Sustainable infrastructure assessments in remote areas in Egypt

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ABSTRACT
Remote societies often have a local economy that depend on natural resources, which attract tourists, but the problem lies in the difficult accessibility to remote areas and lack of interest in its infrastructure, so they have become unexploited areas and wasting wealth.

The research aims to provide a methodology for assessing the most appropriate ways to develop remote areas and to apply this methodology to different remote areas in Egypt to measure their effectiveness.

The methodology of the research depends on the theoretical, analytical and applied approach; the theoretical approach reviews the definition of remote areas, and then studies the elements of sustainable infrastructure in remote areas, concludes criteria for assessing sustainable infrastructure in remote areas, then uses the analytical approach to analysis three remote areas in Egypt, which are Shali in Siwa Oasis, Basaysa in South Sinai, and the village of Wadi Rayyan in Fayoum, then applies approach to apply the checklist on these areas.

The research concludes that the new Basaysa village achieves the highest infrastructure sustainability assessment, Rayan Valley has the lowest infrastructure sustainability rating as a remote area. As for Siwa Oasis – after the success of the Al-Babenshal Hotel experience, and Adrèe Amellal – infrastructure sustainability has been published in all service buildings, such as Banque du Cairo. Although from the Wadi Al-Rayyan region is a research tourist area like Siwa Oasis, it found no attention from investors, the government or researchers, many remote areas in Egypt are in the same condition.

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Introduction

Most countries of the world agreed to the need of applying the principles of sustainable development, especially in the infrastructure. Sustainable
development is substantial for facing climate change, especially in the field of energy, efficient water systems, and the disposal of waste in less polluted ways. Sustainable infrastructure includes the construction of highways, houses, energy, and water network with due consideration for the economic, social, and environmental impacts [1]. In the next 15 years, the world would spend more than 6 USD trillion per year on sustainable infrastructure; it costs more than double the current amount [2].

Infrastructure is a collection of structural elements that serve daily work and influence human society’s progress [3]. Sustainable infrastructures aim at designing, building, and operating these structural elements in ways that do not reduce the social, economic, and environmental processes needed to maintain natural systems.

According to the national statistics report, 2018 – to follow up the sustainable development indicators for Egypt 2030 – Egypt suffers in terms of sanitation and waste disposal, especially in rural areas, as its rates are lower than global rates, while water and energy are taking steps toward sustainability, as its rates are good compared to global rates (Figure 1).

**Definition of remote areas**

Remote areas are those regions that are very far from urban centers and are separated away from a populated community that lack the components of infrastructure.

Remote areas: can access basic amenities, such as education, health, roads, communications, and electricity (Figure 2), and can find what you need [4].

These areas are characterized by a lack of essential infrastructure, low population density, few economic activities, low per capita incomes, and relative poverty of the population, high illiteracy, difficult environmental

![Figure 1. Comparison between the global and local situation to achieve sustainable development goals and those covered by infrastructure services National statistics report, 2018 – to follow up the sustainable development indicators for Egypt 2030 – Egypt.](image)
and natural conditions, lack of health services [5] and high percentages of a marginalized group (Figure 3) [6].
Sustainable infrastructure in remote areas

Sustainable development is a production that meets the present needs without reducing the ability of future generations’ capacity to fulfill their own needs [7]. Sustainable infrastructure incorporates elements into the planning, designing, and operating phases of a project while maintaining resilience to climate change or other disruptions such as global migration, natural disasters, or economic downturns [8]. Service needs are addressed in a way that minimizes or reverses the harm to the environment, encourages social equity, and does not spend a fortune [9,10]. To achieve sustainable infrastructure in remote areas, its components must be studied as follows:

Water systems

More than two billion people in the world live in countries with excessive water stress. Exposed areas are found in North Africa with water stress levels above 60 percentages [11], which stress the need to implement sustainable water conservation methods. According to UNICEF, 159 million people use untreated water from lakes and rivers, which is the most unsafe source of water [12]. Water sustainability in remote areas can be achieved at three levels: economic, social, and environmental, as following (Figure 4):

**Economic level**: Providing a network for drinking water, maintenance of water networks, efficient water consumption [13], reuse black water, gray water reuse, suitable prices for water relative to individual income and the sustainability of irrigation.

**Social level**: Water reaches all individuals, population awareness of the need to efficiently use water, improving water quality and disease-free [14], using technology for water efficiency.

**Environmental level**: Efficient water consumption, use of new water resources, preserving water resources from pollution [15].

