IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 20, Issue 11, Ver. V (Nov. 2015) PP 38-49
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

An Alternative Model of Sustainable Living: the case of Auroville in India

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I. Introduction

The Auroville bioregion is defined as a large area, bordered by Kaluveli Tank- a large marsh to the north, the Bay of Bengal to the east; Puducherry to the south and the Ousteri Lake to the west. The lands of the intentional community of Auroville are spread out in a patchwork pattern interspersed with temple and village land, fields and plantations, over an area of some 20 square kilometres. The area occupied by Auroville is a plateau land with a maximum elevation of 52 meters above sea level at Matri Mandir (centre of Auroville) and from there it slopes down 5 kms to the coast on the east and to heavier alluvial soil on the west.

This international community as conceived by Mirra Alfassa or The Mother in 1968, would not only look into the spiritual needs of man but also make inroads into social, spiritual and environmental consciousness as well. So much so that when farming in Auroville started in 1969 after the first settlements had been put up, the Mother emphatically stated " Auroville should not fall back into old errors, which belong to a past that is trying to survive" when asked for Her opinion on the use of chemical fertilizers in Auroville. What prompted the first Aurovillians to ask the question was the then state of Auroville – barren dry red soil stretching to the horizon in every direction, with scarcely a tree to stand under (Auroville farms, 2011.p-17). Rain was stripping the top soil away carving deep ravines in the landscape. It later came to light that the area was densely forested before about 250 years ago and extensive deforestation had been the main cause (Rai 2008: 5) mentions that Francois Martin in the early 18 th century had bought land from the Dutch and the forest provided the wood for the construction of Puducherry town. Aurovillians together with the villagers started working together with the object of restoring the land to its former ecological glory. They started planting trees , building bunds to store water and farming on a war footing. On a global scale an urgent need has arisen for sustainable models of development for the future of the human race. Ecovillages and some intentional communities address the need looking at sustainability not only in environmental but also in social, economic and spiritual terms. Such settlements as opposed to unsustainable settlements are complete settlements which harmonise nature into their built up areas thus ensuring sustainable approach in a stable manner (Bissolottiet all, 2006).These communities present themselves as laboratories for experimenting models of sustainable development. This concept is not just restricted to eco villages but has caught on with many intentional communities both urban like *Ecotop-suburban housing* development in Germany and rural like *CamphillSolborg* in Norway. Some like Auroville have governmental help whereas a vast majority of others which are mainly citizen's initiatives are not so lucky. Like Auroville with its foundations based on spirituality, The *Sarvodaya, Shramadana Movement* of Sri Lanka with 15,000 villages in its wings combines social, cultural, moral, spiritual, economic and political development. This unique movement has encouraged the villagers to unite and share resources for their individual and collective empowerment, while preserving traditional Sri Lankan values and culture while promoting peace in a nation suffering from civil conflict (Pathiraja, SajiniMadhavi, 2007. p-113). *Findhorn ecovillage* in Scotland among many others have adapted to sustainable living with 58 barrel /eco houses, innovative use of building materials such as local stone and straw bales, 4 wind turbines for electricity generation, solar water heating systems, comprehensive recycling scheme and a biological sewage treatment system. A Study by Tinsley, S. & George, H. (2006) revealed that Findhorn's ecological footprint was much less than the national average of UK. It was in Findhorn in 1995 a conference on "Ecovillages and Sustainable Communities" was held and the Global Ecovillage Network (GEN) was formally founded. At present Auroville is the largest member of GEN in the emerging network of ecovillages in India (Findhorn Foundation, 2007. para 3.3.9) .

II. Sustainable Activities in Auroville

Auroville is definitely a success story in sustainability. Since its inception in 1968, Auroville has been successful in environmental regeneration on a massive scale. Its efforts in incorporating the sustainable approach in its activities, has been awarded by international recognition in the fields of sustainable practices in forestry, agriculture, industry and rural developmental projects.

Sustainable Forestry

About 200 years ago a scrub jungle covered the Auroville plateau and its surrounding areas. Inscriptions on stone dating around 1750 describing the local king hunting for elephants and tigers have been found. Around 1825, Jipmer area underwent massive deforestation to drive away tigers and other predators. Timber was required to build the towns of Pondicherry and Kalapet. Furthermore land was allocated by the Britishers to anybody who would clear it and cultivate it for a year. Later most of it was left fallow and fell prey to the monsoonal rains which washed away the precious top soil creating gullies and ravines. Afforestation in Auroville started in the early 1970 s with the help of grants from the Point Foundation, the Tamil Fund and the followers abroad. Tree nurseries were started in Success and Kottakarai which spearheaded the large scale afforestation programme. Over a million trees serving multifarious purposes of timber, fruit, fodder and fencing were planted. The Department of Environment, Govt. of India offered a grant of 11 lakhs over a period of 5 years to plant trees and monitor their development the purpose being to find the ideal vegetation for that particular stretch of Tropical Dry Evergreen Forest which was now totally devastated- a situation fairly common in many parts of India. About 2 million trees have been planted in Auroville, which has given the Aurovillians an international reputation in the field of land reclamation and afforestation. Auroville now has focussed on the reintroduction of the Tropical Dry Evergreen Forest indigenous to the area. A study by Dr. VM Meher-Homji, the Dean of the Salim Ali School of Ecology, Pondicherry University and the head of the Department of Biogeography and Bioclimatology of the French Institute, Pondicherry has made a study of the TDEF pockets still available along the Corommandel Coast, revealed about 266 different plant species on the brink of extinction due to extensive deforestation. At present the TDEF (a scrub jungle of three to four metres height containing a wide variety of shrubs, vines and lianas) cover only about 1% of the total area in the plains. Auroville green workers have painstakingly collected almost all the species found in TDEF and reintroduced them in Auroville. They have also conducted courses in afforestation for villagers, social workers, tribals, academics and administrators. Auroville's story of afforestation has spread far and wide and helped inspire many afforestation schemes in similar deforested areas. (The Auroville Adventure, 1998. p- 6).

