Chapter 6

IDEAS, STRATEGIES AND PROGRAMS TOWARDS BETTER ENVIRONMENTAL EFFICIENCY

Contents

6.1 Smart growth initiatives of the west
6.2 Retention and detention of rainwater
6.3 Regional planning approach
6.4 Transferable development right
6.5 Green buildings
6.6 HD/EFP concept and coastal regulation zone rules
6.7 Town planning schemes and global FAR concept of Greater Cochin Development Authority
6.8 Precise and objective decision-making through GIS
6.9 Formulation of environmental efficiency indicator system and 1000 cities program of UN-habitat
6.10 Property taxation based on efficiency
6.11 Sustainable forest management through the HD/EFP enhancement of metropolitan areas and vice versa

References
6.1 SMART GROWTH INITIATIVES OF THE WEST

The compact high density development with compatible mixed land use can go a long way in getting multiplying effect on the HD/EFp index which is known under the pet name of ‘Smart Growth’. Increased traffic congestion, loss of open space, infrastructure cost, desire for choices, social insecurities all have made ‘Smart Growth’ an increasingly powerful strategy for building and revitalising communities. Evidence of this trend is everywhere. Cities and towns across the globe are re-examining and changing comprehensive plans, zoning and other building regulations to make smart growth possible (LGC et al. 2003). Many states and localities are creating neighborhoods that offer a variety of transportation options, access to parks and recreation, a wide range of housing types, economic opportunities, lively streets and quiet residential neighborhoods. Ironically many communities pursuing these goals often inadvertently impede their achievements by opposing density, a feature key to smart growth and to the success of so many great places.

Often blamed for more traffic, crime, parking shortages and ugly architecture density faces broad opposition. Objections to density are without basis and it is an asset rather than a liability. But density can backfire if it is not properly designed, which often creates public frustration. A common community response has been to oppose any and all density.

Density creates great places to live by creating walkable communities (LGC et al. 2003) with mixed land use. High density development contributes to the viability of a wide range of businesses in nearby locations. This, in effect, creates walkable communities.

Also high density development supports housing choice and affordability. In contrast to conventional development in which housing tends to be similar in style and size, higher density projects can provide town houses, apartments, accessory
units and even live-work spaces to accommodate a broad range of life styles. Higher density means less land per unit which reduces the site preparation cost, foundation cost, less road per house and less per capita capital cost for water supply, sewage etc. Thus high density development reduces the cost price of the unit dramatically, which ultimately increases the affordability of the buyer and profit of the seller.

Density also expands transportation choices, walking, cycling and even makes mass transit options like bus and rail a viable enterprise as user can avail the facility at an affordable price, while the entrepreneur will be highly profited as more passengers can be collected from the transit points. From all the above it is seen that density improves community’s fiscal health as it reduces the energy spent on personalised vehicles, avoids infrastructure duplication and minimises the traffic blocks. All these savings are pocketed as cash, which is shared by the buyer and the seller.

In a region depended on agricultural production compact high density development helps to protect valuable farmland. The protection of farmland in effect protects the forestland as it curbs the invasion of forestland. Thus high density development contributes to environment. Less traffic block and less dependency of personalised vehicles reduce the green house gas emissions. The concentrated development and people within a small geographical area protect the valuable open space, habitats and ecologically sensitive areas. It also helps in minimising water pollution and air pollution.

Density also improves security. The common perception is that density increases criminal activity. This belief disregards the fact that criminals tend to favour desolate rather than busy places (LGC et al. 2003). Density has the potential to increase social interaction and deter crime. The concept sometimes referred to as the ‘eyes on the street’ reflects the possibility of less chances of emptying out of streets and common areas.
High density compact development can strengthen the tax base of the local governments and reduces the taxload of the residents. As the development is concentrated revenue expenditure on public services can be minimised, while revenue receipts can be maximised. This may be where the shoe pinchest for the state and local governments of Kerala State in which revenue expenditure is alarmingly very high, while revenue receipts are very low. The public debt is skyrocketing to an unrecoverable heights and the scattered settlement pattern prevalent in Kerala State may be a very strong reason for the high revenue deficit.

Smart growth neighborhoods with proper land use zoning can ensure cheaper land supply in the city for productive purposes like industries and commerce and contributive purposes like provision of physical and social infrastructure which often leads to economic development and job opportunities.

All the above illustrations depict the high scope for smart growth communities to make the cities livable, by ensuring less ‘Ecological Footprint’ and high ‘Human Development’. Smart growth enables increase in human development due to better accessibility, reduction in fossil fuel consumption due to proximity and mass transport viability. Thus, there will be multiplying effect on the efficiency index HD/EFp.

Mega cities of India are overflowing with population due to migration which often exceeds the capacity of the system to accommodate and is often identified as a sustainability issue. Population concentration beyond the system capacity is also dangerous as it backfires and spoils the entire system by creating frustration, traffic block, congestion, chaos, miseries etc. If smart growth is launched as a national policy and smart growth with infill development and redevelopment are encouraged, it can check the migration of people from other parts of the nation to the mega cities. This can ensure environment, economy and safeguards the aspirations of the people of today and tomorrow.
The need of the hour is the propagation of the concept of smart growth with compatible mixed landuse at the grassroot level to ensure public acceptance, while legislative and policy level initiatives are to be ensured from the top. Smart growth can definitely contribute to more livable cities of tomorrow.

6.2 RETENTION AND DETENSION OF RAIN WATER

Three most important water-related sustainability-issues prevalent in the cities of the developing countries are urban floods, depletion of underground water table and water pollution resulting from urbanisation and industrialisation.

