Renaissance Dam, will lead to more water shortage that would threaten the Country's water security [2]. Utilization of the current high groundwater makes sense.

Energy costs is another main problem. While worldwide growth is fast, demand for electricity is exponentially increasing in Egypt and is expected to continue in the future. Due to the fast growth of Egypt population, Egypt struggles today to fulfill its own energy needs [3]. Currently, the government subsidizes Egypt electricity costs. The Egyptian Minister of Electricity and Renewable Energy, Mohamed Shaker, has stated that subsidization of energy prices in Egypt is one of the highest rates in the world and that all subsidies will be removed by 2025 [4]

A hydroponic system can work using photovoltaic panels that derives energy directly from the sun. With sunshine a fairly constant aspect of Egypt, it makes sense to use for long term lower cost. At night, the system can shut down and resume the next day. There would be no need of expensive batteries that would need to be replaced after several years. Maintenance would have to be a major duty of the business to keep the panels clean and the pumps in good working order. Incorporated with the energy issue, transportation costs can be reduced when offering the produce to the local population or shipping to nearby export facilities. No refrigeration would be necessary except in a few cases.

A hydroponics system has several more benefits. There is no need to use pesticides as the system is enclosed, making the produce safer for consumers. Food security is also an issue. Food security is defined as meaning that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life [5]. The system can adjust to the needs of the people they serve.

IV. Conclusion

A hydroponics system is urgently needed in Egypt as a preservation tool and to utilize the groundwater to solve social issues. Preserving Egypt's historic structures positively influences the tourism industry in several ways by opening numerous smaller sites that provides opportunities for the local population to establish small businesses to serve tourists as well as provide sustainable jobs. The high groundwater together with a hydroponics system can be scaled to fit most existing situations where the effects of the groundwater on historic structures are present. With recent events surrounding global warming and climate change, along with the Ethiopian Dam Project, this scenario is needed more than ever in Egypt and the concept can be applied on a global basis in other countries.

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