As a result of greening of Auroville, wildlife is returning to the hitherto barren landscape. Birds, butterflies, different types of lizards such as the monitor and the chameleon can be sighted. Small mammals like mongoose, wild hare, civet cat, porcupines and as many as 19 species of snakes including the Indian speckled cobra and the Russels viper all particularly indigeneous to the TDEF can be found. (Auroville farms, 2011.p-78).

Sadhana Forest located in the south west corner of Auroville is a massive sized reafforestation project founded in 2003 where more than 18,200 plants of the TDEF has been planted on 70 acres of severely eroded in fertile land. The forest uses electricity from solar sources and nothing is taken from the State Electricity Grid. Composted human waste is used as fertilizers for trees. In an effort to conserve water, Sadhna Forest community members have dug pits, bunds and earth dams for storage of rainwater which would otherwise be washed away as runoff, which has increased the water table from 7 meter to 1 metre locally. Pitchandikulam forest located in Auroville too depends totally on solar power. The 50 acre forest is a self generating forest sanctuary containing some 440 plant species of which some 340 are medicinal plants. It has a seed propagation nursery which acts as a gene bank from which medicinal plants are established in the sanctuary and in other locations too. It hosts a medical plant demonstration garden and also acts as a source of supply to the local herbal practioners. (Auroville farms, 2011 .pp 79-88)

Ethno – Medical Forest

- The ethno medical forest is an important component of the Pitchandikulam Medicinal Plant Conservation Park. In the phase before 1973 the area was a dry eroded plateau with Palmyra trees being the main vegetation seen. Erosion control, watershed management and extensive reafforestation work, still continuing has changed the look of the region. The Ethno Medical Forest has a host of activities:-
- Rare and endangered species of the TDEF are conserved here.
- The centre has installed stone panels showing different elements of the ecosystem and explaining the medical uses of individual species together with groups of plants that cure poisonous bites, bone fractures, headaches and stomach problems.
- Collection of seeds of TDEF species is done in Auroville sanctuaries, remnant forest (mostly Reserve Forests) and sacred groves.
- Most of the TDEF species have not been propagated in nurseries before. Various techniques are being tried to develop standard methods of germination for more than 180 species grown in Pitchandikulam.
- Live hedges of more than 50 species are grown around the EMF, forming a protective and productive edge thus initiating edge effects and allowing greater floral and faunal diversity.

This centre has focused on traditional Ayurvedic healing techniques and has maintained a record of such practioners and healers (about 200) in the area. This centre also publishes a regional news letter and provides for dissemination of knowledge regarding natural healing methods through a display of photos, seeds, posters, herbarium sheets and raw drugs all sourced from the forest. As the propagation of both its concepts in sustainability and its dedication to the development of indigenous forest is the central theme of Pitchandikulam Forest's activities, a rural campus about 30 kms away from Auroville, was identified in 2003 to set up an environmental education centre in Nadukuppam village which was identified due to its economic, social and educational backwardness. The local school was adopted and environmental education was integrated in to its educational curriculum to instil in the young students a sense of environmental awareness (Thomas & Thomas, 2013, Chap 5.2). Besides *Nadukuppam Environment Education Centre*, boasts an integrated water sanitation system, solar panel technology and organic agricultural activities (Sustainable Technology, 2014.para 1).Pitchandikulam's environmental education project has extended to 9 schools around Nadukuppam thus resulting in increasing awareness of the surrounding environment (Pitchandikulam forest, 2014, para 6). Tree planting is still continuing in Auroville in Aranalaya or Aranya forest , which lies to the north east of Ousteri lake,12 kms north west of Pondicherry city.Aranya forest is flanked by extensive ravines both to the north and south formed unseasonably privileged that empty into the Ousteri Lake. Severely degraded with no vegetation at all, funding from International Development Research centre (IRDC) led to the framing of a comprehensive plan for large scale deforestation in 1994. Tree planting especially indigenous varieties on a war footing has somewhat restored the area to its earlier self (PriyaSundaravalli, 2008. para 4).

Auroville Botanical Garden

Located in the southern part of Auroville's Green Belt a 50 acre plot of land previously used for cashew plantation, was in the danger of falling in the hands of real estate developers, which Auroville bought as a part of its plan in creating a uninterrupted stretch of green area as the international city's Green Belt. Ever since it was acquired, Aurovillians have converted the dry grassland into a thriving active garden, where visitors can find a young forest, an arboretum, a nursery and multiple gardens. The gardens nursery contains a variety of trees and plants that make up the Tropical Dry Evergreen Forest. It has the capacity of producing 50,000 seedlings a year. They are used in the reforestation project around Auroville and sold to private organisations and individuals for landscaping. This is because such plant types require less care and water compared to foreign plants in the Arboretum and Tropical Dry Evergreen Forest (TDEF) areas. Such plants are watered for the first year or two of their establishment, after which they survive on rainfall. The water supply from the windmill meets the requirements of the area. Formal gardens in the area use sprinklers and mist sprays for irrigation and thus minimise water consumption. Since its inception more than 250 tree species have been planted in the 25 acre arboretum, 5500 specimens have been planted in the 10 acre conservation forest in Auroville. Staff from the Auroville Botanical Gardens collects samples of TDEF forests (many of the species being rare and endangered) from the scared groves as many of these pockets were in the brink of destruction due to encroachment on these communal village lands. This 50 acre garden serves as an area of research into environmentally sustainable approaches to land management as well as a location for environmental education (Auroville farms, 2011.pp 95-100). In 2002 the Garden started to spread the conservation consciousness in the surrounding villages by bringing in local children in five different age groups to the garden. In 2007 a building was established for educational purpose. This enterprise had some specific agendum:-

- An innovative, informative curriculum based programme complementing the education system is being offered by the Botanical Gardens to the local schools so as to nurture a clean and green consciousness among students through various innovative methods.
- To impress upon the visitors the importance of genetic diversity of the forests and the use of TDEF plants in their everyday life.
- To encourage the growth of eco clubs for women and children. The Eco-Clubs augment the school group programs conducted at the Botanical Gardens. The largest one has 40 members. These clubs organize rallies, run litter pick up campaigns, plant gardens at their homes in the villages and in general work in tandem with the Aurovillians to generate environmental awareness in the villages. (Auroville Botanical Gardens (n.d). para1).