Anywhere in the world increase in paved areas is synonymous with urban development resulting in faster run-off, and percolation to ground is substantially reduced. Also the fast run-off results in carrying of more silt leading to siltation of canals and drains. Increase in run-off combined with reduced discharge capacity of drains leads to urban floods for a long time after heavy downpours. Urban flooding creates very unpleasant situation with long hours of traffic block resulting in fuel waste and time loss. Also, when roads get flooded for long hours bituminous roads get damaged resulting in huge maintenance cost of roads. During urban floods there is every possibility of rainwater mixing up with sources of contamination which often results in diseases like leptospirosis, jaundice etc. Also urban floods cause stagnant water pockets, which act as a breeding place for mosquitoes which spreads vector-borne diseases like malaria, dengue fever etc. Urban flood often causes inundation of low level areas, which may be often occupied by low income groups and economically weaker sections of the society.

Pumping of underground water for day-to-day activities with reduced ground percolation often results in depletion of ground water table. This results in consumption of more electricity for pumping out water. Also in coastal areas depletion of ground water leads to salinity intrusion, which results in land
degradation leading to loss of local flora and agriculture. If the aquifers are confined and lie between layers of aquicludes of thick organic clay withdrawal of ground water with no recharge of rain water may lead to compaction of aquifers resulting in irreversible land subsidence (Benjamin 1998).

Water pollution, as a result of urbanisation and industrialisation, often causes surface water pollution leading to treatment of drinking water more tedious. Water scarcity looming in different parts of the city often leads to inflow of tanker lorries creating traffic chaos.

All the above-mentioned problems make the life in city very unpleasant and abatement of the same cost a lot of energy which could have been used for some other developmental activities for the city contributing to the overall quality of life. Solutions to all the above problems are the practice of retention and detention of rain water. Retention is often known as rainwater harvesting and artificial recharge of ground water (ARGW) of urban areas and detention is the water shed management practices of rural areas. In the case of RWH in containers the harvested water is pumped out for day-to-day activities, while ARGW is done mainly to combat the urban floods and other water-related sustainability-issues with a long-term perspective. Watershed management is practised for proliferation of agricultural activities of the rural areas.

**The Concept of ‘Zero Run-Off’**

This is the hypothetical situation wherein there will not be any surface run-off and the total rainwater is going either as underground water or lost through evaporation back to the atmosphere. Rainwater harvesting or artificial recharge to ground minimise the surface run-off which, in turn, slows down the fast run-off. The slow run-off enables percolation of rainwater and thus underground water gets
diluted and subsurface water table rises. This prevents saline water intrusion in the off-season of rains.

**Rain water harvesting in Urban and Rural Areas**

RWH in urban areas is relatively a new concept evolved once the underground water in urban areas reduced substantially. It was made mandatory with building permits in cities like Chennai, Delhi, Jaipur etc and nowadays it is made compulsory in all new constructions in most of the states as per the directives of the Ministry of Urban Development and subsequent amendment of the building rules of the state governments. The RWH practices in urban areas

1. Provide drinking water
2. Increase ground water recharge
3. Reduce storm water discharges and urban floods
4. Reduce overloading of sewage treatment plants
5. Reduce saline water intrusion in coastal areas etc.

**Urban RWH practices**

For drinking and other domestic purposes water from roof top is harvested. Water from road and other open spaces can be harvested for gardening and other purposes. Rain water can be collected and stored in ready-to-use containers above ground or below ground or it can be recharged to aquifers.

**Amount of water that can be collected**

**Urban Scenario**

The total amount of water received from any area from rainfall is known as rainfall endowment of that area. The total amount of water which is effectively harvested is called the water harvesting potential of the area.
The water harvesting potential = rain fall endowment x collection efficiency

Collection efficiency is calculated based on factors like run-off coefficient and first flush wastage.

Suppose the area of the roof is 100 sq. m.

Rainfall, e.g. average rainfall of India is 1170mm

The volume of rainfall from 100 sq. m. area is 117000 lit.

Assuming a collection efficiency of 90 %

The volume of water collected = 0.90 * 117000 = 105300 lit

For a five member family the amount of water required per day for drinking and cooking is assumed as 250 litres/day, the water is sufficient for 420 days, which is in excess of the annual requirement.

Rural Scenario

In rural areas water can be collected from roof top, from monsoon runoff by capturing water from swollen streams and from flooded rivers. Assuming that the average population of an Indian village as 1200, and rainfall being 1170 mm, if half of this water can be captured the average Indian village needs only 1.12 hectares of land to capture 6.57 million litres of water it will need for cooking and drinking. These calculations show the vast scope of rainwater harvesting. If the rainfall is uniform throughout the year it can be stored in ready-to-use containers of high capacity ferro cement water tanks.

Rainwater Harvesting Structures

1. Recharge / percolation pit
2. RWH through open well
3. RWH through bore well
4. Recharge well (deep/large)
Artificial Recharge of Ground Water (ARGW)

Recharge of ground water aquifers. Design considerations

Three most important components to be evaluated for designing the artificial recharge structures are:

1. Hydrogeology of the area including nature and extent of aquifers, soil cover, topography, depth of water level and chemical quality of ground water
2. The area contributing to run-off, land use and general built-up pattern of the area
3. Hydro meteorological characteristics such as general pattern, intensity and duration of rainfall.

Artificial Recharge Structures

1. Percolation or absorption pit
2. Percolation well
3. Percolation well cum bore pit
4. Artificial recharge through injection well

Watershed Management Practices of Rural Areas

There are vegetative methods and mechanical methods. Mixed cropping, multi-tired cropping, growing legumes and grass, and mulching are some examples of vegetative methods. Some of the mechanical methods of watershed management practices are contour bunds, contour trenches, check dams and subsurface dams. This not only checks the soil erosion, but allows the rainwater to percolate to ground resulting in reduced surface runoff.
Rainwater Retention and Detention—Success Stories

Revival of the dying river of Rajastan

The Arvari river in Alwar in the State of Rajastan was dying due to the depletion of ground water table and it was almost dried up by the year 1984. The non-governmental organisation Tarun Bharat Sangh (TBS) lead by Shri Rajendra Singh has since 1985 built 4500 earthen check dams to collect rainwater in around 850 villages in 11 districts of the arid region of eastern Rajastan and he revived the dried-up Arvari River. The Government of India honoured him by giving Ramon Magsaysay Award for community leadership for the year 2001. He is known as the ‘Water Man of Rajastan’.

