Ecological Foot Print Analysis-A Sustainable Environmental Management Tool for Kochi City

First A. Athira Ravi [1], Second B. Subha V [2]
[1] Cochin University of Science and Technology, Kochi, India Email: ravi.athira@gmail.com
[2] Cochin University of Science and Technology, Kochi, India Email: v.subha@cusat.ac.in

***Abstract*— Kochi, the commercial capital of Kerala and the second most important city next to Mumbai on the Western coast of India, is a land having a wide variety of residential environments. The present pattern of the city can be classified as that of haphazard growth with typical problems characteristics of unplanned urban development. This trend can be ascribed to rapid population growth, our changing lifestyles, food habits, and change in living standards, institutional weaknesses, improper choice of technology and public apathy. Ecological footprint analysis (EFA) is a quantitative tool that represents the ecological load imposed on the earth by humans in spatial terms. This paper analyses the scope of EFA as a sustainable environmental management tool for Kochi City.**

***Index Terms*—Ecological Footprint Analysis, Environmental Management, Kochi City**

I. Introduction

Kochi, affectionately called the 'Queen of the Arabian Sea', is located on the west coast of India, in the beautiful state of Kerala. This city in the district of Ernakulum can be regarded as the commercial and industrial capital of Kerala. Kochi city is the second most important city next to Mumbai on the western cost of India. Cochin Corporation has an area of 94.88 sq.km. and is divided into 66 wards.

Kochi is the most urbanized region in Ernakulam district. As per census of India 2001, the population of Kochi Corporation is 5,95,575. Physical, social, political and economic factors have played their decisive role in the formation of land use pattern in Kochi city. Constraints of landforms and lagoon system contributed to the concentration of economic activities to the water front areas. The existing land use pattern has resulted from the complex interactions of varied factors in the urban structures. The characteristic feature of the central city is the predominance of the area under water. The water sheet consists of backwaters, rivers, canals, tanks and ponds and altogether it forms 23.4% of the green land of the city. The net dry land available for urban use amounts to 71.86% of the gross land i.e. 68.18 sq.km.

Truly there could be no ideal location than this, with its protected lagoons directly accessible from the sea, for a major terminal port and with its hinterland bountifully blessed by nature for a concentration of urban population and activities. But the present pattern of the city can be classified as that of haphazard growth with typical problems characteristics of unplanned urban development. To have a better living condition for us and our future generations, we must know where we are now and how far we need to go. We, each individual must calculate how much nature we use and compare it to how much nature we have available. This can be achieved by applying the concept of ecological footprint. In this paper, an attempt is made to explore Ecological Footprint Analysis as a sustainable environmental management tool for Kochi city.

II. Ecological Footprint Analysis (EFA)

Ecological footprint analysis is a quantitative tool that represents the ecological load imposed on the earth by humans in spatial terms. Ecological footprint analysis was invented in 1992 by Dr. William Rees and Mathis Wackernagel at the University of British Columbia. The ecological foot print of a defined population is the total area of land and water ecosystems required to produce the resources that the population consumes, and to assimilate the wastes that the population generates, wherever on earth the relevant land / water are located. The footprint is expressed in global hectares. A global hectare is one hectare of biologically productive space with world average productivity[1].

The important uses of EFA are

- Ecological foot printing is both a technical concept and a metaphor. With its intuitive meaning it says that the human footprint should not exceed the area able to support it.
- EFA is a strategic management tool; strategies that reduce the footprint can then be prioritized.
- EFA is an awareness raising visioning tool that enables us to think about scenarios for the creation of a more sustainable future.
- The footprint can be used to measure any product, activity or impact, at all levels from self to planet. It is therefore possible to use the footprint in Environmental Management Systems (EMS) and as a planning tool.

Limitations of EFA

The ecological footprint is *one* indication of unsustainability. Because of the limitations below, we can say that "x is unsustainable because it's ecological footprint exceeds the fair share" but you cannot say "x is sustainable because it fits within the fair share"; we would then need to account for pollution, water use, toxicity, health, happiness, and so on. The accuracy of any given footprint analysis is also constrained by the quality of the data. Because of these limitations, ecological foot printing should be used as one tool amongst many.