Other than The Botanical Gardens, Shakti Nursery in Auroville is also engaged in the conservation and propagation of Tropical Dry Evergreen Forest. This nursery is apart of a wider project that aims at restoring TDEF in the Green Belt of Auroville. In 1981, Shakti Nursery published the first issue of *"The Auroville Index Seminum"* listing all the seeds (of about160 species) in Auroville available for exchange which was later sent to over 50 Botanical Gardens. In 1999 Shakti Nursery raised over 50,000 seedlings and set up AURO Herbarium with its first collection of rare and probably extinct plants on 5 th April 1994.The Main purpose of the

Herbarium being to acquire a collection of plants found in different soil types e.g., beach, new consolidated dunes, salt marshes, black cotton soils and others. (Auroville farms, 2011.p- 103).

The sustainable activities of Auroville extended to the ecological restoration of the Adyar Creek in the middle of Chennai city. Auroville's Pitchandikulam Forest Consultants was appointed for the above purpose in 2009, to create an ecological park at the creek called the AdyarPoonga which was a garbage dump site.After about 70,000 tonnes of garbage was removed, planting of saplings could commence. *AdyarPoonga Ecological Park* aims to showcase all the ecosystems of the Corommandel coast ie brackish areas, mangroves, mudflats, freshwater ponds and islands. The Pitchandikulam Forest Consultants have signed an agreement with the Tamil Nadu government to maintain the park for two years. This successful venture has established Auroville as consultants in the field of sustainable practices (Thomas & Thomas, 2013, Chap 5.2).

Sustainable Farming

With the founders of Auroville against the use of chemical fertilizers, organic farming was the modus operandi right from the start. It started with the purchase of *Annapurna Farm* in the 1960 s, located some 10 kms from the Auroville centre near *Vanur*. Annapurna is now the largest farm in Auroville covering a total area of 135 acres using non-hybridised seeds for farming. Water catchment ponds have been created so as not to disturb the groundwater reserves. There are 14 other farms in Auroville following the tenants of ecological farming producing natural and healthy food to fulfil its resident's needs (Auroville farms, 2011.p-43).These farms cover nearly 400 acres and are managed by the Auroville Farm Group. All farms are diverse with a variety of field crops, vegetables, orchards and livestock. There is a strong focus on traditional breeds and varieties and seed banks to preserve agricultural diversity (Le Fay, Raven, n.d, p-42).

Most farms adhere to eco-friendly technology such as windmills (for water), solar energy, drip irrigation, micro sprinklers and methane gas collectors. Even in the area of pest management AVFG farms have decided to use an extract from the leaves of the indigeneous neem tree in their farms. Auroville also specialises in the production of spirulina- a low fat, low calorie cholesterol free food supplement. Spirulina cultivation has no hidden costs and produces more nutrition per acre than any other food. It uses water more efficiently per kilogram of protein than any other food source. It grows well on non fertile land in brackish water environment (Spirulina,2014, March). In Auroville where sustainability is the buzzword, spirulina cultivation was only natural. Since 1997, Aurospirul farm in the community of *Simplicity* produces high quality sundried spirulina using sustainable and eco-friendly techniques.

Soil and Water Conservation

Starting from an extremely degraded topography Auroville with its 2 million trees has come a long way. Over two hundred years of deforestation, overgrazing and poor land stewardship had left the land totally bare of green cover. Violent monsoon rains were washing away tons of top soil thus carving deep canyons along the way. Auroville being situated on a plateau at the top of a watershed has several canyon systems in its 25 sq kms area. In 1968 when the first settlers had arrived regeneration of the environment was their primary concern.

Since then an integrated soil and water conservation programme combined with deforestation on a war footing has transformed the landscape and has initiated the development of a Green Belt planned to encircle the city. Aurovillians took the help of the locals to develop an integrated soil and water conservation strategy that would help in water conservation and also control erosion. Extensive networks of raised earthbound and ditches called bunds were placed along the contours of the land along with a series of earth check dams and catchment ponds. Dutch Aurovillian GeradJak has built a series of 60 check dams over a period of 15 years which have helped to rein in the dual problem of soil erosion and fall in water table levels. Rise in the water levels have also acted as a buffer agent against sea water intrusion. These dams made of cement and granite are durable and can withstand the dimensional deluge rushing through the numerous canyons dotting Auroville plateau and saving 50,000 m3 of fresh water each year.

As time went on units like Auroville Water Harvest and Palmyra were set up with the intention to revive ancient community catchment tanks that once dotted the region with the aim to recharge the groundwater aquifers. This Aurovillians believed would prevent saltwater intrusion and conserve water for irrigation.

Auroville Water Harvest also monitors the water quality and the water levels in Auroville aquifers and wells. The Palmyra Centre for Ecological Land Use and Rural Development located in *Aurobrindavan* is on charge of a Rural Development Project funded by the DIK/ OIL Germany. Another 5 year project on integrated waste land development is being funded by the Ministry of Rural Development in 21 villages in *Vanur* and *Marakkanam* areas. Besides this centre conducts training programmes for farmers and NGO s regarding sustainable farming (Thomas, H., & Thomas, M. 2013. Chap 5.2).

Renewable Energy

Solar energy is generally used by all settlements and communities aiming at sustainable living in Auroville. It is the largest renewable source of energy in Auroville. In this connection, the contribution of Auroville's Centre for Scientific Research (CSR) has been commendable. CSR has played a pioneering role in Auroville's efforts in sustainable development. CSRwas started in 1984 and functions as a research trust under the Auroville Foundation, a legal autonomous body corporate enacted by a special act of Indian Parliament. Its research focus is on innovative applied research in Design, Energy and Water (CBERD Research Project , 2012-2017.n.d , para 2).