RWH and metro water board in Chennai

For a rain-deficient, coastal city of Chennai the importance of RWH needs no justification. There is a persistent threat posed to the fragile aquifer by the possibility of saline water intrusion by the indiscriminate extraction of ground water. Keeping this in view as a macro level strategy the Govt of Tamil Nadu introduced ‘Chennai Metropolitan Area Ground Water (Regulation) Act, 1987 which covers the whole of Chennai city and 243 revenue villages around it. It is due to the implementation of this Act, the water table in the southern part of Chennai city, which was on an average depth of 8 meters before 1988, has risen upto an average depth of 4m below ground level. The implementation of this Act coupled with certain measures like construction of check dams improved the situation to such an extent that metro water board is able to increase the drawal from 55 mld to 100 mld of water to meet the 50% of the city supply.
The Delhi experience

A comparison of water levels from 1960 to 2001 shows that the water levels in major parts of Delhi are steadily declining because of overexploitation. During 1960 the ground water level was by and large 4-5 meters and in some parts the water-logged conditions existed. During 1960-2001 the water levels have declined by 2-6 metre in most parts of the alluvial areas. Decline of 8-20 metre had been recorded in south and south-west district. These areas have been identified as priority areas for taking up artificial recharge to ground water by rooftop rainwater harvesting and this technique is implemented in RASHTRAPATHI BHAVAN. The Central Ground Water Board is taking the leading action for this cause in Delhi.

The importance of Retention and Detention of rainwater in Kerala and Greater Kochi

It is learnt that in Kerala and Greater Kochi Region, due to its terrain conditions, only 5% of the rainwater is recharged to ground, while at the national level it is 12.5%. The rainwater in Kerala has fast runoff and it is reported that rainwater from the eastern hills reaches the sea within 48 hours. Water-shed management practices are very important for the people of Kerala and Greater Kochi Region for the sustainable agricultural activities and urban-related activities as they depend on groundwater and river systems for drinking and other household activities. Watershed Management Practices in the hinterland can definitely reduce fast runoff and allow base flow ensuring round the year fresh water flow in the rivers. This, in turn, curbs the salinity intrusion of rivers in the summer season.

All the above illustrations give a promising future for retention and detention of rainwater for the efficiency enhancement of cities resulting in a better HD/EFp. However artificial recharge structures, unless scientifically erected and managed, can
be disastrous as it changes the sub-surface flow pattern, which causes instability of sloppy terrains causing land slides.

All over India detention and retention of rainwater shall be given proper institutional support in terms of technology and financial subsidy as it is an inevitable requirement for the sustainability of the cities of tomorrow, to provide the city with the drinking water, to save the city from urban floods and related issues, and to flourish agriculture in the hinterland. Hastily pumped out underground water will be replaced only with long years of recharge.

6.3 REGIONAL PLANNING APPROACH

Macro economic growth models often adopted at national, state and regional level were aggregative and sectoral in character which cannot be expected to take care of the extraordinary details of physical, cultural and economic dimensions. Though the articulation of spatial development strategy for regions more or less coincided with the efforts for the national economic planning, nonetheless the importance of physical dimension in the national planning has scarcely been understood or appreciated. There has been growing recognition of the need for the development programs in the country to be conceived in terms of region (spatial) defined by economic, social and geographic considerations. In order to achieve regional balance in terms of development the idea of regional planning was introduced by the Government of India in the third Five Year Plan.

Hierarchy of Planning Regions

Depending on the geographical scope within which various developmental programs to be effectively organised and dealt with, it is possible to visualise three major areas of operation, macro, meso and micro. Metropolitan regions are coming under micro regions.
Chapter 6 Ideas, strategies and programs towards better environmental efficiency

The specific criteria that should be considered for delimiting the region must be laid down as follows as reported (TCPO 1982):

1. The planning region must be large enough to contain a range of resources, conditions and attitudes that would help to establish the desired degree of economic viability, but at the same time not too large as to make the comprehensive approach too general.
2. It should have adequate resources of diverse origin to enable a production pattern to be developed both for consumption and for exchange.
3. There should be an organisation in terms of nodal points either developed or developable to satisfy the organisational needs of the region as a total entity.
4. Planning is a mechanism for dealing with resource development problems. Therefore the ideal region for planning purpose must be those in which the area-wise approach to these problems is both feasible and desirable.
5. Planning deals with anticipating the future and an area with common potentials and probabilities of development would be logical for planning purposes.
6. Since planning requires the development of insight into the consequences of various alternatives, a contiguous, internally-cohesive area within which various alternatives can be projected and analysed has importance. Such internal cohesion may be the result of homogeneity of resources or their linkages through complementarity and intra-areal activity or flows.
7. As the ultimate objective of planning is to facilitate the making of rational decisions an area where some degree of social unity exists is desirable, so that the public can identify their problems and accept responsibility for meeting them.
8. The planning regions cannot completely ignore the basic administrative units. They are in fact derived by grouping the smallest administrative units in right
combinations. The advantage of keeping the smallest administrative unit in fact lies in the availability of data by such units and the existence of a system of administrative communication, which provides the mutual feedbacks and appraisal of results for the guidance of future problem-solving techniques.

9. Planning regions should be essentially operational in character. Therefore a high degree of flexibility and elasticity is required in their conception as well as in their delimitation.

**Delineation of a viable Greater Kochi Resource Region**

A study conducted under the aegis of the Ministry of Environment and Forests, Government of India, has identified a region which is the catchment area of Vembanadu estuary system to which five west-flowing rivers are merging. The region extends to 13182 sq. km. spread across six districts of the state either part or full. To coincide with the administrative boundaries four districts in full can be considered for comprehensive regional planning. A viable Greater Kochi Resource Region can be formed by combining the districts of Ernakulam, Kottayam, Idukki and Alapuzha. A variety of ecosystems can be found in this region, marine, estuarine, riparian, wetland, forest etc apart from the fact that it is the most urbanised region of the state and has great socio-economic and cultural achievements.

