CHAPTER 7: METHODOLOGY FOR INTEGRATED ASSESSMENT OF RURAL SUSTAINABILITY LINKAGES FOR ENHANCEMENT OF IMPACT ASSESSMENTS

“The person who knows most about the village ecosystem is not a Harvard, MIT, Cambridge or even Delhi University professor, but the villager himself” --Anil Agarwal (OECD, 2001).

This chapter presents a methodology to understand and assess the Sustainability (ecological, social, physical and financial) linkages of various livelihoods in a rural community in an integrated manner to strengthen the scoping stage for projects in rural areas. The methodology relies on local knowledge and perception and employs cognitive mapping to understand the linkages and derive a detailed list of indicators. Indicators derived from linkages are then developed into a questionnaire to record information regarding indicator status/ trend (positive/ negative) and its spatial property (where is it found?). The utility of the methodology in preparing the Sustainability linkage document is illustrated with the example of an Indian village.

7.1 Introduction

Over 740 million people in India live in around 630,000 villages fully dependent on the environment for their livelihoods. With the increase in industrialization projects are cleared through the EIA process without adequate safeguards to protect the rural environment. The situation of EIA in the developing countries is far from satisfactory as the EIA systems are yet to fulfill its procedural requirements and are yet to provide effective environmental protection as economic considerations dominate (Wood, 2003, Briffet et.al, 2003; Momtaz, 2002; Turnbull, 2003; Rajaram and Das, 2006). This chapter presents the methodology, which is useful to understand and report the linkages, which
the rural communities have with the ecosystem and the economy for their livelihoods based on local knowledge and perception.

This chapter presents the following: section 7.2 details the new scoping provision in India’s EIA process and the need for considering the ecological, social and economic linkages in rural agro-ecosystems; Section 7.3 presents the methodology to understand the linkages through cognitive mapping and assess its sustainability through a questionnaire with the example of a typical Indian village; section Section 7.6 discusses the information uncovered by the methodology, functional aspects of linkages and the implications for environmental assessments and section 7.7 presents the conclusions.

7.2 EIA and Sustainability of rural Linkages

7.2.1 EIA process in India

As the detailed analysis of India’s EIA system under EIA Notification 1994 is available in chapter 3.0 (also refer Rajaram & Das, 2006), it is discussed briefly along with the changes brought in by EIA Notification 2006. In India slow pace of development is cited as the factor which will slow down economic growth in the coming years and EIA is seen as causing the major delay. The EIA system is still a long way from adhering to procedural provisions considered to be good practice, social impacts are largely ignored, post approval monitoring is poor due to lack of resources and the environment around industries in India is heavily polluted (Blacksmith Institute, 2006; Greenpeace, 1999; Rajaram and Das, 2007a). The assessment of India’s EIA system under notification 1994 against Wood’s (2002) criteria can be found in Chapter 3.0 (also refer Rajaram & Das, 2006). The re-engineered EIA process 2006 (MEF, 2006) has introduced a scoping stage and devolved the authority to grant clearance to state level committees for projects of lesser capacity and impact potential. However procedural deficiencies found in the previous notifications such as reduced scope for public participation remain. Though the
MEF had invited comments on draft EIA 2006, it failed to disclose the comments received/considered. Instead it is alleged to have collaborated only with the Industry to come out with its final version (Ghosh, 2006; Menon and Kohli, 2007).

7.2.2 Scoping provisions in India’s EIA Process

It is well acknowledged that an EIA study based on poor scoping is doomed from the start (Weston, 2000; Mulvihill, 2003; Wood, 2003). The first provision for scoping was provided in the EIA notification 2006 which requires the applicants to submit information in a prescribed Form-I (MEF, 2006) to the expert committee along with the proposed terms of reference (TOR), which will then decide the final TOR within 60 days from the receipt of Form-I. Though involvement of public at scoping stage is considered to be unnecessary by the developers, and the cause of opposition against the project before any study (Wood et. al, 2006), the scoping stage gains more importance in developing countries like India where reliable bio-physical information regarding the location under scrutiny does not exist. Hence it is imperative at the scoping stage to gain proper understanding of the ecological system to deal with difficult questions regarding equity and sustainability which the proponents are disinclined to address (Mulvihill, 2003). The EIA process in India which hinges on the scoping stage gains more importance as in the face of liberal economic policies pursued by India, around 530 special economic zones (SEZs) have been approved involving 67000 hectares of land in rural areas till December 2008. Due to ineffective EIA process and impartial understanding of diverse linkages the local populace has with the land, there is widespread conflict over the extent of impact and issue of compensation. Hence the need for a methodology which can document the linkages to not only enhance the scoping and TOR by the authority, but also for the NGOs and the local population to articulate their
interests in order to safeguard their ecological linkages as legal battles become commonplace.

7.2.4 The need to understand linkages

The significance of sustainability linkages was established in Chapter 6. For the sake of continuity it is repeated here in brief. The link between the ecosystem and the poor is clear and the potential of income from ecosystems (environmental income) in contributing to the economic empowerment of the rural poor is very high (WRI, 2005, pp3) and numerous studies have established the importance of ecosystem goods and services as the crucial assets of poor households (MA board, 2005, pp. 49, WRI, 2005, pp-16). It is necessary to appreciate the fact that due to small ecological footprints in developing nations, even small impacts in magnitude can cause disruption in livelihoods.

Frugal lifestyles are often confused with poverty and their significance in terms of achieving sustainability is not considered in techno-centric environmental assessments (Rajaram & Das, 2007b). As Jay et. al (2007) point out “The continuing aspiration that EIA should contribute to the wider endeavour of bringing about sustainable development has provided EIA with its most strategic sense of purpose but this has not been translated clearly into EIA frameworks, principles or methodologies”. If EIA is to contribute towards sustainable development, understanding and identifying human livelihood patterns which are in sync with nature and functioning in a sustainable manner becomes a priority.