Photovoltaic panels custom built in Auroville, used to generate solar energy is attached to roofs of houses which provide solar electricity not only for domestic use but also are stored in inverter batteries for cloudy/ rainy days. A unit of CSR called Aurore has stimulated the use of solar installations (about 8700 domestic PV systems and 6000 PV powered lanterns) in various parts of rural India. Due to its pioneering efforts its co coordinator Hemant Lamba received the Ashden Award for Sustainable Energy, the equivalent of a Green Oscar in the industry in 2004 (The Ashden Awards for Sustainable Energy, 2004). Several units in Auroville actively research, develop and maintain a wide range of solar energy harvesting systems for cars, water pumping, desalination systems, solar lanterns, refrigerators, charge controllers and inverters. Aurore is also responsible for the installation of 132 solar pumping systems in the Auroville community during 1993-94. The 36.6. kwp Matrimandir solar power plant was also set up by Aurore in 1997. It was also responsible for the installation of 500 solar pumping systems in rural Punjab. Since then Aurore has also successfully executed renewable energy projects, particularly solar, in some of the remotest areas of Gujarat, Ladakh, Orissa, and the Andaman and Nicobar Islands (Aurore – Auroville Renewable Energy, n.d).

The Solar Kitchen has one such successful project running on solar power. A Solar Concentrator which is a large sized spherical bowl 15 m or (49 ft0 in diameter with hundreds of mirrors focussing the light on the heat receiver around which are coils fitted up with water which automatically gets heated up. The heated water is used for cooking operations mostly in the solar kitchen which turns out meals for 2000 people a day. The Solar Heat generator uses prefabricated ferrocement segments lined very precisely on the inside with 11,000 small ordinary mirrors, which make it easy and cheap to maintain. The receiver is a 4m (13ft) high cylinder that is kept in focus through a computerised tracking system. A heat transfer liquid circulates and produces steam in a heat exchanger, which is sent to steam cooking vats in the kitchen (Le Fay, Raven, n.d, p-41). Wind Energy and Bio Gas Energy are the other types of renewable energy used and experimented on in Auroville.

III. Waste Water Treatment

The Centre for Scientific Research has developed systems to treat the wastewater in communities in Auroville. CSR has developed systems which are affordable simple with minimum energy output. The technique adopted is the Integrated Decentralised Waste Water System (DEWATS) which consist of underground containment and pre filtration tanks and overhead oxygenation sting and polishing ponds. For commercial spaces that have little space for ponds , the institute has designed a cylindrical vortex system which takes advantage of centrifugal forces to filter and oxygenated the water. The grey water from the system may then be inserted into the water table or used for local irrigation purposes. Another such technology used is the Effective Micro organisms (EM) which is an organic liquid composed of microbes which help quicken the decomposition of waste. EM when effectively added to grey water reduces the amount of sludge in it. CSR has implemented about 100 treatment systems ranging from 1m3 for domestic households to larger plants of 800 m3 for communities resorts and companies like ITC. Water Audit has been done for several companies like ITC Ltd (Sobo D, Hoberg Z. (2010) p-6)

IV. Sustainability in Building Technology

Compressed Earth Blocks: Auroville has always experimented with natural architecture ie the use of locally available building materials. Natural architecture takes into account natural lighting, wind direction and makes the most of what is naturally available to reduce the need for artificial lighting and cooling systems. Center for Scientific Research (CSR) Auroville is experimenting with enforcement and earth blocks in the field of architecture. The Auroville Earth Institute previously named the the Auroville Building Centre / Earth Unit, had been funded by Housing and Urban Development Corporation Limited, in 1989. It was renamed Auroville Earth Institute in 2004. This institute is researching, developing,promoting and transferring earth based technologies both cost and energy effective. The Auroville Earth Institute and the Centre for Sustainable Research (CSR) have developed a manual press to create Compressed Earth Blocks (CSEB). Earth Blocks are building blocks made of soil, sand and 5per cent of cement mixture. The eco-friendly blocks are produced by first mixing the components with water, manually compressing them with customised presses and cured for 28 days to reach a dry compressive strength of 7.5M Pa. The presses are robust, using a high compression ratio of 1.83 with 13.5 metric tons (15 tons) available force, and produce up to 1000 accurate blocks per day of adjustable height and

shape. The Auroville Earth Institute also produces hollow bricks that save on material and provide insulation. The blocks are stabilized with 3-5 per cent cement to prevent water erosion but lime or bitumen is used. CEB' s are energy efficient using between 5 to 15 times less energy efficient using between 5 to 15 less energy than to make a fired brick. The blocks are adaptable and can be used without support or form. Many Auroville buildings use these blocks to create vaulted floor and roof design. Nubian technology is used and is made possible due to the blocks adhesive properties with clay mortar. These environmentally friendly blocks have many advantages:

1. Local soil is used in making, thus reducing transportation cost of bricks among other things.
2. Earth blocks have a naturally aesthetic earthen look about them as opposed to bricks.
3. Earth blocks are less susceptible to humidity changes compared to bricks.
4. They require low maintenance in the long run as opposed to cement plastered walls which require periodic replastering and painting.

Ferrocement: Another innovative ecologically friendly adaptation by the Auroville Earth Institute is Ferro cement which is used making chicken mesh plastered in mortar (cement, sand and water). While using ferrocement a thin cement mortar is laid over steel wire meshing that acts as reinforcement. It is cost effective, durable and highly efficient. It is used mostly in water tanks, latrines roof materials and biogas plants (Sobo D, Hoberg Z.(2010) p-8).Ferrocement requires less material than reinforced cement thus making it as more acceptable option between ferrocement and conventional cement for construction purposes. The year 2011 recorded about 2 billion tonnes of CO2 being added to the atmosphere from cement production over the world (Puyvelde V Dennis. (2013).

Production of ferrocement involves much lesser CO2 production. Besides it is also the ideal construction material for infrastructure that requires minimal design intricacies eg., school buildings, religious buildings etc. Both these materials have been successful in reducing the 'embodied energy' of the product and the buildings environmental impact in general. CSR – Aurore unit has also supplied prefabricated ferrocement biogas plants to the Andaman and Nicobar islands for more than 15 years (CBERD Research Project 2012-2017,n.d. para 7).