**Strategic Approach**

The strategic approach of Greater Kochi Resource Region should be in such a way that the carrying capacity index $\text{CCI} = \frac{Bc}{EFp}$ is not less than one, where $Bc$ is the bio-capacity and $EFp$ is the ecological footprint. Regional planning must be aiming to get an increased value of biocapacity and a reduced value of ecological footprint. Biocapacity can be increased by measures to increase the productivity of the eco-system. Ecological footprint can be decreased by planned compact high
density development with compatible mixed land use zoning. This can be achieved as per the following:

1. Identify the potential ecosystems in the region and bring regulations to preserve the value of the ecosystem and to prevent from further disturbance.
2. Introduce the disturbance reversal if possible to bring back the rural values.
3. Urban renewal of the already-performing urban areas through infrastructural up-gradation.
4. Least performing areas may be identified to inculcate planned compact high density development.
5. Existing scattered settlements in areas with rural values shall be encouraged to stand on their own with the least dependence on the public infrastructure. Those settlements may be encouraged to set up biogas plants, solar panels, rainwater harvesting units and artificial recharge wells etc.

Effect of preservation of rural values of Ecosystems

The literature support on the ecosystem services rendered by the biosphere and direct anthropogenic threat to bio-diversity are explained in Chapter 2. Preservation of rural values of ecosystems and discouragement of built-up disturbance can enhance the efficiency of ecosystem resulting in increased productivity. This, in turn, reduces the ecological footprint as the resources can be transported from the region to metropolitan area rather than from other states or countries. Increased productivity also results in better HD values due to increase in per capita income, giving a better HD/EFp.

6.4 TRANSFERABLE DEVELOPMENT RIGHT (TDR)

Traditional town plans, zoning and land use regulations often created desktop maps which were seldom implemented in its true spirits, as it may not be compatible with the aspirations of the public. Very often individuals are forced to compromise...
for public interest which was never compensated in a time-bound manner. The resulting tendency is to violate the plan stipulations and zoning regulations. Political compulsions also arise to violate/vary the land use and zoning regulations. Due to these reasons the development authorities/local and state governments were not getting enough political support to go ahead with the implementation proposals. Land acquisition procedures also face public protests and litigations.

It is high time for government to think about alternate development strategies which would take public in confidence with fair amount of equity. ‘Transferable Development Right’ gives a promising future for effective implementation of master plans and zoning regulations. TDR enables the preservation of natural areas, agricultural land and heritage structures. It also helps in curbing development in disaster-prone areas and ecologically-fragile ecosystems. Transferring the development rights from low efficiency zones to high efficiency zones can create multiplying results and is beneficial to both public and government. Infrastructural upgradation is also effective through TDR technique as developer gets his profits multiplied with higher order infrastructure.

**What is TDR?**

TDR is an implementation tool that encourages the voluntary shift of development from places that communities want to save called sending areas to places that communities want to grow called receiving areas. With TDR the landowners of the reserved land as per master plan receive compensation by selling their development rights in return for voluntarily surrendering their land or for reserving/retaining their default activities. TDRs are purchased by developers in receiving areas, the places that are appropriate for development.

When TDR works, sending area property owners are given ‘development right certificate’ which can be sold to a prospective developer in the receiving area.
In the case of agricultural land reservations land owners are often allowed to continue owning the land and receive non-development income from it, while enjoying the development rights to a sending area. Receiving area developers enjoy extra return on their investments, while contributing to land reservation as per landuse plan. Finally TDR allows communities to achieve their landuse goals with compensation to property owners without public exchequer. TDR is indeed a market-based preservation technique.

Compact cities of Curitiba and Sao-Paulo in Brazil used the TDR tool as early as 1960s to achieve their development targets. In the United States Montgomery County in Maryland has preserved over 40,000 acres of farmland and New Jersey Pinelands saved 31,000 acres of farmland using TDR tool. India also has sufficient TDR experience.

**TDR experience in Mumbai**

Rule 34 of the development control regulations for Greater Bombay, 1991, defines TDR as under:

>'In certain circumstances the development potential of a plot of land may be separated from the land itself and may be made available to the owner of the land in the form of transferable development rights. Development control regulations lay down the rules for grant of TDR. The owner of the land which is reserved for public purpose and additional amenities are eligible for transferable development certificate which is known as Development Rights Certificate (DRC). The landowner may use the right himself or transfer to any other person. When the owner constructs an amenity on the surrendered plots at his cost he may be granted a further development right'.

School of Management Studies, CUSAT
Different Types of TDR Practised

1. **Slum TDR**

   When the developer or owner surrenders his land to the government and agrees to rehabilitate slum dwellers free of cost he is issued a TDR certificate that gives him additional construction rights in the designated areas. Slum TDR is effectively practised in Mumbai.

2. **Heritage TDR**

   A landowner who cannot develop his property despite unutilised floor space index as the existing structure is a heritage building, can use or sell the development rights in the open market. Builders who buy the TDR can use the right in designated areas. The aim of heritage TDR is to protect the heritage buildings without penalising the landowner.

3. **Agricultural land TDR**

   In the United States TDR is effectively used for the protection of farmland and ecologically sensitive zones.

4. **Amenity/road TDR**

   If any of the amenities mentioned in the master plan is constructed by a party, in lieu, he is given a TDR in a designated area.

   For an environmentally-efficient development management system ‘Transferable Development Right’ is an indispensible tool to be applied for effecting development in the efficient zones and discouraging development in inefficient zones.

**Making TDR a Success**

Conditions to be complied for making TDR a success are:

1. The scale of the TDR program should be large enough to provide a large pool of potential sellers and purchasers.
2. The underlying landuse regulations are sufficiently restrictive relative to the market demands to encourage participation.