In developing nations like India environmental assessments will be more effective when it is carried out in an integrated manner involving the social component which interacts and thereby decides the sustainability of the ecological component. Hence the need for a method which can assess the ecological-social coupled system in an integrated manner. The function evaluation framework presented by Slootweg et al (2001) effectively guides
assessments towards thinking that biophysical changes and social change processes are interlinked and only through serious consideration of both can we arrive at the full range of impacts. We point out that it is effective to use local ecological knowledge to understand the way ecological functions are derived in a particular area in developing countries short on EIA expertise, unlike the function evaluation framework which puts the onus on the expert and directs his/her thinking. It would be appropriate to state that the conceptual basis for the proposed methodology tends more towards Mode-2 science which is academic and social, trans- and interdisciplinary, participative, uncertain and exploratory unlike Mode-1 science which is academic, Monodisciplinary, technocratic, certain and predictive (Gibbons et. al, 1994 and Martens, 2006 as quoted in Kemp and Martens, 2007).

7.2.5 How can the linkages be understood and communicated?

It is well acknowledged that Local knowledge is important to understand the local linkages (MA Board, 2005: 98; Berkes et al. 2000; Cundill et al., 2005; Folke 2004) and its potential to add value to impact assessments is recognized (Wiles et. al 1999; Palerm and Aceves, 2004). By giving primary standing to the local knowledge and perceptions we can hope to improve current expert centered approaches towards sustainable development which is ‘criticized as “a new class version of managerialism that functionally serves to globalize and perpetuate the techno-managerial elite’s control over everyday life” and in so doing is antisocial’ (Roe, 1998 as quoted in Kemp and Martens, 2007).

The methodology was aimed at answering the following questions needed to understand the linkages and their status:
• What is the ecological structure of the area under scrutiny i.e. what are the primary ecological components that enables the sustenance of social component and how the society is organized into livelihood groupings? and

• How is the social component linked with the ecological component to derive its sustenance?

• Are there marginalized groups and what are their linkages with the dominant social and ecological components?

• What is the status of the linkages and its trend with respect to long term sustainability of the system?

• How are the linkages distributed in terms of its spatial occurrence?

• What is the functional aspect of the linkages: internal and external linkages, hierarchy of linkages, interaction between livelihoods, means of access/ level of entitlement to resources, temporal aspect of linkages, ongoing interventions and ecological changes?

7.3 Rural linkages assessment methodology: Example of an agro-ecosystem

The methodology followed in the generation of rural sustainability linkage document (SLD henceforth) is shown in figure–7.0. Three villages in the Perambalur block were selected for the preliminary study of understanding the overall linkages in the area i.e. Kalarampatti, Ammapalayam and Ladapuram. The study villages are situated in Perambalur block of Perambalur district (State of Tamil Nadu, India, 78°44’23”E and 11°12’51”N). The overall map of the study area is shown in figure-7.1. These villages are situated adjacent to a hilly range covered with dense to sparse vegetation declared as reserve forests by the government with strict prohibition of entry/ extraction of timber and grazing. The soil is of red loamy type which is considered to be suitable for cultivation of crops such as onion and groundnut which require loose soil. The surrounding hills form a healthy watershed replenishing the manmade lakes & ponds and thereby the groundwater in the area.
Figure 7.0  Methodology for generation of Rural Sustainability Linkage Document

Figure 7.1  Map of the Study Area
7.3.1 Linkage elicitation through cognitive mapping

As the second step, the village of Kalarampatti was selected to carry out the detailed study of linkages. The population of the village is 3132 and the literacy rate is 66.5%. Farming, farm labour and goat/sheep herding are the main livelihoods. The profile of the village is given in table 7.1 and the ecosystem profile of Kalarampatti village is shown in figure-7.2. The detailed study was carried out through cognitive mapping of each livelihood and its linkages, preparation of questionnaire from cognitive maps and elicitation of status and zonal linkage of each component indicator. Cognitive mapping was carried out with individuals/ groups involved in each livelihood category (non-random purposive sampling) - one focus group each for farming & labour and two individual interviews for Goat/ sheep herding. Totally sixteen cognitive maps were drawn (four for each livelihood and twelve for various sustainability components and sub-components) which formed the basis for extraction of indicators (appendix-B) and formation of questionnaire.

The livelihoods, Sustainability components and sub-components taken up for cognitive mapping are listed below:

<table>
<thead>
<tr>
<th>Livelihoods</th>
<th>Sub-components for Natural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming – Irrigated</td>
<td>Land</td>
</tr>
<tr>
<td>Farming – Rainfed</td>
<td>Water</td>
</tr>
<tr>
<td>Sheep/ Goat Herding</td>
<td>Fertility-Pests</td>
</tr>
<tr>
<td>Farm Labour (Marginalised)</td>
<td>Farm practices</td>
</tr>
<tr>
<td><strong>Sustainability Components</strong></td>
<td></td>
</tr>
<tr>
<td>Natural / Ecological</td>
<td>Livestock</td>
</tr>
<tr>
<td>Marginalised Section</td>
<td>Energy</td>
</tr>
<tr>
<td>Social</td>
<td>Biodiversity</td>
</tr>
<tr>
<td>Physical</td>
<td>Forest</td>
</tr>
<tr>
<td>Financial</td>
<td>Monitoring</td>
</tr>
</tbody>
</table>
Table 7.1: Profile of Kalarampatti Village