With the progress of time, AVEI, other than carrying out research on earth based construction techniques also started consultancy services to promote its technologies in India and abroad. AVEI networks with CRATerre- a centre for Earth Construction in France, ABC Terra in Brazil and a host Non Governmental Organisations in India. AVEI also has an agreement with the School of Architecture of Grenoble in France for conducting long term training courses for their students. AVEI is the representative as well as the resource centre for Asia for the UNESCO Chair for Earthen Architecture, Constructive Cultures and Sustainable Development, set up for the diffusion of information regarding earthen architecture all over the world (Thomas & Thomas,2013.Chap 5.5. Construction and building technologies).

Design Planning & Building Activities: Auroville Earth Institute (AVEI) has commissioned a number of residential building projects in Auroville itself. Providing sustainable and affordable homes with people's participation is the principle idea behind these projects. *Realization* – a residential project of 17 apartments and Vikas Apartments are energy intelligent buildings using natural ventilation and solar energy for its power requirements. Fitted with Rain Water Harvesting structures and biological wastewater treatment plants these buildings are integrated into the landscape, in accordance to the existing natural surroundings. *Vikas Apartments* was chosen as a finalist for the World Habitat Award 2000. Other than residential projects AVEI is also responsible for the construction of *Sri Karneshwar Nataraja Temple* in Pudhukuppam near Auroville and the *Al Medy mosque* in Riyadh which was a finalist of the Aga Khan Award of Architecture in 2007. The project was granted the 'Prince Sultan Bin Salman Award For Urban Heritage' in 2010. Visitors Centre in Auroville was awarded 'The Hassan Fathy Architecture for the poor 'in 1992. AVEI has also provided consultancy support in construction projects in Haiti, Nigeria, Tanzania and Egypt. Auroville Earth Institute's work with earth in design and construction of ecological houses has won international accolades and in the process championed Auroville's sustainability cause (Auroville Earth Institute, AVEI Construction Projects, n.d).

Besides rainwater harvesting systems, water management systems and landscaping are designed keeping the natural terrain in mind. Indigenous plant and tree species are planted (especially those that require little maintenance and water for growth) for landscaping properties in Auroville. Auroville architects themselves designs the landscaping which allows them to happily juxtapose the building and landscaping requirements.

Rainwater harvesting designs have been incorporated in almost all Auroville building designs. Through an ordinance titled Tamilnadu Municipal Laws Ordinance 2003, dated July 19, 2003, the Government of Tamilnadu has made rainwater harvesting mandatory for all the buildings both public and private in the state.

The ordinance also cautions the citizens that if rainwater harvesting structures were not incorporated in the buildings by August 31, 2003, the Commissioner can cause such a structure to be installed in the building and recover it's cost from the owner. It also warns citizens on the disconnection of water supply connection provided rainwater harvesting structures were not included (Municipal Administration and Water Supply Department, 2003, July 21). These legislations were prompted by the alarming fall in water levels in the state

especially in the coastal areas. Auroville was no exception and thus the inclusion of rainwater harvesting structures and storage facilities have become common in Auroville. After the rainwater has been captured, it can be redirected to the water table through various measures such as percolation gardens or is used in household and building activities (Sobo D, Hoberg Z. 2010. p-9).

Auroville Design Consultants started as a branch of Auroville Centre for Scientific Research in 1988. Their range of activities includes planning, design and consultancy services for sustainable construction. Other than within Auroville itself, Auroville Design Consultants have been responsible for planning and design of sustainable projects outside Auroville like the Aravind Eye Hospital in Puducherry where attempts have been made to integrate sustainable concepts in an urban setting. Auroville Design Consultants have also integrated waste water recycling and rain water harvesting in a housing complex of 35-50 cottages in the hills of Kodaikanal in Tamil Nadu. Their work in the field of solar technology and consequent energy efficient planning has received international recognition which has reaffirmed Auroville's expertise in the field of sustainable technology. (Thomas & Thomas, 2013.Chap 5.5. Construction and building technologies).

Sustainability options for daily activities.

For its day to day activities Auroville keeps the sustainable option in mind. Most of the practices adopted are simple by nature but are meant to have huge impacts on the environment in the long run.

1. Garbage Separation

Separation of garbage is done in all communities within Auroville as separating the bio degradable ones enables it to be used as compost for fields and gardens.

2. Lavatory and Eco Sanitation

Some settlements in Auroville have ecosan toilets. Any system of human excreta sanitation that aims at saving water and reuse of plant nutrients and bio mass may be called ecological sanitation or ecosan. Ecosan toilets function on the principle of separating treating and actually gaining benefit from our sewage. Dr. Lucas Dengel, an Aurovillian- an expert on ecosan, champions its adoption citing the following advantages:

- **Reuse of biomass and plant nutrients**

Human excreta especially urine contain essential plant nutrients which are sufficient to produce the food required by one person. Human urine is a source of macro nutrients like Nitrogen, Phosphorous Potassium, Sulphur and Sodium chloride which are incidentally the main ingredients of manufactured fertilizers. Human stool provides the bulk of carbon matter in human excreta as much required for sustainable farming as macro and micro nutrients. This cycling of nutrients in nature is thus sustainable as it concerns renewable resources as opposed to non renewable resources.

- **Saving Water Resources**

As ecosan toilets do not require flushing of excreta; a lot of water is saved, at least 7 litres and in case of urine at least 2 litres. According to Dr. Dengel the percapita water use will be in the range of 20-30 litres per day.

- **Improved Handling of waste matter**

Ecosan toilets are mostly constructed as outhouses. Toilets are built above chambers that collect the solid waste. Often two chambers are used alternating over a time period of 12-15 months as per WHO standards. By the end of 12-15 months, the faeces have dried, the pathogens killed and the remaining material is rich fertilizers, ready for agricultural use and poses no threat to health. Urine is diverted by pipes because it is sterile and is used as fertilizes for the plants.

- **Avoiding Soil and Water Pollution**

Since no sewage is either produced or released the risk of sewage spill thus polluting groundwater, soil or water bodies is not there. For the existing sewage system raw sewage still runs in open sewers in most parts of India, increasing pollution in the process. (Sobo D, &Hoberg Z. 2010. p-11).