3. Program must offer significant benefits as incentives for landowners to participate.

4. Receiving area should have sufficient capacity to accommodate high density development.

TDR contributes to environmental efficiency HD/EFp due to the following reasons:

1. It increases the land utility index by bringing the ownership of the land from a single ownership to collective ownership by providing more and more amenities.

2. Road TDR always expedites the road formation which, in turn, increases the accessibility.

3. TDR reduces the disturbance to ecosystem of the sending areas.

4. TDR increases the productivity-multiplier value of receiving areas.

5. TDR in receiving areas causes less per capita built-up consumption.

**Development Authorities, Where the shoe pinched? and the Remedy**

The activities of the development authorities are highly contributing to environmental efficiency through the implementation of town planning schemes, as they increase the land utility, increase the accessibility, reduce the per capita built-up and carry out bulk development, so that productivity-multiplier values were high. However, land reservations without compensation were highly detrimental to the interest of the individual landowners and thus the development authority lost the goodwill of the public. TDR is a remedial tool to effectively implement the environmental efficiency through the land reservation in town planning schemes.
6.5 GREEN BUILDINGS

The Concept

The concept of Green Buildings envision a new approach to save water, energy and material resources in the construction, operation and maintenance of the buildings and can reduce or eliminate the adverse impact of buildings on the environment and occupants.

Green building concept rightly coincides with the environmental efficiency index HD/EFp, as it concentrates on increase in human development by increasing the comfort level with reduction in ecological footprint by energy saving measures.

The salient feature which contributes to human development is improved air and water quality for health and comfort, resulting in increased productivity while the salient features of the green building contributing to reduction in ecological footprint are:

- Effective use of soil and landscape
- Efficient use of water
- Energy-efficient and eco-friendly equipments
- Effective control and building management system
- Use of renewable energy
- Use recycled/recyclable materials.

Unlike a conventional building, green buildings intend to achieve operation and maintenance savings, reduction in initial investment, while there is strong concern for human comfort, indoor environment and safety.
Green Building Movement in India

The Indian Green Building Council (IGBC)

To enable construction industry to be environmentally-efficient Confederation of Indian Industries-Sohrabji Godrej Green Business Centre (CII-Sohrabji Godrej GBC) in Hyderabad has established Indian Green Building Council (IGBC). IGBC is a consensus driven not-for-profit council representing the building industry consisting of more than 350 committed members. The vision of IGBC is to usher a green building movement in India and aim India to become one of the world leaders in green building.

The green building movement in India has been spearheaded by IGBC since 2001. IGBC continuously works to provide tools that facilitate the adoption of green building practices in India.

LEED-India (Leadership in energy and environment design) is the rating program adopted by IGBC to facilitate rating of buildings with respect to energy and environmental efficiency and the technology support is given by the United States Agency for International Development (USAID).

Services offered by IGBC towards green building concept are:

- LEED India certification
- LEED workshops
- Green Building Congress
- Publication and information dissemination
- Membership services
- Green building tours
- LEED AP Examination

In LEED India rating system life cycle cost of building materials are considered and the incremental cost is offset by operational savings.
Levels of certification by LEED India are LEED Certified, silver, gold and platinum.

Green Buildings in India

Four platinum-rated green buildings in India along with plinth area, incremental cost and payback period are as below:

**Table 6**

Cost and Payback period, Platinum-rated Green Buildings

<table>
<thead>
<tr>
<th>Name of the building</th>
<th>Plinth area in Sq.Ft.</th>
<th>Incremental cost</th>
<th>Payback period</th>
</tr>
</thead>
<tbody>
<tr>
<td>CII-Godrej GBC (2003)</td>
<td>20,000</td>
<td>18%</td>
<td>7 years</td>
</tr>
<tr>
<td>ITC Green Centre, Gurgaon (2004)</td>
<td>170,000</td>
<td>15%</td>
<td>6 years</td>
</tr>
<tr>
<td>Wipro Gurgaon (2005)</td>
<td>175,000</td>
<td>8%</td>
<td>5 years</td>
</tr>
<tr>
<td>Special Service Consultants office, Noida</td>
<td>15,000</td>
<td>8%</td>
<td>4 years</td>
</tr>
</tbody>
</table>

Source: www.igbc.in

IGBC Green Homes rating system addresses the features under the following categories:

1. Site efficiency
2. Water efficiency
3. Energy efficiency
4. Materials
5. Indoor air quality
6. Innovation
6.6 HD/EFp CONCEPT AND COASTAL ZONE REGULATION (CRZ) RULES

For regulating developmental activities the coastal stretches within 500 meters of high tide line of the land-ward side are classified into four categories namely I, II, III and IV.

CRZ I, Areas which are ecologically sensitive and important ecosystems.

CRZ II, Areas which have already been developed.

CRZ III Areas which are relatively undisturbed and considered as rural areas.

CRZ IV Coastal stretches in Andaman and Nicobar, Lakshadweep and small islands except those designated under CRZ I, II or III.

As per CRZ rules vide Kerala Coastal Zone Management Plan, the Greater Kochi Metropolitan Area is coming under three zones namely CRZ I, II and III. All the coastal municipalities and Cochin Corporation are coming under CRZ II, while all the coastal panchayats are coming under CRZ III.

Building regulations as per Kerala Coastal Zone Management Plan are framed in such a way that building activities in CRZ II zones are encouraged, while the building activities in CRZ III are discouraged by framing more relaxed rules in CRZ II Zones. No new construction activities are permitted in CRZ I zone.