![Figure 4. Water systems sustainability.](image-url)
Sewerage systems

According to the United Nations, the open defecation of 892 million people \[12\] of the world’s population would pose major health risks \[11\].

Sewerage system sustainability in remote areas can be achieved at three levels: economic, social, and environmental, as following Figure 5:

**Economic level:** Providing a sewage network, maintenance of sanitation networks, waste generation, and using waste as an organic fertilizer.

**Social level:** Suitable sewage system for social culture, use a safe sewage system

**Environmental level:** The distance of individuals from direct handling of waste, treatment of exchange, disposal of sanitation safely, the sewage system is not polluted by water resources \[16\].

Energy systems

According to the United Nations, 27% \[11\] of the world’s population still lacks electricity in rural and remote areas. Therefore, the principles of energy sustainability must be applied in remote areas by three levels: economic, social, and environmental, as following Figure 6:

**Economic level:** Efficiency of the electrical network, maintenance of electricity networks, energy saving urban planning, efficiency of power generators, energy efficiency \[17\], suitable prices of energy used relatively to

Figure 5. Sewerage systems sustainability.

Figure 6. Electricity systems sustainability.
individual income, use applications powered by renewable energy, use of local building materials, using natural lighting [18], and use natural ventilation.

Social level: Affordable energy availability for all individuals, individual awareness of the need to reduce energy consumption, awareness of the importance of renewable energies, energy saving technology application.

Environmental level: Reducing fuel pollution, rationalization of energy consumption, use of renewable energy [19] (solar, wind, biofuel, geothermal, and hydroelectric energy)

Transport systems

Transport systems sustainability in remote areas can be achieved at three levels: economic, social, and environmental, as following Figure 7:

Economic level: Easy access to service centers, the tracks are suitable for alternative transportation, separate the traffic paths with urban plans, availability of alternatives to fuel transportation, efficiency of the public transport system.

Social level: Transportation is available to all residents, Main roads are safe and paved, appropriateness of methods for the community and living context, adaptation of transportation to the community and living context, control the noise level caused by transportation, apply the use of technology in the transportation system.

Environmental: Reducing walking distances with urban plans, energy efficiency of the transportation system, reducing transportation carbon emissions [20], improving the quality of fuel used in transportation, using environmentally friendly transportation, the use of renewable energies in transportation.

Figure 7. Transport systems sustainability.
Waste management systems

Waste management systems in remote areas can be achieved at three levels: economic, social, and environmental, as following:

- **The economic level:** Waste reuse, Waste recycling [21], the use of organic waste to support fertilizer cultivation, energy generation from waste, selling waste.
- **Social level:** No waste disposal in waterways, choose the locations of the landfill, population awareness of reducing waste from the source, population awareness of waste separation.
- **Environmental level:** Waste collection, places of landfill away from urban gathering, achieving a safe environment for residents away from waste, protection of surface water from pollution from waste, reducing pollution from burning waste [22,23].

Assessing the infrastructure systems in some remote communities in Egypt

Some remote communities managed to provide a decent life for people. They succeeded in converting their weaknesses to strength because their isolation preserved their identity, also they used that to attract tourists and researchers. Some examples will be explained and evaluated to measure their ability to deal with infrastructure.

The projects that achieve the objectives of the study were selected, by the following criteria, (Table 1):

1. The urban communities should be remote and far from the service center.
2. That the population density in the urban settlement is small.
3. Diversity in the nature of the urban community.

| Geographical location          | main activity                        | distance from urban centers                  |
|-------------------------------|--------------------------------------|---------------------------------------------|
| Siwa Oasis (Adrère Amellal group) | Western desert (oasis)               | 306 km Away from Matrouh 820 km Away from Cairo |
| New Basaisa village           | North Sinai (agricultural land reclamation) | 200 km away from Zagazig 180 km away from Cairo |
| Wadi Al-Rayyan- Safari Village | Urban outskirts (Western Desert) (sandy land) | 87 km away from Faiyum city 146 km away from Cairo |
(4) Diversity in the economic situation of the settlement and the main activity that depends on it.

**Figure 8.** Layout of Adrar Amlal Environmental Quality International (EQI) – 2002.

**Figure 9.** Jaafar spring – EQI.
Siwa Oasis (Adrèe Amellal group)

Old Siwa-Shali Siwa has built on a high hill - (Figure 12), away from the city of Matrouh 306 km, and 820 km from Cairo. To assess the infrastructure in Siwa Oasis, the paper will study the case study of the Adrère Amellal Hotel which it’s lay out shown in - (Figure 8). The designers are Emad Farid and Ramiz Azmy.