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under panchayat (Ha)</td>
<td>973.75</td>
</tr>
<tr>
<td>Cultivable farmland (Ha)</td>
<td>707.54</td>
</tr>
<tr>
<td>Population (2001)</td>
<td></td>
</tr>
<tr>
<td>Total (Male/ Female)</td>
<td>3132 (1522/ 1610)</td>
</tr>
<tr>
<td>Marginalised (male/ female)</td>
<td>1449 (696/ 753)</td>
</tr>
<tr>
<td>Housing - Total</td>
<td>1097</td>
</tr>
<tr>
<td>(Thatched/ tiled/ RCC/ Row-tiled)</td>
<td>(458/ 307/ 261/71)</td>
</tr>
<tr>
<td>Farming wells (open dug well)</td>
<td>550</td>
</tr>
<tr>
<td>Drinking water</td>
<td></td>
</tr>
<tr>
<td>Dug Wells</td>
<td>12</td>
</tr>
<tr>
<td>Handpumps - mark 2</td>
<td>26</td>
</tr>
<tr>
<td>Pumpsets</td>
<td>3</td>
</tr>
<tr>
<td>Deep borewell pumpset</td>
<td>1</td>
</tr>
<tr>
<td>OverHead Tanks</td>
<td>3 ( 2 Nos- 100,000 litres &amp; 1 No. 60,000 litres)</td>
</tr>
<tr>
<td>Public Water Supply taps</td>
<td>68</td>
</tr>
<tr>
<td>Private House connections</td>
<td>149</td>
</tr>
<tr>
<td>Roads (km)</td>
<td></td>
</tr>
<tr>
<td>Water Bound Macadam</td>
<td>2</td>
</tr>
<tr>
<td>Bitumen black top</td>
<td>4</td>
</tr>
<tr>
<td>Cement</td>
<td>2.5</td>
</tr>
<tr>
<td>Gravel</td>
<td>2.6</td>
</tr>
<tr>
<td>Lakes (area irrigated in Ha)</td>
<td>1 (183 Ha)</td>
</tr>
<tr>
<td>Ponds</td>
<td>6</td>
</tr>
<tr>
<td>Schools</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>2</td>
</tr>
<tr>
<td>Secondary</td>
<td>1</td>
</tr>
</tbody>
</table>

The time required for preparing the rural sustainability linkage document consisting of cognitive maps and filled in questionnaire for a village can range from 2 to 3 weeks depending on the ecological & social complexity and co-operation from village council and inhabitants. In the reported study only the author was involved along with a facilitator from the village studied for the preparation of the cognitive maps. The coverage of various stakeholders was ensured by first preparing the rural linkage structure of the village studied (left side box in \textbf{figure-7.1}), which indicates the basic ecological components and social groupings in terms of livelihood. Then participants were selected from each livelihood category to ensure complete representation. Participants from each livelihood grouping were approached through the facilitator from the village.
Focus groups were used for farming and agricultural labour (marginalised) categories as it was easy to engage informal gatherings of such groups near tea shops and temples in the evenings after work. Individual interviews were used for livelihoods such as goat herding since they constitute a minor segment of the population and it was easier to approach them during the day when the goats were grazing. Depending upon the various livelihoods found in a particular village focus groups can be applied for major segment of the populations and individual interviews for livelihoods which might constitute a few families.

Cognitive mapping was found to be appropriate to understand ecological linkages both through focus group discussions and individual interviews. The method of cognitive mapping was very useful in this context as the participants were just required to describe

**Figure 7.2 Ecosystem Profile of Kalarampatti with watershed zones**
their linkages with the ecological, social, financial and physical components in their day
to day life. Mendoza and Prabhu (2006) report that “Cognitive maps (CM) were first
introduced by Axelrod (1976) as a way to represent complex decision problems
composed of dynamic entities which are interrelated in complex ways, usually including
feedback links”. They further elaborate that, CMs are essentially structured ideas with
nodes representing complex entities with arrows indicating links and direction of
influence. Among the cognitive maps the one made for sheep/goat herding is shown in
figure – 7.3. The cognitive maps were drawn by the author as the linkages with the
natural, social, physical and financial components were narrated by the participant/s. For
example for the map given in fig. 7.3 for goat herding, the main components as identified
by the participant/s (shaded boxes) are drawn first on a sheet of paper. Then as the
factors which influence these main boxes are listed out they are added around them and
finally arrows are drawn to connect all the boxes (with the arrows indicating the
direction and type (+/-) of influence). Brief notes regarding the current status are added
in the boxes along with separate additional notes regarding the range of influence
possible among these interconnections.

From figure-7.3, it can be seen that farming status (top right hand corner) influences the
amount of land left fallow which in turn affects the extent of land available for grazing.
Hence following the direction of arrow from grazing area it can be understood that
grazing area influences the herd size, which in turn affects the income of herders and in
turn the health care they can afford. This way starting from any component we can derive
detailed understanding about how various components are interlinked and how the
impact of an activity on any component (box) will affect the other components linked to
it in the cognitive map.
Figure 7.3 Cognitive Map for Goat/Sheep Herding
When fallow land is converted for any other non-agricultural use (for ex. Industrial), the impact pathway follows the same direction as explained above in addition to various other pathways. Further the components and the factors that influence them as shown in the map are listed down as indicators (refer indicators under Goat/sheep and Grazing of Livestock category in Table-7.2) to derive their current status and zonal linkage in the questionnaire.

Cognitive mapping of stakeholders enhances the participatory component of resource management by considering their experience without the imposition of expert’s opinions/perceptions. The mapping was mainly conducted in the afternoon and evenings when the participants were resting after work. To facilitate detailed understanding of the spatial distribution of the linkages, the area surrounding the village was divided into five zones on the basis of a unit watershed (refer figure-7.2). Depending upon the ecosystem profile of individual villages the area can be divided into four or more zones. Assessment at the watershed level provides a logical basis to divide an ecosystem and also monitor degradation due to any project and release of contaminants at the identifiable outlet. The study was conducted intermittently between August 2006 to June 2007 and tools used in the study were toposheets prepared by Survey of India in the scale of 1:50,000 and freely available satellite imagery from Google Earth. The interaction was fully conducted in the local language Tamil and the social data was collected from the village panchayat office.

Marginalised group: Among the various livelihoods the marginalised section contributing agricultural labour represent the outcastes of the society in every agrarian village in India and are officially designated as scheduled castes. This section which has been oppressed for centuries and forced to work under near slavery conditions pose the greatest challenge to social equity in India. In this village the marginalised population comprise 46% of the total population and around 60% of it depends only on agricultural
labour. Despite abolition of untouchability and caste based discrimination by the
constitution of India in 1950, it is still a part of rural India. A major proportion of this
population engages in casual labour, tends to 4-5 heads of goats, farms in marginal rain-
fed holdings and engages in contract farming. They depend on the fallow lands, road side
vegetation and lake bed pasture for grazing their goats and to collect firewood.