DOI: 01.IJTUD.01.01.10

TABLE I. COMPARISON OF EFA AND EIA

EFA	EIA
Impact of a single man can be measured. Considering our present situation, each and every impact including human impacts should be studied to have a sustainable living	*Impact of a single man can be measured. But done mostly for large projects.* EIA is mostly done for macrolevel projects which have regional implications resulting in the fact that the local environmental issues are often neglected.
Energy consumption is given due consideration.	*Did not have an analysis on the energy consumption.* This is a major drawback in the impact assessment mechanism which is very essential in the present days of energy depletion.
Quick and easy There are many softwares developed for the quantification of the impacts and with these technologies the analysis can be made quick and easy.	*Time consuming* Since the preparation of the environmental statement is done by the members of the expert committee, the difference in their views will lead to cost and delays.
Impacts are quantified and compared with the capacity. Both the environmental and social impacts are quantified and compared with the capacity	*Impacts are quantified to an extend only.* Impacts are quantified with respect to the effect on the environment only.
Can accurately measure how far we are away from sustainability.	*Tries to keep a balance only in the environmental aspects.*
Whoever assesses the impact, the result will be the same.	*Changes will depend on the views of the expert committee*
Criteria for assessment vary depending on the region and depending on the time when it is assessed. Each country can use the methodology in the assessment but the criteria can be changed with respect to their locality.	*Criterion for assessment is purely developed by foreign agencies.* Most of the developing countries are adopting the same criteria for impact assessment, developed by the foreign agencies, which may not be applicable to their region.

TABLE II. ECOLOGICAL FOOTPRINT OF SELECTED COUNTRIES

	Per capita EF (gha/person)	Biocapacity (gha/person)	Ecological reserve/deficit (-ve) (gha/person)
World	2.2	1.8	-0.4
USA	9.6	4.7	-4.8
China	1.6	0.8	-0.9
India	0.8	0.4	-0.4
Russian Federation	4.4	6.9	2.5
Japan	4.4	0.7	-3.6
Brazil	2.1	9.9	7.8
Germany	4.5	1.7	-2.8
France	5.6	3.0	-2.6
UK	5.6	1.6	-4.0
Canada	7.6	14.5	6.9

Source: Living Planet Report 2006

Ecological footprint of Kochi City

The ecological footprint of Kochi city was calculated using the global footprint calculator developed by Redefining Progress and Earth Day Network . These are organizations conducting Ecological Footprint studies and generating environmental awareness around the world, along with WWF. Components for footprint calculation were food, mobility choices, shelter and goods and services. For the purpose of primary studies representative random samples of the residential areas in the city were selected. The criteria for selection were

- Density of population
- Concentration of high rise buildings
- Location

Results and Findings from the primary studies

The ecological footprint of the residential areas in the corporation area has been studied and the following were inferred.

- The average footprint of residents in the city area is above the national average. (2.19 > 0.8).
- Consumption exceeds the available bio productive space per person in the world. (2.19 >1.8).
- According to the Global footprint calculator if everyone like this we would need **1.3 PLANETS** to sustain our life.
- Average shelter footprint for
  - Flats- 0.21
  - Row housing Units- 0.568
  - Independent units- 0.77-1.21

Low land area occupancy when compared to other units reduces the average shelter footprint of high rise buildings.

- The mobility footprint of the population in the wards near to the CBD and major transportation nodes is low because of their dependence on public transportation facilities when compared to the other wards.
- Average dependence on public transportation facilities in the city is about 36.4%.
- Improper waste disposal at the source (house) is contributing to high waste footprint which in turn raises the goods and services footprint of the population.

Average footprint comparison

The average footprint is highest in Ward No.58 (2.52gha) because of the high shelter footprint (1.21gha) because of high house area usage. The lowest ecological footprint is in Ward No. 53(1.79gha).

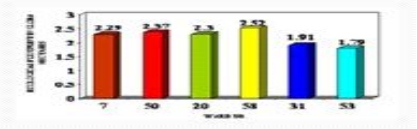

Fig.1. Average Footprint of the Wards

Footprint components comparison

For all residents, the shelter footprint goes to the maximum followed by goods and services footprint, food footprint & mobility footprint. In most cases the shelter footprint constitutes about 46.37% of the footprint. Average house area usage is 400.45 sqft/person. This is contributing to high shelter footprint.

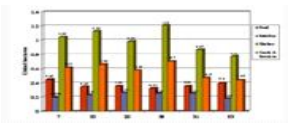

Fig.2. Footprint components comparison

Gender and footprint comparison

The average male footprint is greater than the female footprint because the male mobility footprint is more than that of female.