- The transportation system: depends on the road that connects the oases, but there is no direct road between Siwa and Cairo.
- Water system: the population depends on the springs for drinking and agriculture. Artesian water – Figure 9 – is used in the wells to make a drinking water distribution network. Reuse gray water in irrigation, and using drip irrigation and restricted cultivation.
- Sewerage system: Collect the sewage wastes into a closed tank, then drained into a wetland (Figure 10) ending with a garden of plants of lotus and papyrus.

Figure 10. Wetland in adrar amlal – EQI 2010.

Figure 11. Candles AND torches in adrar amlal – EQI.
Figure 12. The hotel building EQI.

- Energy system: the use of biogas as a source of energy in the hotel, using solar water heaters and solar cells. For lighting, they use lamps, candles (Figure 11) and oil lamps used in the rooms and torches on outside spaces.

- Waste management: The waste separating into organic and inorganic. Organic waste collecting in an isolated area to be used as agricultural fertilizers in the organic farms, and Inorganic waste separating into glass, plastic, and metal and transferred to the city council. Adrère Amellal hotel assessed with the proposed system of sustainable infrastructure in remote areas as in Table (2).

The sustainability of the Adrar Amlal is shown in - [Figure 13].

The village of new Basaisa has located 180 km from Cairo, and kilo 50 of the tunnel of Ahmed Hamdi. The architect, Karim Aouf, and the developer, Prof. Salah Arafa.

- Transportation system: The assembly designed to consist of two parts that are penetrated by the road, which provides housing units with direct to the north and north-east, separating the movement of pedestrians with cars, while provides shade for pedestrian roads, by planting plants suitable for the area from the palm, olive, and jojoba (Figure 14).

- Water systems: The irrigation system used drip irrigation (Figure 15), well water and wastewater treatment, but drinking water purchasing from the city of Ras Sidr.

- Sewerage system: biogas units have been used to treat animal waste, and the remainder used as organic fertilizer for home garden (Figure 18).

- Energy systems: using renewable energy through the use of photovoltaic cells (Figure 17) and solar water heaters, using wind energy to raise groundwater wells (Figure 16), and using animal and human waste to produce biogas for use in food cooking.

- Waste management systems: recycling of solid waste and the production of composites municipal fertilizer that comes from plant residues. But the rest of the waste was not managed.
Table 2. Assessing the new Al-Bisayah, Shali, Siwa and Al-Rayyan Valley with the proposed system for assessing sustainable infrastructure in remote areas.

| Elements of evaluation | Siwa Oasis | Basayseh | Rayyan Valley |
|------------------------|------------|----------|---------------|
| **Water systems sustainability** | Economic | 1 Providing a network for drinking water | - | - |
| | | 2 Maintenance of water networks. | - | - |
| | | 3 Increasing water efficiency. | - | - |
| | | 4 Reuse black water. | - | - |
| | | 5 Reuse graywater. | - | - |
| | | 6 Prices of water relative to the income of individuals in these areas. | - | - |
| | Social | 7 The sustainability of irrigation methods. | - | - |
| | | 8 Water reaches all individuals. | - | - |
| | | 9 Population awareness of the need to efficiently use water. | - | - |
| | | 10 Improving water quality and disease-free. | - | - |
| | | 11 Using technology for water efficiency. | - | - |
| **Sewerage systems are sustainable** | Economic | 12 Efficient water consumption. | - | - |
| | | 13 Use of new water resources | - | - |
| | | 14 Preserving water resources from pollution | - | - |
| | | 15 Providing a sewage network | - | - |
| | | 16 Maintenance of sanitation networks. | - | - |
| | | 17 Power generation from Waste | - | - |
| | | 18 Using waste as an organic fertilizer. | - | - |
| | Social | 19 Suitable exchange system for social culture. | - | - |
| | | 20 Use a safe sewage system | - | - |
| | Environmental | 21 The distance of individuals from direct handling of waste. | - | - |
| | | 22 Treatment of exchange. | - | - |
| | | 23 Disposal of sanitation safely. | - | - |
| | | 24 The sewage system is not polluted by water resources | - | - |

(Continued)
Table 2. (Continued).