7.3.2 Rural Sustainability Linkage Questionnaire (SLQ): what is the status of the
linkages and its spatial distribution?

The cognitive maps were used as a base to generate a list of indicators which were then
framed into a questionnaire divided in terms of sustainability components i.e., natural,
marginalised, social, financial and physical components. Indicators were grouped based
on their relationship in individual sub-components. Hence the livestock sub-component
under natural component will contain indicators pertaining to the price trend of milk and
also veterinary infrastructure. The marginalised community is treated as a separate
component to highlight its importance in the quest for overall sustainability of the
ecological system.

Published literature in the area of rural agricultural sustainability (Paudyal et al., 2005;
Rao and Rogers, 2006; Rigby et al., 2000; Rodrigues et al., 2003) was also reviewed to
cross check the completeness of the sub-components and indicators identified. The SLQ
was filled through one focus group for farming, two persons for goat/sheep herding and
one focus group for marginalised labour. This minimal sampling is effective at the
village level as information regarding both positive and negative aspects of linkage status
were actively shared among the inhabitants of the village and hence justified as a rapid
exercise to generate information for scoping.
The format of the questionnaire was framed with the objective of understanding the linkages in terms of its current status (positive, neutral and negative) and its spatial property (where is it found?). Since efforts towards sustainability has to be rooted in the local culture of resource use and perception of its importance, it is essential to understand its trend of availability and use before trying to judge the impact of an intervention on the existing scenario. The extract of questionnaire as given in table-7.2 was designed to take advantage of both qualitative and quantitative data.

Table- 7.2: Format of Rural Linkage Questionnaire

<table>
<thead>
<tr>
<th>Sub-Component : Livestock</th>
<th>Indicators</th>
<th>Range/ of Indicators</th>
<th>Zonal linkages</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HP</td>
<td>P</td>
<td>NU</td>
</tr>
<tr>
<td>Grazing</td>
<td>trend in area of permanent pasture</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>access/ mgt of pasture</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>range quality</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Access to forest range</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>seasonal pasture (months accessible/ year)</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>lakebed (months accessible/ year)</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Rain-fed cropland (months/yr)</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Roadside vegetation (quality)</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>conversion of seasonal pasture-% (last 10 yrs)</td>
<td>5</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>disputes regarding grazing</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>pressure from external herders</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>water for livestock</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: HP-Highly positive, P-Positive, Nu-Neutral, N-negative, HN-Highly negative, H-High, M-Medium and L-Low.

The current state of a particular indicator was noted in terms of its trend (+/-) with respect to sustaining the livelihoods on an average in the last 5 years. They were assigned numerical scores corresponding to their qualitative status such as neutral (given a score of 0), positive (+0.3), highly positive (+0.5), negative (-0.3) or highly negative (-0.5). For example as given in table-7.2 access to rain-fed farm land when it is fallow is an important indicator of grazing sustainability, access is quantified in terms of months/year with 8 months in a year classified as highly positive (though it indicates reduced cropping and negative for rain-fed farming livelihoods) and 7, 6, 5 & 4 months as
positive, neutral, negative and highly negative respectively. Where such quantifications were not possible, for example the quality of roadside vegetation for grazing, status of indicators were assigned numerical values ranging from +0.5 to -0.5 depending on their status as explained above. It is pointed out that though assigning status indicators (highly positive, positive, etc.) was based on the opinion of the village residents, assigning quantitative ranges such as considering 60% adoption of natural pesticides as highly positive is very much based on the author’s judgement rooted in local perception and is open to debate and adaptation to different situations and benchmark of sustainability targeted i.e., strong sustainability or weak sustainability.

A simple bar graph was chosen to represent the status of indicators in terms of its numerical score (+0.5 to -0.5) for sub-components as it was more effective in communicating the meaning to village residents and council members in comparison with a radar diagram which is more popular among researchers. It was found that individuals from all levels of literacy found the simple bar graph with positive indicators above the x-axis and negative indicators below the x-axis easy to understand the overall status it was built to convey (refer figure-7.4).

Figure 7.4 Status of Indicators and Zonal Linkages for Water
The questionnaire also required the participants to indicate the association of each of the watershed zones with the indicator in terms of high, medium and low linkage (table-7.2). This information can indicate the relative importance of the different zones with respect to ecological linkages. The cognitive maps for various livelihoods and sustainability components and the linkages represented by these maps are discussed in detail in the following sections.

7.4 Cognitive mapping, status and zonal linkage of indicators

7.4.1 Cognitive mapping of Farming-1 (irrigated)

The cognitive map of past & current socio-ecological linkages for irrigated farming is shown in Figure-7.5. From this map it can be clearly understood that the linkages have increasingly become external for fertilizer instead of internal organic sources like cow dung manure & green manure. The main reason for this trend is attributed to the difficulty in finding farm labour, which is attributed to a changed preference among the marginalised community to rather migrate to work in cities for increased pay under less oppressive environment. As agricultural labour has become scarce, activities like ploughing, transporting and threshing grains with bullocks have been replaced with machinery. But the sustainability contribution of bullocks which ate the crop residue providing their energy for farm activities and dung as organic manure are yet to be replaced. The initiatives of forest department to regenerate the forest cover in the surrounding hilly ranges by imposing a total ban on fuel wood and green manure extraction has further reduced the availability of organic manure. Then ban on grazing of goats in the forest area has resulted in decrease in goat herds and subsequent fall in on-field manure application.

The scarcity of labour has affected the farming system in the following ways: increased choice of crops with less labour requirement like onion which do not provide fodder for
livestock; green manure though available in trees around the farm are not extracted for field application; increased use of weedicides than hand weeding; reduced number of cows/ buffaloes to manageable one or two per family which also reduces dung manure and increased tendency to leave large portions of farmland fallow as spending on scarce labour increases losses in the event of frequent price crashes for produce. The other key factors which have increased external dependency include seeds which have to be bought from private agencies; pumping equipment which would have become unviable but for the free electricity provided by the state government to run them and increased use of pesticides. These increased external links have resulted in the importance of pre-planting credit which is not sufficiently available through banking institutions. Farmers have to rely on informal lending sources at steep interest rates which due to frequent crop losses or price crashes lead to indebtedness. Lack of storage facilities with the farmers and the marketing agents affects the ability to store produce in times of low prices resulting in low profits and at times losses.

