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Landscaping in Arid Areas: Battling the Threat of Desertification

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Abstract—*Landscaping has always been an integral part of a built environment. It started with the dawn of human civilization, be it the hanging gardens of Babylonia or the famous Mughal garden. There always has been a desire to cultivate a garden around the dwelling. Along with being an aesthetic need it has been used to minimize or enhance the nature and its manifestation. Soil erosion, barren land, sea water invasion or desertification are looming as major threats in our future. A major reason behind these is the human activities itself. Region and problem specific landscape has proved to be a strong measure to curb the above mentioned problems with the benefit of providing a pleasant environment to people.*

This paper talks about landscape planning in arid areas, focusing on large scale townships. Arid areas such as Rajasthan face a threat of desertification and soil degradation. Moisture retention, shade provision are few challenges to be dealt with. It discusses the site planning measures as it's an integral part of landscaping. The importance of sustainable site planning is also highlighted in the GRIHA LD Manual for large scale developments. A well planned, indigenous landscape design keeping in mind the climate, native vegetation, water demands and functional usage can provide the community with better environment, more water and buffer zones from the harsh desert climate. This paper discusses the strategies needed to achieve the same taking an example of a large scale educational campus in the city of Jodhpur.

1. INTRODUCTION

Deserts are a natural phenomenon but desertification on the other hand is due to human beings to a large extent. The word "desertification" was introduced in 1949 by the French scientist Aubreville in his report "Climats, forêts et désertification de l´Afrique tropicale". Desertification, at the beginning of last century, meant the spreading (expansion) of deserts or desert-like (nonproductive or very low productive) conditions from existing deserts into non-desert areas close to the desert margins [1] . Desertification is defined by the United Nations as 'land degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities'.

Few important events related to this issue are the UN conference on Desertification (UNCOD) in Nairobi 1977, the UN conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 and the UN Convention to Combat Desertification (UNCCD) adopted in 1994.

Desertification is global in dimension. By now, 70 % of all dry lands are at risk of desertification. Which is equivalent to around 4 times the size of China [2]. This threat is usually dealt at a larger scale, overlooking large scale educational and residential campuses sprouting in the outskirts of the cities amidst the expanse of farmlands. These alien built environments popping up without any consideration given to dealing with the threat of desertification may become roots of a future trouble. Generally, a tree belt and some parks are the extent of the landscaping, where as a well thought of landscape plan can go a long way in soil regeneration, moisture retention and soil protection.

2. UNDERSTANDING DESERTIFICATION

As per the Encyclopedia of Life Support Systems, Rajasthan covers 61% of the arid zone of India, which makes the problem of desertification most threatening here. The state suffers from land degradation due to wind erosion in the Western and North – Western part. Water erosion also causes the land to degrade in the South-Eastern part. [3]

The major causes of desertification are as following:

- Lack of sustainable land planning.
- Favoring mono – cultures and export oriented farming
- Population pressure of farmlands.
- Lack of technical knowledge in common people

This threat has consequences such as Increase in barren land, mounting danger of famine etc.

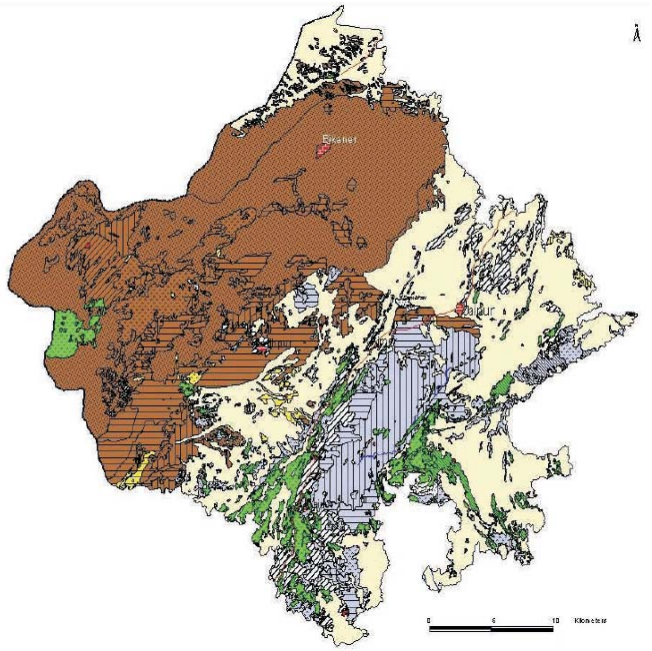

Fig. 1: Brown colour depicts land degradation due to wind erosion and blue due to water erosion [3]

3. MITIGATION THROUGH PLANNED LANDSCAPING

Land is scarce and the ecological footprint of the world's population is increasing. That's why planning of site must be the basis of sustainable planning and using landscape as an answer to many ecological problems. Site planning is the first point in GRIHA LD manual, which focuses on the assessment of larger developments, the singular units which together make cities [4] all projects which satisfy either of the following two thresholds may apply for a GRIHA LD rating: total built up area greater than or equal to 1, 50,000 Square Meter and/ or total site area greater than or equal to 50 Hectares.