| Elements of evaluation | Siwa Oasis | Basayeh | Rayan Valley |
|------------------------|------------|---------|--------------|
| **Energy systems sustainability** | **Economic** | | |
| 25 Efficiency of the electrical network | - | - | - |
| 26 Maintenance of electricity distribution networks. | - | - | - |
| 27 Energy saving urban planning. | - | - | - |
| 28 Efficiency of power generators. | - | - | - |
| 29 Energy efficiency. | - | - | - |
| 30 Suitable prices of energy used relative to individual income | - | - | - |
| 31 Use applications directly powered by renewable energy. | - | - | - |
| 32 Use of local building materials | - | - | - |
| 33 Using natural lighting | - | - | - |
| 34 Use natural ventilation | - | - | - |
| **Social** | | | |
| 35 Affordable energy availability for all individuals. | - | - | - |
| 36 Individual awareness of the need to reduce energy consumption. | - | - | - |
| 37 Awareness of the importance of renewable energies. | - | - | - |
| 38 Energy saving technology application. | - | - | - |
| **Environmental** | | | |
| 39 Reducing fuel pollution. | - | - | - |
| 40 Rationalization of energy consumption | - | - | - |
| 41 Use of renewable energy | - | - | - |
| **Transport systems sustainability** | **Economic** | | |
| 42 Easy access to service centers. | - | - | - |
| 43 The tracks are suitable for alternative transportation. | - | - | - |
| 44 Separate the traffic paths with urban plans. | - | - | - |
| 45 Availability of alternatives to fuel transportation. | - | - | - |
| 46 Efficiency of the public transport system. | - | - | - |
| **Social** | | | |
| 47 Transportation is available to all residents | - | - | - |
| 48 Main roads are safe and paved. | - | - | - |
| 49 Appropriateness of methods for the community and living context. | - | - | - |
| 50 Adaptation of transportation to the community and living context. | - | - | - |
| 51 Control the noise level caused by transportation | - | - | - |
| 52 Apply the use of technology in the transportation system. | - | - | - |
| **Environmental** | | | |
| 53 Reducing walking distances with urban plans. | - | - | - |
| 54 Energy efficiency of the transportation system. | - | - | - |
| 55 Reducing transportation carbon emissions. | - | - | - |
| 56 Improving the quality of fuel used in transportation. | - | - | - |
| 57 Using environmentally friendly transportation. | - | - | - |
| 58 The use of renewable energies in transportation. | - | - | - |
| Sustainability of waste disposal systems | Economic                      | Elements of evaluation | Siwa Oasis | Basayseh | Rayan Valley |
|-----------------------------------------|-------------------------------|------------------------|------------|-----------|--------------|
| 59 Waste reuse                          |                               | -                      | -          | -         |              |
| 60 Waste recycling                      |                               | -                      | -          | -         |              |
| 61 The use of organic waste to support fertilizer cultivation. | | -                      | -          | -         |              |
| 62 Energy generation from waste.        |                               | -                      | -          | -         |              |
| 63 Selling waste                        |                               | -                      | -          | -         |              |
| Social                                  |                               |                        |            |           |              |
| 64 No waste disposal in waterways.      |                               |                        |            |           |              |
| 65 Choose the locations of the landfill. |                               |                        |            |           |              |
| 66 Population awareness of reducing waste from the source. | |                        |            |           |              |
| 67 Population awareness of waste separation. |                               |                        |            |           |              |
| Environmental                            |                               |                        |            |           |              |
| 68 Places of landfill away from urban gathering. | |                        |            |           |              |
| 69 Achieving a safe environment for residents away from waste | |                        |            |           |              |
| 70 Protection of surface water from pollution from waste. | |                        |            |           |              |
| 71 Reducing pollution from burning waste. |                               |                        |            |           |              |
Figure 13. Sustainability of infrastructure in adrar Amlal.

Figure 14. Layout of New Basaisa – the developer.

The sustainability of the New Basaysa village is shown in - (Figure 19). New Basaysa village assessed with the proposed system of sustainable infrastructure in remote areas as in Table (2).

Al-Rayyan Valley – Safari Village

Al-Rayyan Valley region consists of a research center, cafeterias, and a safari camp. A safari Village located in Al-Rayyan Valley on the coast of the Lower Industrial Lake. It is within the framework of Wadi Al-Rayyan Registered Reserve. The camp area is about 60,000 m², and the site had gide boards, (Figure 23).
Units built on the site distributed in a simple organic manner, which allows the buildings to have natural ventilation. The use of local and environmental building materials such as the reeds that grow on the edges of the lake and the raw clay mixed with straw, Figure (22). In Fayoum, there is no public transportation that can reach the area. During the site visit, the overall condition of the toilets is poor, and drainage tanks are damaged.