The components relating to social and financial aspects for this livelihood is not shown in the cognitive map for the sake of not complicating it further, but is discussed in this paragraph. The population dependent on this livelihood category is at the top in terms of socio-economic indicators for the village. The only objective pursued is to educate the children till the undergraduate level at least to enable them to integrate into the mainstream urban economy. Even land holdings are liquidated or mortgaged to secure funding for education. The dominant section of the village comprising of large landholders have all but vanished owing to their children having settled in urban cities. This short term focus on elevating their children out of the farming profession is a factor which negates long term sustainable practices of farmland.
Further there is a sub-group in this category which does not have an electrical connection and hence depend on diesel pump sets which change the profit loss equation substantially.
due to high cost of fuel. These are farmers who are on waitlist for free farm connections which stretches way back to 1980s. The sub-components such as water, land, fertility which are linked to many other factors were mapped separately to arrive at indicators which form the questionnaire.

7.4.2 Cognitive mapping of Farming-2 (rain-fed)

The external linkages discussed for farming-1 are all applicable to this category also and are not repeated here. The cognitive map for farming-2 is shown in figure-7.6. The distinguishing feature of this group is the absence of irrigation facilities i.e. dug well and pumps. Since most of the holdings are very small and held by socially marginalised section, they cannot afford to dig a well and install pumps. The location of these lands mostly upland from lakes/ponds increases the cost of dug wells as they need deeper wells to reach the water table than lands located downstream of lakes/ponds. Those farms which have shallow wells (6-15 feet/2-5 m) are dry most of the year and thus effectively rely on rainfall for farming. Banking institutions do not extend credit as the land size is not attractive as collateral. Income from these rain-fed farms is invariably less owing to erratic rainfall and inability to spend for quality inputs. Lack of quality fodder affects the option of relying on cows/buffaloes which are restricted to one/two maintained through grazing on fallow land and lakebed pasture. Low return from this livelihood obviously pushes this group to the bottom of development indicators such as: access to adequate nutrition, health care, education and social status.
Figure 7.6  Cognitive Map for Rainfed Farming
7.4.3 Cognitive mapping of Goat/Sheep herding

As shown in figure-7.3, this category mainly depends on availability of grazing lands. The grazing area have been drastically reduced owing to the following changes: denial of forest access, conversion of fallow land to farm land and conversion of rain fed land to irrigated land. Hence the remaining herd of about 500 numbers (down from 5000) rely on grazing on lakebed when there is no/ less water, farm land left fallow, rain-fed land when it is not cultivated and roadside vegetation. Further for these remaining pastures they have to contend with grazing cattle, external nomadic herds which also pass on diseases to native herds adding to the difficulty. Most of the families have changed their livelihoods to work as casual agricultural labour. Credit from banking institutions is non-existent in the absence of collateral. Loan allotment through government welfare schemes are allotted based on political preference than on need. Veterinary expenses are difficult to bear for families owning just 5-10 heads of goat. With no avenue of growing their food they are fully dependent on ration shops for subsidized food grains and kerosene. Children normally reach upto 10th standard in school and without ability to afford private tuitions usually fail the public exams and dropout.

7.4.4 Cognitive mapping of Agricultural labour (marginalised)

They represent the outcastes of the society in every agrarian village and are officially designated as scheduled castes. This section which has been oppressed for centuries and forced to work under near slavery conditions pose the greatest challenge to social equity in India. As shown in the cognitive map for farming-1 (figure-7.5), this section of a village population is the lynchpin of farming system. The cognitive map for this section of population is shown in figure-7.7.
In this village the marginalised population comprise 46% of the total population and around 60% of it depends only on agricultural labour. The male labourers were usually loyal to particular families for generations carrying out tasks ranging from tending to cows, buffaloes, bullocks, ploughing the land, drawing water from wells with bullocks, irrigating the land, harvesting and threshing and transporting the grains in bullock carts to the market. Apart from these activities a sub-group among them are entrusted with the job of cremating the dead from all sections of the village society and disposing of cattle carcases after removing the leather for processing. They were kept on a tight leash justified with religious dogma which held that they were suffering for their sins from previous lives and good conduct in this life alone can elevate them in next birth. Even
today their living quarters are outside the main village with separate sources of water, temples, and burial grounds and are prohibited to cycle/ ride through main streets. Despite abolition of untouchability and caste based discrimination by the constitution of India in 1950, it is still a part of rural India (HRW, 2001).

Hence the younger generations of this category who get schooling at least upto high school prefer to migrate to cities for work even if it means living in slums but minus the oppressive conditions of the village. Still a proportion of the population engages in casual labour, tends to 4-5 heads of goats, farms in marginal rain-fed holdings and engages in contract farming. They depend on the fallow lands, road side vegetation and lake bed pasture for grazing their goats and to collect firewood. Apart from farming, few options are available for employment such as the rice mill in the village and construction works. Though the government run schools provide free education, noon meals, books and uniform; the quality of education provided is not enough to get them through the public exams of high school and higher secondary.

The cognitive maps of each category was used as a base to generate a questionnaire divided in terms of sustainability components i.e., natural, marginalised, social, financial and physical components. However sub-components and indicators were grouped based on their relevance from the sustainability point of view rather than strict segregation based on their nature. Hence the livestock sub-component under natural component will contain indicators pertaining to the price trend of milk and also veterinary infrastructure. The marginalised section is treated as a separate component to highlight its importance in the overall sustainability of the socio-ecological system.

7.4.5 Cognitive maps for natural components

The cognitive maps for sub-components of natural component i.e. water, land, fertility-pests, farming practices, livestock, energy, bio-diversity, forest and monitoring, are given
in section 7.5. Indicators for the sub-components were derived from these cognitive maps. These maps also provide important information regarding the relationships among various factors in each of the sub-components.

7.4.6 Cognitive maps for Social, Financial and Physical components

Cognitive maps were drawn for social, financial and physical components to understand the linkages these components have with internal and external factors and to derive the list of indicators. The cognitive maps for social, financial and physical components are given in Section 7.5.3.