Kerala Coastal Building Regulation contributes to HD/EFp concept as building activities are prohibited/discouraged in sensitive ecosystems and relatively undisturbed areas, while building activities are encouraged through relaxed rules in already disturbed zones which result in a better Productivity Multiplier Value ‘1/1+δ’ where, δ is the disturbance factor.
6.7 TOWN PLANNING SCHEMES AND GLOBAL FAR CONCEPT OF GREATER COCHIN DEVELOPMENT AUTHORITY

Detailed town planning schemes which are being implemented by the Greater Cochin Development Authority (Annexure 2) under the aegis of Town Planning Rules contribute greatly to HD/Efp due to the following reasons:

1. As it transformed the land ownership from single to collective.
2. As it invariably provided/ attracted human development-prone facilities.
3. It always improved the accessibility to human development-prone facilities of the city by providing good quality roads.
4. It encouraged compact development with good common facilities with less per capita built-up area.
5. It always created bulk development, so that disturbance factor is minus and thus productivity-multiplier value is high.

Apart from a master plan for the Central City Area (1/3rd core area of the Greater Kochi Metropolitan Area), there are 24 detailed town planning schemes which are in its various stages of implementation (Annexure 2).

Global FAR in Cochin Marine Drive Scheme

The Global FAR concept is used in the Cochin Marine Drive Scheme which is successfully implemented by the Greater Cochin Development Authority. The DTP scheme was sanctioned by Government as early as in 1971 for an area of 25.29 hectares, the global FAR adopted being 1.7. The total built-up area permissible throughout the scheme is 1.7 times the area of the scheme which was prudentially distributed to a few plots with compact vertical development resulting in large open spaces, wide roads and recreational areas. The landuse break-up is as follows:
Chapter 6 Ideas, strategies and programs towards better environmental efficiency

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>-</td>
<td>1.6</td>
</tr>
<tr>
<td>Residential</td>
<td>-</td>
<td>3.5</td>
</tr>
<tr>
<td>Residential /Commercial</td>
<td>-</td>
<td>5.0</td>
</tr>
<tr>
<td>Public</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>Transportation</td>
<td>-</td>
<td>0.8</td>
</tr>
<tr>
<td>Park/Open space</td>
<td>-</td>
<td>3.6</td>
</tr>
<tr>
<td>Walkways</td>
<td>-</td>
<td>3.0</td>
</tr>
<tr>
<td>Utility</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Roads</strong></td>
<td>-</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Source: Greater Cochin Development Authority

Global FAR concept improves the land utility which contributes to efficiency HD/EFp as the resources/facilities provided in land are converted from a single ownership to common ownership. This results in better human development-prone facilities at walking distance for many.

**Global FAR provision in the Master Plan**

Although the term global FAR is not used the concept is included in the Structure Plan (prevalent Master Plan for Greater Kochi Central City) through variation effected on 31\(^{st}\) May 2007. By the introduction of clause 4.13 (ix) in which it is mentioned that large scale development proposals in area not less than 2 hectares, exceeding an investment of Rupees 50 crores, which provide direct employment (after commissioning of the project) to the tune of not less than 500 may be permitted in agriculture and developed landuse zones, subject to the recommendation of the committee to be constituted by Government for this purpose. Maximum FAR of two for a minimum access width of 12 meter is permissible.

Although the concept is nearly acceptable on efficiency consideration the clause is to be modified to fit the efficiency index HD/EFp and the proxy efficiency index $\mu \alpha^2 / \beta (1 + \delta)$. This can be achieved by giving compliments for reduced per capita built-up with ample human development-prone facilities under common
ownership and for putting up construction in relatively disturbed area, leaving the ecosystems and agricultural areas undisturbed.

6.8 PRECISE AND OBJECTIVE DECISION-MAKING THROUGH GEOGRAPHICAL INFORMATION SYSTEM (GIS)

GIS integrates hardware, software, data, personnel and procedure for capturing, managing, analysing and displaying all forms of geographic information. It is a technological tool for comprehending geography and making intelligent and smart decisions.

GIS organises geographic data, so that a person reading a map can select data necessary for specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a base map of real-world locations. GIS can be integral to fashioning system-based solutions to our environmental challenges.

Relevance of GIS maps

Creation of traditional paper maps are costly and time-consuming. It is difficult to combine and store large volumes of data associated with the map, while in GIS maps huge amount of data can be added as attribute information, which can easily be retrieved, manipulated, updated and analysed. It is possible to integrate GIS maps with satellite imagery, so that spatio-temporal analysis can effectively be done.

Salient Events in the history of Remote Sensing and GIS

- **Pre200 AD** They neither had computer nor paper, they did have clay.
- **1351** The Medici Sea Atlas is published
- **1441** The World Map is prepared by Fra Mauro
- **1541** Mercator prepares a globe
- **1675** The Royal Observatory at Greenwich
- **1752** Jean Baptiste publishes a map of India
Chapter 6 Ideas, strategies and programs towards better environmental efficiency

- 1767  East India Company establishes Survey of India
- 1802  GTS Survey commences in Madras
- 1930  Survey of India maps are published
- 1957  First National Atlas of India in Hindi
- 1958  NASA is established
- 1966  IIRS is established
- 1969  ISRO is established, ESRI is founded
- 1975  Aryabhatta is launched, NRSA is established
- 1981  ESRI launches Arc/info
- 1982  Insat 1A is launched
- 1983  Insat 1B is commissioned
- 1985  GPS becomes operational, GRASS package is developed
- 1987  TYDAC releases SPANS GIS
- 1988  IRS is commissioned with IRS-1A
- 1989  Intergraph launches MGE
- 1991  MapInfo Professional is launched, IRS-1B is launched
- 1994  IRS – P2 is launched
- 1995  IRS – 1C is launched
- 1996  ESRI India is formed, IRS – P3 is launched
- 1997  CSDMS is launched, GIS@Devpt is launched, IRS – ID is launched
- 1999  IKONOS is launched, Autodesk India Ltd is formed
- 2005  Google has published Google Earth, Cartosat 1 of NRSA is launched
- 2007  Cartosat 2 is launched
- 2008  Cartosat 2A is launched.