V. Community recycling and reuse projects

Aurovillians instead of dumping old and unwanted items in the garbage the community members are encouraged to exchange or donate these items so that other members of the community might find it useful. 'Freestore' in Auroville is one such store and as the name suggests it offers used clothes, freshly laundered, stitched and repaired for free. Crockery, books and music materials are also on the offer. This place is a blessing for many Aurovillians who live as voluntary workers on a very basic maintenance. It is also one of the many sustainable options offered in Auroville. WELLPAPER is another project which was inspired by the concept of

sustainability in 2005 in Auroville. WELLPAPER stands for Womens Empowerment through Local Livelihood. It was initiated in 2005 in South India as a tsunami relief effort to provide alternative livelihood to affected families from local areas. It gradually developed into a social enterprise model for women from the villages in Auroville. WELLPAPER promotes products made of recycled materials and thus promotes the sustainability clause as well. WELL PAPER uses waste magazines and news papers to create beautiful handicrafts. The waste produced in their units during work process is also recycled and remodelled into other crafts at Well Studio. At WELLPAPER instead of heavy machinery only simple tools like scissors and needles are used. Since Auroville discourages the use of plastic bags paper bags and recycled shopping bags are widely used (Well Paper, n.d. para 1).

Sustainability in the Community Spirit

Aurovillians generally have their meals together which involves less consumption of energy as food is prepared and served in bulk. Communities within Auroville such as 'Verite' are examples of how sustainable living can be successfully incorporated. Verites houses are made of Compressed Earth Blocks and they have communal lavatories and bathrooms. Verite is off the municipal grid and its electricity requirements are met from a PV Panel System which is hooked up to a battery bank storing enough electricity for cloudy days and nights. Rainwater harvesting systems have been incorporated in the settlement and water is drawn using a wind pump. Verite has a large community vegetable garden and orchard which is watered by treated grey water and fertilised by composted kitchen waste. Believing and actively pursuing green practices and methods of living,Verite and many of the other Auroville settlements are proving themselves as champions of the sustainability cause (Sobo D, Hoberg Z.2010.pg-13). Houses in Auroville ranged from tree houses, bamboo capsules to aesthetically pleasing ecologically sensitive bungalows complete with the use of solar panels and recycled wastewater. As the community became aware of the consequences of increased urban density, it became cautious about the use of its land resources and construction of collective urban facilities like multi-storeyed buildings came up in Auroville residential zone.

Other Alternative Technologies

Auroville covers an area of 25 km2. Having no public transport, motorbikes, scooters and mopeds are the most preferred modes of transport. In order to reduce this carbon footprint the use of electric vehicles - electric cars, bicycles and motorcycles is being initiated in Auroville. Putting up charging points at convenient locations within Auroville is expected to help the population to switch to greener options from the existing fuel driven ones. Converting the existing vehicles into Electric Vehicles is also another option being thought of as it would reduce the need to buy new ones.

Service units in the Industrial zone like Shradhanjali which specialises in making handmade flower cards consciously follows eco friendly methods of production. The building is equipped with solar power, uses recycled waste water for the gardens and is fitted with rainwater harvesting structures. Shradhanjali uses only organic manure and natural pesticides against caterpillars and insects. Drip irrigation is used wherever possible to prevent water wastage. Most of Shradhanjali's products are made of handmade paper, made from recycled shopping rags, straw, wool, algae, banana pulp or bamboo. A section of its profits are spent in reforestation and growing sustainable timber (Thomas, H., & Thomas, M. 2013. Chap 5.4. Shradhanjali).Upasana, the garment making enterprise, is committed to making socially and environmentally responsible products which have made their way to markets around the world (Thomas, H., & Thomas, M. 2013. Chap 5.4. Upasana). The Appliqué unit makes use of the discarded pieces of cloth from the garment manufacturing units. About 40 % of its raw material is collected in this manner. Organic dye is used in garment units to ensure that garments produced are free from ASO (a particular dye banned in Germany because of its harmful effect on skin. For its leather manufacturing units makers are attempting to use lacquer as colour instead of chemical dyes, which however have not proven to cost effective. In food processing the preservatives used for jam and jelly making is organic i.e. made from flowers grown in Auroville. Care is taken for the proper recycling of wastes in these units. Pottery units take care to burn their kilns at 1300 C rather than 800 C which prevents the formation of glass in ash which if leached may contaminate the water table. The ash is however used on roads as a precaution rather than as fertilizer. Waste from the furniture making industry is used for firing ovens. Leather manufacturing units sells the scrap to the cobblers. All possible materials are recycled whereas those that cannot be are separated and disposed off in a proper manner (Study of Industries in Auroville.(n.d). p-22).

A Study of the Impact of the Sustainability Projects on the local populace.

A study was conducted in Auroville bioregion to estimate the impact of Auroville's sustainable programmes on the local populace in the bio region. There are 21 villages in close proximity to Auroville. Some villages belong to Puducherry state and some to Tamil Nadu. Subsistence agriculture being the way of life here most of the villagers are small farmers, skilled and unskilled labourers and fishermen. Auroville bioregion has

been certified as a backward area in need of development by the collector of South Arcot District in 1984. Other than elected political leaders the villages also have traditional heads who play an important role in social set up of the village. This two tier leadership makes the implementation of development projects difficult. With more and more villagers finding employment in Auroville, cultivation of traditional crops have decreased and cultivation of cash crops like cashew have increased. (The Auroville Adventure, 1998.p- 24). Of the 21 villages, two villages have been chosen for sample study.

Kuilapalayam is a revenue village in Vanur Taluk of Villupuram district in the state of Tamil Nadu having a population of 2256. One of the closest to Auroville settlements, Kuilapalayam is well equipped with a bank, post office, Auroville Health Centre, New Creation School for village children, Crèche, night school, day school, training centre, workers education programme, Woman's club, toilets and kitchen gardens. Auroville has played a role in installation of hand pumps and in a credit and savings scheme in the village.

Irumbai Dalit village is located to the west of Auroville having a population of 570. This scheduled caste colony is the site of an ancient Shiva Temple and has the facilities of a small night school, kitchen garden, women's club, community health worker. Danish International Development Agency (DANIDA) has invested in a Well Project which has made drinking water available to the villagers. Along with that Auroville has invested in hand pumps and a credit and saving scheme in the village.