7.5 Status and linkage of sustainability components

The results of SLQ for the village of Kalarampatti are discussed in detail in the following sections. The entire questionnaire containing the status of indicators and zonal linkages is given in Appendix-B.

7.5.1 Natural Component

7.5.1.1 Sub-Component: Land

Status of indicators: The cognitive map for Land is given in figure-7.8. The land resource in the village is highly suitable for farming. The top soil cover is adequate ranging from 1.0 to 1.5m. Majority of the farms (80%) are equipped with irrigation source (lake/ well). The area under double cropping is around 70%, which are mostly downstream of the lake, whereas the single crop farms border the foothills where it is much expensive to develop a dug well owing to its raised elevation. The land use has been stable with negligible loss of farmland to residential use. However in recent years a major proportion of land which was fallow near the foothills has been converted to farmland, thus increasing the area under agriculture.
The negative aspect of land has been the area of farm holdings which have been decreasing due to fragmentation among the family members. Currently the majority of holdings are around 2 acres or less. The other negative trend is the per capita availability of farmland which has been decreasing even at the national level owing to increase in population. The per capita farmland availability in the village stands at 0.76 acres and the land is well protected from severe weather events by the surrounding hilly range, with flooding of farmland during monsoon the only occasional risk. The overall status of indicators for land is shown in **figure-7.9**.

**Zonal Linkages:** As shown in **figure-7.9** all the zones i.e. ABCDE exhibit high to medium linkages with respect to the main farming activity. Zone D represents the important area with respect to irrigated highly productive land along with portions of zone C. The zones CDE have the major portion of well irrigated farmlands which are under double cropping. Single cropped rain-fed land mostly borders the foothills of Zones A & D on their western side.

![Figure 7.8  Cognitive map for Land](image-url)
Figure 7.9  Natural Components – Status of Indicators and Zonal Linkages
(for indicator list refer appendix B)
7.5.1.2  Component: Water

Status of indicators: As shown in Appendix-B and figure-7.9 the village enjoys a relatively abundant water resource in the district. This is mainly due to its first use of the water streaming down the watershed of the surrounding Palamalai range. Hence after a good monsoon the village is able to sustain itself through the recharged groundwater for the next two years even on below average monsoon. Though the groundwater is available, the depth of dug wells plays an important role in deciding the quantity that will be available for extraction. As developing a dug well of about 40 feet involves expenses in the range of INR 300,000 (USD 7500), it is beyond the reach of small and marginal farmers who depend on rain fed farming alone. The extent of rain-fed farmland is about 20% of total cultivated land. The cognitive map for water is shown in figure-7.10.

Figure 7.10  Cognitive Map for Water
With the monsoon’s increasing erratic nature, about 2-3 years of below average rainfall is interspersed between good monsoon years. As this brings down the water table, the farmers resort to deepening their wells in order to reach adequate quantity of water. The average depth of dug wells stands about 40 feet. Small and marginal farmers with wells of depth 10-20 feet who cannot afford to deepen their wells are severely affected by this fluctuation in the water table.

The negative indicators are the trend in water use, which has not improved with the farmers still adopting the traditional method of flooding the whole plot to irrigate it. Very few farms have internal pipes to take their water to individual plots, the water flows through unlined channels from the well upto the plot to be irrigated. The adoption of drip/sprinklers is very negligible owing to the availability of groundwater. Testing water for its quality is not practised and quality judgement for its use is mainly made by its taste alone. There is no program for monitoring the waters for pesticides or inorganic nutrients. The main lake does not show any signs of nutrient loading as the catchment area does not contain intensive double crop land. The two ponds in the middle of prime agricultural land show signs of nutrient loading and eutrophication as result of farm runoff and its use for washing cattle, clothing, bathing, etc.

**Zonal Linkages:** The zonal linkages for water are shown in Figure-7.9. The zones ABC form the important linkages as they are the main catchment areas for the lake and subsequent ground water recharge. Major portions of these zones consist of reserve forests, with zone B being the important one in terms of drainage area and stream order. Farming activities of hill communities at the upper reaches of the catchment is an important factor affecting soil erosion and subsequent silting of channels and the lake. As the hill communities are still engaged in subsistence farming, farm runoff consisting
of pesticides and nutrients is not a major concern yet. The zone D constitutes the prime agricultural area owing to its lower elevation and downstream location with respect to the lake. This allows wells of relatively lower depth access water throughout the year. Zone E does not contribute much to the main water system of the village, but caters to the farmland in that zone through recharge and rainfed farming.

### 7.5.1.3 Fertility & Pests

**Status of indicators (Fertility):** Fertility as a sub-component best illustrates the changed scenario of farming altogether in the village. The status of indicators for fertility and pests are shown in Appendix-B and Figure-7.9. The cognitive map for fertility-pests is given in figure-7.11. Moreover the indicators listed under fertility captures the complex linkages which were present between the indicators and the ecosystem and also among them. It also brings to light the social scenario which was responsible for fostering the links and as a result the present decadence in the linkages mainly due to the changed social scenario in the village community. As shown in figure-7.9, the numerous linkages are a classical example of how the village community had created linkages with the available ecosystem components to increase the sustainability of their farming systems by reducing the need for external inputs. The organic manure was met from two sources i.e. livestock and vegetation. The cattle population comprising of atleast two bullocks and 2-3 cows/ buffalos per household were dependent on crop residue, grazing areas and fodder from farm. The large land holders typically possessed about 20-30 heads of cattle. These cattle were maintained by agricultural labourers from the marginalised community who were mainly paid in kind i.e. grains, cooked food on festive occasions and clothes.
The migration of younger generation of marginalised communities to better jobs in government to a lesser extent and to urban areas to a large extent has contributed to the paucity in the availability of farm labour. This has given rise to increased patronising of mechanised ploughing, harvesting, threshing; reduced practice of adding lake sediments onto farmland; use of fertilizers in place of organic manure and use of weedicides in preference to manual de-weeding. A total ban on grazing in the reserved forest range and conversion of grazing & fallow land into agricultural land has led to reduction in cattle and goat/sheep numbers in addition to the problem of finding farm labour. The use of green leaves as manure directly without composting is another activity which has been affected. The portion of green leaves derived from forest range is totally stopped because of the ban and the portion from farm side trees is also not used due to labour constraints.