Figure 15. Drip irrigation of New Basaisa – the developer.

Figure 16. Wind energy, the developer.
The site is accessed through a dirt pavement branching from the main road from Lake Qarun- (Figure 21). A diesel engine is used for power generation, and residential units lighted with candles and oil lamps.

The sustainability of Al-Rayyan Valley – Safari Village is shown in - (Figure 20).

Al-Rayyan Valley – Safari Village assessed with the proposed system of sustainable infrastructure in remote areas as in Table (2).
Figure 19. Sustainability of infrastructure in new Basaya village.

Figure 20. Sustainability of infrastructure in Al-Rayyan Valley – Safari Village.

Figure 21. The site and the layout of Wadi Al-Rayyan, Source.
Applying checklist on remote areas

Through what has been presented previously, a methodology has been developed to assess sustainable infrastructure systems in remote areas, by making a checklist for water, sanitation, electricity, energy, transportation, and waste disposal systems to find out the compatibility of the infrastructure systems in urban communities of remote areas that achieve Sustainability on the social, economic and environmental levels, and by applying the list on the remote communities under study after analysis, also a comparison between those communities according to the list, are presented in Table (2) as follows:

Table 3. Results of the study samples according to assessing.

|                     | Siwa Oasis | New Basaisa | Rayan Valley |
|---------------------|------------|-------------|--------------|
| Water systems [14]  | 10         | 10          | 4            |
| sanitation systems [10] | 6         | 6           | 2            |
| energy systems [17] | 13         | 15          | 7            |
| Transportation systems [17] | 10           | 13          | 6            |
| waste management systems [13] | 6           | 8           | 4            |
| Total (71)          | **45 (63.3%)** | **52 (73.2%)** | **23 (32.3%)** |

Figure 22. Residence units and tent coverage. Source from the site.

Figure 23. Guide boards in Wadi Al-Rayyan. Source from the site.
Figure 24. The results of the study for the remote areas.

**Results and discussion**

By applying the assessing elements to the remote areas Table (2), and Considering that the element when achieved is equal to one point, therefore, the total number of points is 71 points; the number of points in water systems is 14 points, the number of points in sewage systems is 10 points, the number of points in electrical systems is 17 points, the number of points in transport systems is 17, and the number of points in waste disposal systems is 13. (Table 3) The new Basaysa village cluster is the best in energy, transportation, waste management, sanitation, and water systems. Rayan Valley is the worst, especially in sanitation and water systems, Figure (24).

Through studying and analyzing some samples of remote areas and applying the assessing element to them to determine their sustainability, it achieved:

- (Adrère Amellal) in Siwa Oasis obtained 45 out from 71 points (63.3%) as following:
  - The water system obtained 10 from 14 points because of: The use of a simple network that depended on the reservoir and its distribution to the units, the reuse of gray water in irrigation of crops, the use of the drip irrigation system, and the treatment of water in the wet land was used for fertilization. But the weaknesses were: less water treatment, excessive use of underground water, and people awareness less on the need of efficient water use.
  - The sewage system obtained 6 points from 10 due to: sewage treatment in wetland, where fermentation and treatment are performed away from the urban population. But the weaknesses were: the lack of maintenance of a sewage network and the possible pollution of underground water due to drainage.
  - The electricity and energy system, it obtained 13 out from 17 points, due to: rely on natural ventilation and lighting, use natural gas to heat water, using vernacular architectural style of the community, using of
kirchevs as local building materials, increase of walls thick, and did not use electricity for lighting and the use of solar heaters. However, the limitations were the lack of sustainable fuel usage and the application of energy-saving technologies.

- The transportation system got 10 from 17 points due to: depended on pedestrian paths paved with stone and gravel, cars did not enter the pedestrian paths and dependence on alternative means of transportation, such as walking and carrying animals. Nevertheless, the limitations were revealed: difficulty to access service centers, the inefficiency of the public transportation system, and the lack of dependence on renewable energies.

- The waste disposal system got 6 out from 13 points due to: organic waste used as agricultural fertilizers, and the waste was collected and separated into organic and inorganic within the community. But even so, the waste management scheme has the following faults: the choose the location of the landfill, use waste by reusing, recycling, or even selling it, and Population awareness of reducing waste from the source.

- The new Basaysa Village achieved 52 out from 71 point (73.2%) as following:

  - The water system got 10 out from 14 points because of: well water was used for reclamation and irrigation, recycling water and using it to irrigate gardens, and using sustainable means of irrigation. Unfortunately, the limitations were identified: not using of the recycling of gray and black water and buy drinking water from the city network.