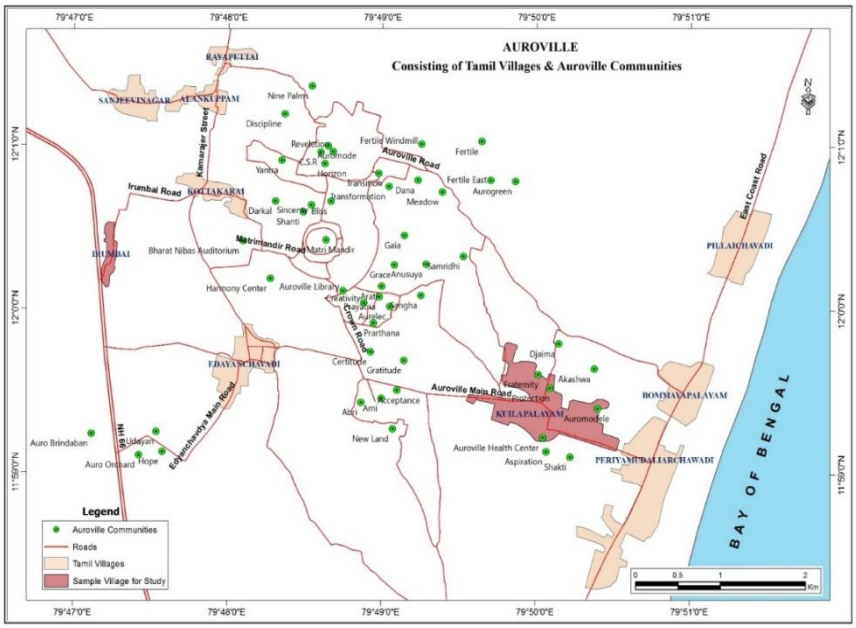
Though these two villages are located in the Auroville bioregion they are different from one another with respect to both their site and situation.**Kuilapalayam** though outside the Master plan area (radius 3.5 kms) is well connected to Auroville by the Auroville Main Road which branches out from the East Coast Road linking Puducherry to Villupuram and Chennai. Anyone travelling to Auroville from either Chennai or Puducherry will have to go through Kuilapalayam village, thus making it a well frequented place for visitors. It houses a number of Auroville shops selling Auroville products and emporiums of other states too. Cafeterias, western style German Bakeries juxtaposed with mud roads and thatched houses of local Tamils give this place a East meets West feel. Majority of the adult villagers work in Auroville.

Irumbai villageis on NH 66 on the west of Auroville and is not on the Auroville main Road. Though it is closer to the Auroville Visitors Centre (within a radius of 2.5 kms) it is not so well connected to Auroville and definitely not on the visitor's route to the Place. The village has benefitted from a number of development projects by Auroville.These two villages are very different from each other in composition of population, economic and social characteristics.

VI. Methodology:

The basis of this study was a survey of residents in the above mentionedsettlementsofthe Auroville bio region. Inordertogatherinformationonresidents'perceptions, structure dandunstructured personalinterviews, werecarriedoutintheregionovera2 weekperiodinDecember 2014.Thequestionnaire inthesurvey (based on 5 point Likert scale) was wholly conductedtheauthors.

Map 1: Irumbai village and Kuilapalayam village in the influence zone of Auroville



Sample sizewassetat61 for Irumbaidalit village and 66 for Kuilapalayam village. Thissample size,thoughrelatively smallbysocialsciencestandards, representsapragmaticcompromise between level ofprecisionandcostofdatacollection. Insettingsamplesizesforeachsettlement, thenumberofinhabitants weretakeninto consideration and was calculated using the standard sample size calculator with a confidence level of 90% and a margin of error of 10%. Thedemographicprofileofthesamplerepresentsthepopulationof theregionasreportedbylocalauthoritiesofthesettlements. Almost allthe respondentshavelivedintheregion forovertenyears.

Perception of the locals about Auroville and the sustainable practices eschewed by it*

	Perceptions regarding changes brought about by Auroville in Irumbai dalitvillage	Mean	SD
1	The villages are greener now thanks to Auroville's extensive afforestation programme.	4.31	.738
2	The villages have better soil management, due to the organic methods and sustainable options used by Aurovillians.	3.18	.827
3	The villages have better water management, now after help from Auroville.	4.23	.761
4	General cleanliness of the place has improved after the development of Auroville.	2.81	.908
5	Rainwater harvesting methods are being adopted by locals with help from Auroville.	4.18	.975
6	Organic manure are is used in place of chemical fertilizers in the village farms.	2.53	.823
7	Organically developed pesticides are used in place of chemically made ones in village.	2.34	.975
8	Setting up of sustainable alternatives is expensive which is what prevents the locals from adopting them.	4.07	.929
9	Adopting green practices lowers the yield.	4.11	.777
10	Auroville farms helps the farmers in adopting these practices.	2.18	.975

	Perceptions regarding changes brought about by Auroville in Kuilapalayam village	**Mean**	**SD**
1	The villages are greener now thanks to Auroville's extensive afforestation programme.	4.5	.789
2	The villages have better soil management, due to the organic methods and sustainable options used by Aurovillians.	4.34	1.004
3	The villages have better water management, now after help from Auroville.	3.91	.988
4	General cleanliness of the place has improved after the development of Auroville.	3.33	1.136
5	Rainwater harvesting methods are being adopted by locals after help from Auroville.	3.99	.972
6	Organic manure is used in place of chemical fertilizers.	3.89	1.273
7	Organically developed pesticides are used in place of chemically made ones.	2.64	.998
8	Setting up of sustainable alternatives is expensive which is what prevents the locals from adopting them.	4.44	.611
9	Adopting green practices lowers the yield.	4.33	.997
10	Auroville farms helps the farmers in adopting these practices.	2.79	1.247

*Responserangebetween1-5with1=strongly disagreeand 5=strongly agree

Residents wereaskedtoexpresstheirperceptions about the sustainability practices of Auroville and their impactonavarietyofareas. Tenperceptions(variables)wereevaluatedin both the villages.