**Zonal Linkages (fertility):** zone ABC have their high linkages owing to the presence of forest range, fallow lands, seasonal pasture interms of lake bed and rainfed farmland.
Zone D has its linkages in terms of farm side vegetation for fodder and manure. Zone E which is also adjacent to forest range, and seasonal pasture in rainfed farms has strong linkages with fertility.

**Status of indicators (pests):** The indicators under pests can be classified as relating to damage from insects, rodents, wild birds & animals and weeds. The prevalence and the impact of these pests and the management strategies adopted to deal with them will influence the sustainability of the farming system. The status of pests attack by insects is not considered to be causing significant economic losses and they are being dealt with mainly through pesticides. The practice of integrated pest management is negligible among the farm community. The impact of rodents on the rice and ground nut is reportedly huge, frequently causing damage upto 50-90 % crop loss in groundnut. The strategy adopted in rice consists of rigging up a crude electric fencing which electrocute the rats while entering or leaving the field. But in groundnut this does not work satisfactorily as there is no standing water, rats are able to use their burrow without coming in contact with the fence. The same strategy had been adopted for control of wild animals such as boars from the surrounding reserve forests and has been effective to the extent of totally eliminating the populations of wild animals. However bird pests such as peacocks which are the current scourge and others like parakeets, etc. continue to remain a concern which requires continuous guarding during the day.

Control of weeds constitutes a major challenge faced by the farmers. The control of weeds in fallow lands which were done through frequent ploughing has given way to spraying weedicides. Though it is detrimental from the ecosystem point of view it is popular as it involves less labour, time and expenses. Weedicides are applied even on cultivated land for crops such as onion, mainly to minimize the dependence on farm labour which is difficult to organize.
**Zonal Linkages (pests)** – As wild animals & birds have their origin from the surrounding ranges, zones ABC have their high linkages in terms of their presence and impact. But the wild animals have all been wiped out through adoption of electric fencing. The zone E which also has a surrounding forest range did not have the problem of wild animals as the forest range is too sparse to support any viable population. In terms of control of insect pest, suitable vegetation to support nesting communities of insect eating birds play an important role. Hence the zones ABCE have their high linkages in supporting bird populations, and the zone D with its farm periphery vegetation and the native vegetation along the waterways also has its high linkage.

**7.5.1.4 Farming Practices**

**Status of Indicators:** farming practices are an important society held knowledge which has been adapted to the local ecosystem involving crop selection, crop rotation, intercropping and integrated farming. The cognitive map of farming practices is given in figure-7.12. The status of indicators for this sub-component is shown in Appendix-B and Figure 7.9. But as has been happening all over the world the farming practices are increasingly becoming intensive marketable mono cultures aimed only at maximising the returns without regard to its sustainability. The practice of intercropping was arrived at to provide for holistic dietary requirements and growing crops with complimentary nutrient requirement. But this meant expending high manual labour to sow, maintain and harvest and lower yields relative to intensive farming. Hence intercropping in the village is negligible restricted to marginal rainfed farms and small plots in regular farms. The other aspect of crop rotation which took care of maintaining the fertility of the soil has also been discontinued owing to market dynamics.
The cultivation of leguminous plants which improve soil nitrogen is not preferred due to longer growing period, increased pest damage and uncertain market price. The cropping diversity has reduced and the main crops cultivated are onion for its year round demand for domestic consumption and rice for sentimental reasons of growing their own staple food. Though 60% of the farms are considered profit making the real income has not grown much to enable adoption of technology to enhance usage of water and land. The productivity achieved is well below the national average for all the main crops. Cost of seeds has increased as it is mainly bought from private agencies marketing seeds from domestic & international companies. However there is no mechanism to compensate for failures which have been reported though of reduced frequency. The exchange of seeds among the farmers has reduced mainly due to constant release of new varieties and monopolistic property rights under globalized trade regime. Lack of adequate storage infrastructure with families or in the village is one of the reasons farmers tend to lose a portion of their harvest and also tend to sell even at times of low prices.
Zonal Linkages: though sustainable farming practices are not widely prevalent, it still has a medium presence in the zones of ABCE, while zone D which is mostly irrigated follows intensive routine of mainly onion and rice. The rainfed and upland farms in zones ABCE still account for high diversity in terms of number of cultivated crops. In terms of high productivity and profitability the farms are mainly concentrated in the zones of CD & E. The zonal linkages are presented in figure 7.9.

7.5.1.5 Livestock

Status of indicators-Goat/ sheep herding: The status of indicators for Livestock is shown in Appendix-B and figure-7.13. The cognitive map for Goat/ sheep herding is shown in figure-7.3. The number of goat herds in the village has come down drastically over the years. This has affected the activity of direct manuring of farmland. The reason for decline is mainly the ban imposed on grazing in the surrounding forest range and also the conversion of grazing land near the foothills into farm land. Hence the sustainable transfer of nutrients from the surrounding vegetation onto the farm land through goat manure has been totally reduced. Though sheep are allowed to graze in the forest range (owing to the fact that they graze only the grass and do not browse the vegetation like goats), their higher cost and low availability of credit from financial institutions to goat/ sheep herders has not reversed their decline in their numbers. Of the remaining population which are held in numbers of 5-10 by small/ marginal farmers, the productivity is low owing to low quality fodder and the energy spent in covering long distances to access them. Currently they are totally dependent on seasonal pastures such as the lake bed when it is dry, fallow rain fed lands after their single crop in a year and road side vegetation. Further they have to contend for the meagre fodder with migrant sheep/goat herds from outside the region, which also pass on diseases to further add to the misery. This category seems to have an inverse relationship with farming, better the
farming less area for grazing; too little rainfall/ water for farming more fallow land equating to more area for grazing.