  - The sewage system got 6 out from 10 points because of: each unit was responsible for treating its own sewage and using the drainage system for anaerobic decomposition ponds, treating it, producing methane. Nevertheless, the weaknesses included a loss of a sewage network and a lack of public cleanliness when dealing with anaerobic fermentation units.

  - The electricity and energy system, characterizing by its utilization of renewable energies, got 15 out from 17 points due to: reliance on natural lighting and ventilation, and renewable energy, as every home produces its own energy. Such as solar heaters and cooking with biogas resulting from the decomposition of waste, and not relying on fossil fuels while taking into account the hot and dry climate (few openings, roofs were domes and vaults, light colors, rough ceilings) and the weaknesses were: the absence of an electricity network.

  - The transportation system got 13 out from 17 points due to: use of straight paved safe roads, rely on alternative transportation and walking inside the community. With the separation between pass and the movement of cars. While the weaknesses were: the absence of dependence on renewable energy, and improve fuel efficiency.
The waste disposal system got 8 out of 13 points because of: reusing of food waste as animal food and animal waste as fuel, and the production of fertilizer from plant residues. And biogas from organic waste. However, the problem was that the landfill site was not chosen.

- Rayan Valley achieved 23 points out from 71 points (32.3%) as following:
  - The water system received 4 out of 14 points due to its regular reliance on lake water, except for drinking.
  - The sewage system received two out of ten points because the bathrooms were isolated from the units, and the failures were that there was no sewage network and that drainage could pollute underground water.
  - The electricity and energy system got 7 out from 17 points, since lighting is all provided by candles and fire. As well as a focus on locally sourced construction materials, the following were the shortcomings of the electricity and energy system: the use of diesel generators rather than renewable energy.
  - Since they depend on SUVs inside the sand dunes, the transportation system received 6 out of 17 points. The flaws were that there were not enough tracks in the urban plans to accommodate transportation, and there was no public transportation in the region.
  - The waste management system received 4 out of 13 points for not utilizing the following: selecting the landfill site and utilizing the waste.

Conclusion

The main conclusion is inference a list for assessing the infrastructure in remote areas in Egypt; it can be generalized to remote areas through three dimensions: economic, social, and environmental. through applying the assessment list to the following areas (Adrar Amlal Group in Siwa, New Basaisa Village, Wadi Al Rayan region) after their analysis, it reached to: The new Basaysa village achieves the highest infrastructure sustainability assessment, Rayan Valley had the lowest infrastructure sustainability rating as a remote area. That is regarding to the support and development of civil society organizations. As for Siwa Oasis, it was developed by the EQI office, after the success of the Al-Babenshal Hotel experience and Adrère Amellal. It had been generalized in all service buildings in Siwa, such as Cairo bank. Al-Rayyan valley is a research tourist area, but it did not get the attention of investors or the government. Many of Egypt’s remote areas are in the same state.

This research presents two successful models of remote areas that use sustainable principles to provide the infrastructure for its residents that can be used to develop the rest of the deprived areas, such as Wadi Al Rayyan. Remote areas generally suffer from the absence of water networks, and accreditation directly on underground water. Water and sewage system suffered from bad condition due to the lack of maintenance.
Remote areas generally suffered from the absence of sanitation networks and depended on a rudimentary system such as tanks and cesspits, which may be in poor condition and the consequence leads to pollution.

Many remote areas did not depend on taking advantage of human sanitation as fertilizer after treatment or fuel production like Wadi Al Rayyan and Siwa but Basaysa was more improved by applying treatment or fuel production.

In many remote areas, waste did not safely disposed, and as a consequence the health of the individuals and the environment may be affected.

Most remote communities depended on the urban and architectural style that resulted from local architecture (vernacular), which improved energy efficiency, its spontaneous consumption and local architecture must be preserved, developed, and utilized.

Some remote communities depended on patterns of renewable energy such as biofuels, solar energy, and wind like the new Basaysa Village. Some of them used a diesel adapter like Wadi Al Rayyan.

Recommendations

- Guide scientific research institutions in Egypt to encourage spreading the culture of orientation toward sustainable infrastructure, through conferences, seminars, and lectures.
- Encourage students to study remote areas and how to deal with them at the level of architecture or urbanism.
- Guide scientific research institutions in Egypt toward studies related to remote areas to overcome their problems.

Disclosure Statement

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