As it can be seen from the table residents of both villages shared the opinion that the bioregion was definitely greener than before. However maintenance of the green areas is difficult with encroachment by villagers for a variety of reasons including grazing. The soil management too was much better after input from Auroville. However the high SD in Kuilapalayam village indicates a section does perceive differently. According to them organic method was used only in Auroville owned farms whilst the locals used chemical fertilisers, as before for high yield. Subsistence farming has long given way to much less labour intensive cashew monoculture. However ever since it became evident that Auroville produced organic cashews which being free from harmful pesticides was more in demand in the market, the villagers have mostly followed suit. In order to encourage farmers, boards were erected in all the locally managed organic cashew farms to tell everybody those which are organically managed and thus puts pressure on those which aren't to follow suit as well. After Auroville, the water situation is much better in both villages as indicated by a high mean and low

SD, more so in the case of Irumbai dalitvillage. The villagers have been supportive and have participated in strengthening the bunds and dikes of their old tanks. Auroville Water harvest is working with several European NGO's for salt water intrusion management and replenishment of groundwater aquifers in the Auroville bio region. In collaboration with DANIDA, programmes for solid waste management, EcoSan toilets, water purification, grey water for kitchen gardens and rainwater harvesting, water delivery to most houses in the Irumbai village was initiated and carried out with a population mostly unaware of the need for good sanitation. General cleanliness of the villages have improved, though not very as observed from the Mean and SD figures in the above tables which are more or less the same. According to residents though a section of Kuilapalayam residents feel that old habits die hard and the practice of emptying garbage on public places continues. A pilot project by Auroville Clean and Beautiful involved the setting up of community bins (concrete ring bins) for the collection of residual waste which after the initial success failed to garner much enthusiasm and waste dumping goes on unabated. Auroville funded schools for local village children are doing their best to change the situation by educating villagers about hygiene and cleanliness. Shankar Vengadesan, Principal of Aikyam School informed that the school children regularly go on anti-plastic campaigns and cleanliness drives in Kuilapalayam village. Regarding adaptation of rainwater harvesting techniques by locals, roadside trenches being dug by village women to increase rainwater seepage has been noticed around the Kuilapalayam village area. The villagers have been supportive and have participated in strengthening the bunds and dikes of their old tanks. Regarding the use of organicmanure and organic pesticides in the Auroville villages, Kuilapalayam has a few farmers going the organic way as indicated by the high mean. The high SD indicated that many still follow the conventional system which they say is much convenient and guarantees a high yield. However some complained that since organic cashews are more acceptable in the international market and Auroville farm products are organic, they are being forced to adopt organic cultivation in order to cater to the lucrative international market. The main deterrent for the organic cultivation is the cost involved and the comparatively low yields as compared to conventional agriculture. The area has also been witnessing a scarcity in agricultural workers as women and the youth population, who was earlier employed in the agrarian sector, have now been absorbed by Auroville or nearby towns through schooling, in the service sector, in construction, handicrafts or in export units.The villagers of both villages are very much aware of Auroville's work in exploring sustainable options, however they are yet to adapt these in their day to day lives. Adoption of sustainable methods in agriculture is seen more in Kuilapalayam in comparison to Irumbai Dalit village. For the dalits living in thatched huts and a meagre income adoption of sustainable techniques is a costly option they cannot afford.For villagers just out of their hand to mouth existence courtesy Auroville and enjoying their new found economic prosperity, sustainability is not much high on their agenda. Kuilapalayam village, being economically better off is however experimenting with such techniques.

Auroville's sustainable practices has improved conditions in other Tamil villages also within the bioregion. However a gap still remains between implementation of the sustainability projects and their maintenance. Educating the locals about the need for sustainable approach in all activities is imperative for the success of the Auroville initiatives. Involvement of the locals with backup from Auroville is essential for the success of these projects to be self-sustaining in the long run. The Tamil villagers, who value their new found material prosperity after years of living at a subsistence level finds it difficult to understand the importance of "back to the nature approach" of the Aurovillians for cause of sustainable development. This lack of understanding happens to be the major hurdle for the success of these projects.

VII. Conclusion:

The World Commission on Environment and Development (WCED), 1987, has defined sustainable development as that which meets the needs of the present without compromising the ability of future generations to meet their own needs. By 'needs', only the basic requirements of the poorer sections of the society are meant as fulfilling them will ensure greater ecological stability. The WCED Report has also stressed the need to integrate economic and ecological perspectives of development which will help preserve inter-generational and intra generational equity for the future. It also stressed the importance of community participation in the use and management of the available resources. (UN Documents Gathering a body of global agreements .n.d. chap 2. para-1).

Ecovillages the world over have proved beyond doubt that they are role models for sustainable living. They are also serving as testing grounds for ecological and renewable energy based technologies, offering opportunities for the application of methods for strengthening local and regional economies (Wahl, Daniel. n.d). Extensive studies on intentional communities have led to the conclusion that while there was no single ecovillage could be identified as a wholly sustainable one, it was definitely proven that their ecological footprints were considerably low. A recent study regarding the ecological footprint of the Findhorn Foundation in Scotland revealed that the total ecological footprint for its residents was 2.71 gha per person whereas that for UK and Scotland was 5.40 and 5.37 gha per person respectively (Tinsley, S., & George, H. (2006 August).p-

31). In a society already burdened by the social and environmental consequences of our economic activities, intentional communities in the form of eco villages offer a happy alternative.

True to its reputation of being a flagship community of the ecovillage movement, Auroville has successfully embraced all the dimensions of sustainability ie environmental, social and economic. It has adopted all possible ecofriendly measures for resource development and management and has in the process helped in improving the quality of life in the villages in its bioregion. Providing education and employment opportunities to the locals, Auroville's impact on local communities especially women in general is immense. Though its commercial outlets, staffed mostly by the locals and the Aurovillians themselves, this city has promoted endogenous growth and has opened up the region to a host of new market opportunities and consequent economic betterment, however remaining within the boundaries of sustainable development.

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