When a project is proposed on a site, the natural ecological cycles existing on the site get disrupted so the first and foremost point must be a deeper understanding of the site, its ecology and the indigenous flora – fauna. The project must be planned around it rather than other way around.

4. CLIMATE RESPONSIVE PLANNING

The master planning of the site should consider the prominent wind direction is summers, the annual rainfall and humidity levels. In arid areas the winds are usually dusty and dry, the rain is low and evaporation is high. So through landscape planning focus must be on increasing humidity, retaining moisture and filtering air.

Fig. 2: Layering of landscape

A layering of landscape elements creates a thriving environment for most of the plant and animal species. Different height, spread and typology of plants result in a wholesome forest like development. This could be tried along the boundary walls, in small patches in the site or near the water bodies. These patches also act as water collection and filtration areas.

Moisture retention is a major issue to be dealt with. The quantity of rainfall is very less in the arid areas of Rajasthan and the sun light is harsh so the ground becomes parched very quickly and the remaining rain water recedes too low in the ground. The ground water is saline in most of the areas making it unusable. Run off losses are also more in such areas, Rajasthan has run off losses as high as 50%. So retaining the moisture in the shallow depth of the soil is of utmost importance. The micro catchment rain water harvesting technology by AFRI (Arid Forest Research Institute,, Scientists: Dr. G.N. Gupta and Sh N. Bala) work wonders by enhancing the soil moisture storage by 42% in the upper 75 cm layer alone after a mild shower f o27.5 mm in January. It also shows improvement in the growth of the trees like neem, Imli etc. This technique is also labor intensive, thus generates additional employment when used on a large scale.

Fig. 3: Ring pit watering technique developed by AFRI

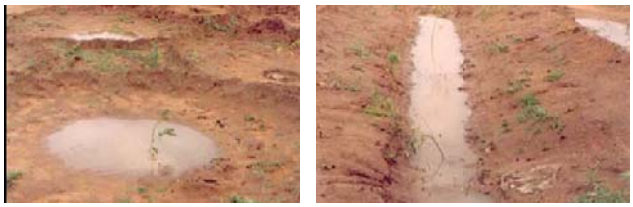

Fig. 4: Shallow saucer like catchments and trenches along the plants developed by AFRI

The saucer shaped depressions of 3 meter diameter around the plantation increase the water retention. Similarly the shallow trenches break the flow of rainwater and collect it into small catchments. Such techniques help in getting water to the tree roots and ensuring a better spread.

Another technique of irrigation practiced in some areas like Tilonia, Ajmer is digging a 2 feet deep hole near each tree, in which 5-6 liters of water is poured twice a month. This ensures low evaporation and deeper penetration of water into the roots. Since salinity is a major problem in such areas, drip irrigation does not work efficiently due to salt deposits on the equipment.

Fig. 5: Soft pavers with a higher percolation rate of water

Reducing the hard paved surface is insisted upon to mitigate the heat island effect and increase rain water percolation. Porous paving areas help in reducing the run off and increasing the height of the ground water table.

5. SELECTION OF FLORA

The ecosystem in semi –arid and arid areas is very fragile. The native vegetation is of xerophytic variety generally. Plants with high resistance to drought have a greater chance of survival. While selecting the trees, care must be taken to ensure that at least 20% are fruit trees so that the birds and animals can survive. It's important for the thriving of the entire eco system. Maximum 10 % may be exotic trees but rest 90 % must be of indigenous variety to control the water demand.

The concept of carrying capacity is needed to be understood and enforced. Such large developments create pressure on the water and food resources. Water has to be supplied from faraway places using miles of pipelines and food has to be transported from the neighboring areas. So water need must be reduced, all rainwater must be captured. The landscape should not remain an ornamental feature only but compose of kitchen gardens, fruit trees to minimize the need of food transportation over great distances.