GIS Softwares, Available Packages

2. GRASS by OSGeo Foundation (1985)
3. SPANS GIS by Tydac (1987)
4. MGE by Intergraph (1989)
5. MapInfo Professional by MapInfo Corporation (1991)
6. ArcGIS by ESRI

Infrastructure requirements of GIS are Computer Hardware, Software, Geographic data, Personnel and Procedure. Geographic data includes both spatial and attribute information.

**Process in GIS**

Process in GIS involves the following:

1. Procurement of spatial data
2. Projection
3. Geo-referencing and Vectorisation
4. Creation of Topology and Editing
5. Addition of attribute information
6. Analysis
7. Creation of maps and presentation of results

Usual spatial data are either in raster format or in vector format. Sources of data are toposheets, paper maps, satellite data, GPS data from field surveys etc. Toposheets, paper maps etc. are scanned. There are raster scanners as well as vector scanners. In raster scanners data is entered as raster data (in the form of pixels), while GPS data in digital form can be directly entered. Classified satellite data can be entered as raster data, which can be converted to vector format in GIS. Projection involves bringing the data to a common co-ordinate system. Georeferencing involves registering the data to the real world coordinates. Scanned data in raster format can be vectorised/digitised in GIS platform. Once the raster data is georeferenced and vectorised, topology is created to establish the relationship between features. After editing they are stored as shape files, which can be exported to the geodatabase to create feature classes. Attribute table associated with each feature class invariably contains object ID, the shape area and shape length of features. Any number of fields
can be created to which attribute information can be added. Attribute information can be in the form of text, integer data or floating data. Once feature classes are created and attribute information are added, analysis can be done.

Operations involved in different analysis modules available in ArcGIS are geographical analysis, spatial analysis, network analysis, geo-statistical analysis, survey analysis etc. Geographic analysis is also known as vector analysis. There are umpteen number of tools in geographic analysis package such as clip, erase, update, union, intersect etc. Spatial analysis is also known as raster analysis in which data is created in the form of pixels/grids with specified values.

Once analysis is completed, the results can be presented in the form of maps, which can be formed by combining different feature classes in the table of contents associated with the ArcMap.

**Application of GIS**

GIS has versatile applications. Apart from environmental management it can be used for business studies, disaster management studies, pollution studies etc. It is a powerful tool for precise and objective decision-making with great amount of transparency and accountability. The main drawback of developmental decision-making is its arbitrariness and subjectivity which can easily be overcome by GIS-enabled objective decision-making and hence for attaining environmental efficiency application of GIS is invariably required.

**6.9 FORMATION OF ENVIRONMENTAL EFFICIENCY INDICATOR SYSTEM AND 1000 CITIES PROGRAM OF UN-HABITAT**

A serious problem associated with environmentally-efficient development management is the lack of organised data for efficient evaluation and monitoring. There is an urgent need for capacity-building at local level. Collection of data, creation of statistics and formulation of indicators and indices enable monitoring and
evaluation. This, in turn, enable policy formulation and intervention towards better environmental efficiency.

**Indicator Initiatives**

The United Nations Conference on Environment and Development (UNCED), the Earth Summit held in Rio de Janeiro 1992 was attended by 120 heads of state. A large number of documents on various issues concerning mankind and to save the earth were prepared for global action. The action program called upon countries, particularly developing countries, to initiate programs in the area of governance for sustainable development. The program covered various aspects like capacity building, fine-tuning of the existing institutional framework, good governance, need for better policy formulation and improved planning and management of the environment. Initiation of CSD indicators of sustainable development was one of the major outcomes of the UNCED. The key areas of CSD indicator framework are social, environmental, economic and institutional.

In the Habitat II Conference held in Istanbul (1996) member countries committed themselves to implement the Habitat Agenda through policy and plans of action designed at each level in cooperation with all interested partners. All partners were asked to monitor and evaluate their own performance in working towards adequate shelter for all and sustainable development in an urbanising world.

United Nations Centre for Human Settlements (UNCHS), in close partnership with United Nations Development Program (UNDP), World Bank and other organisations conceived and developed Urban Indicators Program (UIP). The emphasis of UIP is adopting a partnership approach involving decision-makers at the government level and stake-holders who have interest in urban development issues. The program was envisaged to be implemented through the setting up of a system of observatories at the global, regional, national and local levels. The key areas of
Urban Indicator framework are socio-economic development, infrastructure, transportation, environmental management, governance and housing.

Setting up of an indicator system for efficiency evaluation at city/metropolitan area and carrying capacity evaluation at the regional level is highly essential for decision-making and policy formulation to guide the development in the optimum path.

**Indicators of Environmental Efficiency**

Some of the indicators which can be evolved from HD/EFp concept towards environmental efficiency are:

**Life expectancy at birth**

- Life expectancy at birth of both male and female
- Death rate due to accidents
- Death rate due to epidemics
- Morbidity rate
- Percentage of people suffering from life style diseases
- Percentage of people dying of cancer

**Adult literacy rate**

- Adult literacy rate of male and female
- Percentage of people well versed in English
- Number of professionals
- Overall skills achievement (swimming, cycling, driving etc)
- Budget Allocation for R&D activities
Chapter 6 Ideas, strategies and programs towards better environmental efficiency

**Gross Enrolment ratio**
- Gross enrolment ratio of male and female
- Enrolment ratio of primary education
- Enrolment ratio of secondary education
- Enrolment ratio of tertiary education

**Per capita income**
- Per capita income from the primary sector
- Per capita income from the secondary sector
- Per capita income from the tertiary sector
- Per capita income of male and female workers
- Workers participation ratio
- Percentage of 60+ and 75+ population

**Per capita energy consumption**
- Per capita energy from hydel power
- Per capita nuclear energy
- Per capita fossil fuel consumption
- Percentage of non-conventional energy
- Transportation trip length and trip time
- Percentage trips by public transport
- Percentage trips by walking and cycling

**Per capita built-up area consumption**
- Built-up area break-up based on use
- Ratio of non-residential to residential use
- Ratio of floor area to built up area of the city (city FAR)
- Percentage of government land
Chapter 6 Ideas, strategies and programs towards better environmental efficiency

- Percentage of occupied land
- Percentage of occupied buildings
- No of high rise buildings

*Some of the proxy indicators of efficiency identified are:*

- Land utility index
- Accessibility
- Per capita built-up area consumption
- Productivity-multiplier value derived from the ecosystem disturbance factor
- Effective space/land utilisation constant of shared communities
- Human development prone facility index of the city
- Per capita floor area to built-up area ratio of the city

Three of the above proxy indicators are used in this thesis for efficiency evaluation and preparation of efficiency map.