DOI: 01.IJTUD.01.01.10

Gender and footprint comparison

The average male footprint is greater than the female footprint because the male mobility footprint is more than that of female.

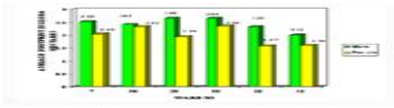

Fig.3. Gender & Footprint

Family structure and footprint comparison

The average footprint of nuclear family footprint is more than that of joint family.

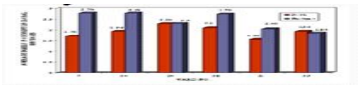

Fig.4. Family structure & Footprint

Age & footprint comparison

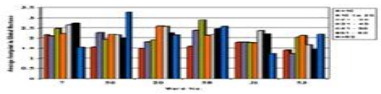

Fig.5. Age & Footprint

Income & footprint comparison

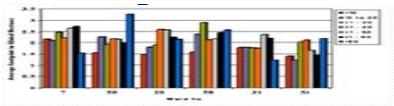

Fig.6. Income & Footprint

Distance to place of work and mobility footprint

Mobility footprint is directly proportional to the distance to the place of work or education.

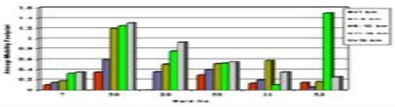

Fig.7. Distance to place of work and mobility footprint

III. The Ecological Footprint and Sustainable Environmental Management

Basically, the aim of ecological footprint analysis is to quantify the consumption and waste generation of a population and to compare it with the existing biocapacity. By quantifying the ecological footprint we can formulate strategies to reduce the ecological footprint and there by having a sustainable living. The ecological footprint of waste generation provides per capita land requirements for waste generation. Thus calculating the footprint for an area, the ecological footprint can be a tool for sustainable environmental management as:

- The calculation of ecological footprint of food can suggest strategies and create awareness to reduce the food consumption, change the food composition, reduce the food waste, increase the efficiency of food production and improve the efficiency of food distribution and delivery.
- The calculation of ecological footprint of waste generation is the primary and basic stage of sustainable waste management
- The calculation of goods and services footprint can suggest strategies to reduce the demand or to shift the demand for goods and services, to prolong the life span of products, to purchase goods that are sourced and manufactured locally.
- The calculation of shelter footprint can formulate strategies to reduce the house area usage, reduce energy demand for housing .
- The calculation of mobility footprint can formulate urban planning measures and to propose a mode shift to reduce the mobility foot print.
- The calculation of waste can determine the land required to assimilate the waste generated in present and future.
- Calculation of footprint is handy for selection of disposal site like land required for disposal, disposal site characteristics determination based on the footprint of waste components, etc.
- The design of landfill site can be supported through the footprint calculation of wastes providing information on land required for different components of wastes.
- Selection of the suitable site for landfill can be supported through footprint calculation as the calculation provides the information on land requirement in the predicted future. Thus many suitable sites can be selected if the requirement can be known.
- To determine the importance of recycling of different waste categories in order to reduce the footprint.

IV. Conclusions

The Ecological footprint has a higher flexibility as it can be used for many different purposes. For Kochi city the ecological footprint can be a valuable tool for education at all ages, for businesses to understand their all impacts and as a comparative tool with other cities and local authorities. For effective footprint reduction through strategies, the city should develop its own ecological footprint calculators or models based on their consumption pattern and life style of the population. This calculator should be made available to the public through media. Steps and provisions should also be given in the calculator so that they can compare their current profile of consumption and waste generation to a profile which reduces their ecological footprint. Thus the Ecological Footprint Analysis also helps in creating public awareness apart from a technical tool. This will make Kochi greener, cleaner, safer and self sustainable as in our good old days.

References

[1] W.E.Rees, "*The concept of ecological footprint*", Academic press, 2001.
[2] Living planet report 2000,2006,2009
[3] Practice compassion: Reduce your ecological footprint[Online].Available:http://www.mandalamagazine.org/climate_crisis/Reducing_your_Ecological_Footprint.pdf
[4] S.Bond, "*Ecological footprints:A guide to Local authorities*", 2002.
[5] Dr. MD. Salequzzaman, Umme Tania Sultana, "Ecological footprint of waste generation: a sustainable tool for solid waste management of Khulna city corporation of Bangladesh", 2009.

DOI: 01.IJTUD.01.01.10