Various types of plants should be utilized

A. Hedges: Bougainvillea is a study shrub with a high growth rate. It could become a good hedge if pruned regularly. It should be planted along the boundary wall on the prominent summer winds side to break the flow of hot winds and act as a filter to the sand. With a height of 4-6 meters and a low water usage once established, it's a must have plant in large scale campuses. The vibrant colors are a bonus.

Fig. 6: Bougainvillea

B. Shrubs: low height, ground crawling plants provide shade to the ground thus limiting evaporation. These must be used as fillers where ever possible.

C. Ground cover: Grass is a water intensive venture so it must be limited and provided in areas which are shaded by a good growth of trees or buildings. Grounds cover also stabilizes soil and protects from low winds. Fog (Calligonum Polygonoides) could be grown as filler in the shelter belt.

Fig. 7: Fog grass

With a height of 1-1.8 meters, it's an important habitat element for a wide range of species in the semi – desert wildlife. It's an endangered plant with edible flowers. Khimp (Leptadenia Pyrotechnica) and fog can also be planted around water bodies as they are excellent soil binders and pioneers in sand bank fixation.

Dab (Desmostachya Bipinnata) is a 1 meter high grass that could be cultivated on the edges of the peripheral roads etc. Badelia could be used for moisture retention and over the sand dunes to stop them from shifting.

Fig. 8: Dab grass

D. Climbers: certain climbers with their spreading habit will provide shade to the built forms as well as the ground. Railway creeper (Ipomea Palmata) is evergreen, easy to grow and a treat to eyes with ephemeral mauve flowers. Rangoon creeper (Quisqualis Indica) is another sturdy choice with cluster of pink and white blossoms.

E. Trees: these have a variety of functions such as protection from wind, dust filtration, shading to the ground and to the buildings. Rohida, Farash and Babul must be used extensively as they act in stabilizing the soil and require less water.

Fig. 9: Babool tree

For tackling wind erosion, reducing the surface velocity of wind by vegetation can be done. The effectiveness of a shelter belt depends more on the height and permeability than on width. A decrease of 15% is observed when the height of the trees is increased twice.

Fig. 10: Farash Tree

So it's better to have several wind breaks 5 to 6H apart rather than large forest stands with wide open spaces in between [4]. Some trees which could be used as wind breaks in dry and arid areas are: Azadiracha Indica (Neem), Dalbergia Sisso (Sheesham), Albizia Iebbeck (Siris), Eugenia Jambolana (Jamun), Tamarindus Indica (Imli), and Merium Odorum (Kaner)

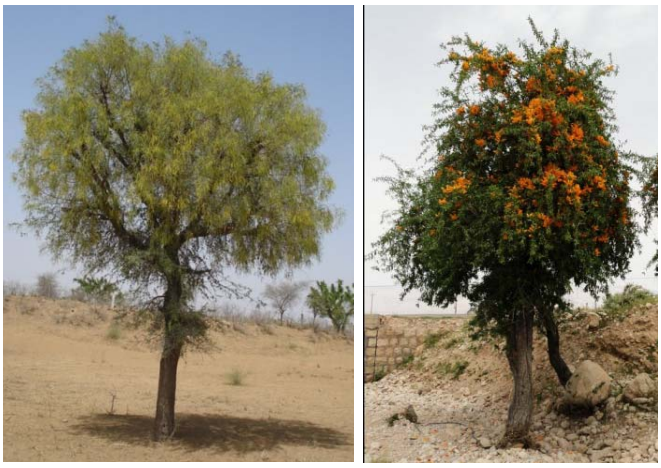

Fig. 11: Khejri and Rohida tree

Complete dust interception can be achieved by a 30 meter belt of trees. Even a single row of trees can bring about 25% reduction in airborne particulate [4]. So well planned shelter belt can provide double benefits of soil erosion mitigation and dust cleansing.

6. CONCLUSION

Auroville, Tamilnadu is an international community, was established in 1968 on a severely eroded plateau. With 2 million trees of a large variety it has slowly turned into a thriving and green community. It's an example of what even the simplest act of planting trees can do. So a planned landscape can work wonders in balancing much worse problems. Desertification is a threat which will create food shortage, fodder shortage, water deficiency in coming years. To create a centimeter of top soil hundreds of years are needed so it's better to conserve what is left.

The landscape of a project must be thought of from the initiation only, not like a pasted upon ornamental feature afterwards. These steps can prevent the land from going barren and check the desertification.

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