There is an urgent need for Greater Kochi Urban Observatory to be formed in line with the Global Urban Observatory Program of UN-Habitat to obtain the infrastructure and methodologies to incorporate efficiency-related indicators to quantify and monitor the efficiency of the development management system. For an application made by the Greater Cochin Development Authority, it is informed by UN-Habitat that the Greater Cochin Development Authority has been certified as a member of the Global Urban Observatory Network by successfully meeting the general criteria for the establishment and implementation of a Local Urban Observatory for the Greater Cochin Metropolitan Area. The said communication is attached as Annexure 5. In India Bangalore Metropolitan Regional Development Authority is a member of the Local Urban Observatory Network of UN-Habitat.
1000 Cities program of UN-Habitat

ESRI and UN-Habitat jointly formed the 1000 cities program in which ArcInfo software is available free of cost to those cities, universities and research organisations which take up Local Urban Observatory and Urban Indicators Program most successfully.

6.10 PROPERTY TAXATION BASED ON EFFICIENCY

Property taxation prevalent in Greater Kochi is often unscientific and arbitrary. For an environmentally-efficient development management system property taxation based on efficiency is a powerful tool to achieve the objective. The formula based on proxy variables to evaluate the environmental efficiency in chapter five holds good for sustainable taxation also.

Efficiency index, $I_e = \frac{\mu \alpha^2}{\beta (1 + \delta)}$

- $\mu$ = land utility index
- $\alpha$ = accessibility index
- $\beta$ = per capita built-up
- $\delta$ = ecosystem disturbance factor of the grid in which the building is located.

In the case of residential buildings efficiency evaluation formula can be further modified to accommodate the effective space utilisation constant.

Concept of effective space utilisation constant of residential buildings

Common facilities provided in apartments or gated communities directly contribute to human development as those facilities are adjacent to residence and the chances of using the facility are more. Usual common facilities attached to apartment complexes are jogging track, swimming pool, health/yoga clubs, shuttle court, basketball court, table tennis, libraries etc., which contribute to health and education.
component of human development. Per capita ecological footprint of common facilities is less as it is under common ownership and the facilities are shared.

Suppose in an apartment complex, there are ‘x’ number of apartments. Individual area of each apartment is \( A_i \) and common area is \( A_c \).

Effective area of each apartment is \( A_i + A_c \), while actual area is \( A_i + A_c/x \),

Effective space utilisation constant = \( A_i + A_c/A_i + A_c/x \)

where,
- \( A_i \), the area occupied by individual apartment
- \( A_c \), the common area of the apartment
- \( x \), the number of units.

**Mode of Taxation, Occupied Buildings**

In the case of occupied buildings property tax charged shall be inversely proportional to the efficiency of the building to encourage people to put up their residence in high efficiency areas which, in turn, inculcate human development with less ecological footprint.

**Mode of Taxation, Vacant Land and Buildings**

In the case of vacant land in high efficiency grids, taxation shall be exorbitant to discourage people to keep the land vacant as it is non-performing.

Similarly in the case of vacant buildings in high efficiency locations, property taxation shall be exorbitant to prompt the landowner to rent it out, so that it shall be contributing to human development with less ecological footprint.

**6.11 SUSTAINABLE FOREST MANAGEMENT THROUGH THE HD/EFp ENHANCEMENT OF METROPOLITAN AREAS AND VICE VERSA**

It is already explained and demonstrated that inefficient development management of cities causes urban sprawl. This causes fragmentation of agricultural land and disturbance to ecosystem which affects the agricultural productivity. When agricultural land becomes less productive people refrain from doing agriculture there
and invade forestland for agriculture and allied activities. This causes disturbance to forest ecosystem through fragmentation.

Going through the literature it is reported that the forests are among the first casualties as human population explodes. It is scientifically established that fragmentation of shrinking of forests into smaller patches honeycombed with human settlements, highways, dams, mines or developmental projects is the most serious threat to bio-diversity and forest conservation. When a large block of forest gets fragmented the edges of all the bits come into contact with human activities, resulting in the degradation of the entire forests. As continuity of forested landscapes and corridors getting disrupted, populations of single species and the composition of entire animal communities are affected. Rare inferior forest species are replaced with common, adaptable ‘trash’ species of plants and animals (Bharghav, 2007). A study on the ‘Deforestation in parts of Western Ghats Region (Kerala)’ (Chattopadhyay, 1985) reports that there is substantial depletion of forestland. 1905 estimate of 44.4% area under forest vegetation had declined to 27.7% by 1965 and 17.1% by 1973 and 14.7% by 1983. Achieving sustainable forest management results in a better biocapacity of the supporting region. This, in turn, again contributes to HD/EFp of the metropolitan area as the region becomes highly productive.

It is learnt that a sum of Rs 5000 crore corpus fund collected by imposing levies on many development projects in forest areas is available with Ministry of Environment and Forests, Government of India under the head CAMPA (Compensatory Afforestation fund Management and Planning Authority). Bharghav.P opined that disturbance to the forest ecosystem cannot be compensated by planting in nearby grasslands the exotic species such as Acacia, Eucalyptus and Casua rina, as it end up in destruction of two natural habitats.

Sustainable forest management can be effectively achieved by achievement of environmental efficiency of metropolitan areas as it curbs urban sprawl and invasion of forestland. This, in turn, again contributes to HD/EFp of cities due to Bc/EFp enhancement of the supporting region.
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