**Cattle:** The cognitive map of livestock-cattle is given in **figure-7.14.** The need for a healthy cattle population for sustainable farming cannot be overemphasized. Farmers have developed the symbiotic relationship where both benefit immensely and sustainably. The reduction in cattle numbers has affected the availability of organic manure. The replacement of bullocks with farm machinery has made things easier for the farmer, but has increased the input cost which is now dependent on the ever increasing cost of imported fuel. The buffaloes which were admired for their docile nature and their ability to survive on the driest crop residue while giving milk with higher fat content, have all but vanished owing to the shortage of farm labour.

![Figure 7.14 Cognitive Map for Livestock-Cattle](image-url)
Figure 7.13 Natural Components – Status of Indicators and Zonal Linkages (Contd.)
The same reason applies for the reduced number of cows maintained even by large landholders. Further the reduction in the grazing area and the high cost of cattle feed also contributed to the current situation of just 1-2 cows per family, just as a means of supplementary income through the sale of milk.

With the cattle population coming down at an alarming rate, the help from the government has not been very forthcoming. The animal husbandry infrastructure is far from satisfactory. The farmers have to walk down with their cattle for miles even when they are sick or for artificial insemination, where the treatment goes ineffective mainly due to exertion. There is hardly any scheme for distribution of nutritional supplements, awareness campaigns to highlight the importance of cattle and the doctors manning the centres are poorly paid with no career prospects.

**Zonal Linkages:** linkages with respect to this sub-component as shown in figure-7.13 were pointed out based on grazing land (permanent/seasonal), roadside vegetation and the forest range (even though grazing has been banned currently). Zones ABCE have their high links owing to their forest range. Zone AB has their high links owing to the presence of lake bed which provides pasture ground year round expect for 2-3 months after monsoon. Roadside vegetation provides fodder for landless cattle owners in the all the zones, and zone E with a highway lined with tamarind trees passing through it having good quality shade and fodder. In addition zones ABCE have a large portion of seasonal cop land (rainfed) which is available for grazing in summer months. The zones ABC which had fallow land outside the forest boundary have been developed in the recent 1-2 years into farm land thereby reducing the area available for grazing.

7.5.1.6 **Bio-diversity**
Status of indicators: The status of indicators for Bio-diversity is presented in figure-7.13 and Appendix-B. The cognitive map for Bio-diversity is given in figure-7.15. Diversity in species is an important factor which gives resilience to any ecosystem, as it dampens any disturbance which is resisted by a variety of organisms. Diversity is evaluated in terms of native flora & fauna (wild/ domesticated), crops cultivated and consumed. Floral diversity is widely preserved in the forest ranges, field edges and roadside. In terms of fauna, the big mammals such as wild boars, fox, etc have been wiped out through hunting for food by the hill communities, ritual hunting in the village and field electric fences. Livestock such as cattle, goat and sheep are fully comprised of hybrids promoted by the government for their improved productivity. The indigenous varieties of livestock have been totally replaced by these hybrids. Availability of floral diversity is important for the practice of traditional medicine. Traditional medicine is an important knowledge of the local area in terms of available herbs and their usage in human and veterinary medicine. The village has a lone practitioner who offers herbal formulations for snake bite and other diseases for human and cattle.

Figure 7.15  Cognitive Map for Bio-diversity
The crop diversity has come down significantly with traditional varieties of pearl millet, coarse millet, ragi, etc. totally absent from the fields. The widely cultivated crops are onion, rice and maize. The reduction of crop diversity has contributed to low nutritional diet mainly of rice. The grove of trees near the lakeshore temple contributed a type of sticky sweet flower used to make confectionery in the past. Presently the grove consists of 8-10 trees only and farm land has encroached into areas where the grove area extended earlier. Tree diversity in the farm has also decreased as most of them were sold as timber in times of crop failure. The common trees in the farms currently are coconut, mango, neem, etc. Native vegetation is found along the edges of stream courses coming down the hills and the farm hedges.

**Zonal Linkages:** The zonal linkages are presented in figure-7.13; zones ABC have their highest linkage for floral diversity in their forest ranges. Zone E also has its share of forest range though of reduced cover. All the zones have the native vegetation along the road edges and also high links in terms of farm trees for fruit and timber which have been planted in recent years as saplings were supplied free by the forest department. The rainfed farms of Zones ABCE have their links in terms of traditional varieties of coarse grains which are cultivated. Faunal diversity though much reduced is accounted in the forest ranges of ABCE. The same zones are the sourcing areas for medicinal herbs apart from the farm side vegetation in zone D.

**7.5.1.7 Energy**

**Status of indicators:** The status of indicators for Energy is presented in figure-7.13 and Appendix-B. The cognitive map for Energy is given in figure-7.16. Electricity plays an important role in a farming system in terms of powering the pumps for irrigating the field. In the state of Tamil Nadu the electricity is supplied free of cost for agriculture
from the year 1991. This has been done as a supporting measure to reduce the input costs amidst concerns that it is leading to wastage and fast depletion of groundwater. Though the Tamil Nadu Electricity Board (TNEB) provides about 30,000 free farm connections every year, the waiting list of farmers for free connections is pending from the year 1989-90. However with pressure from the Central government and World Bank to start collecting nominal electricity charges, the future of free electricity is uncertain. The opinions among the farmers—who are used to this free gift—regarding future tariff is very negative and feel whatever little profits will be wiped out. The situation on the lighting front is also negative as the adoption of solar/renewable energy is absent.

The fuel requirement for cooking in terms of LPG and diesel for farm machinery is another external input which the community is fully dependent on. The dismal adoption of biogas systems is due to space constraints near residences, labour requirement for maintenance and shortage of cow dung. However the reliance on LPG & kerosene for cooking has reduced the demand for fuel wood, which in turn has eased the pressure on the surrounding forest range. Hence the health of the forest range is directly linked to the

**Figure 7.16  Cognitive Map for Energy**

cooking has reduced the demand for fuel wood, which in turn has eased the pressure on the surrounding forest range. Hence the health of the forest range is directly linked to the
fluctuating price of LPG/ kerosene which is currently subsidized by the government. Further the price of diesel which is more closely linked with world oil prices makes a bigger dent in farm profits due to greater dependence on farm machinery for ploughing, harvesting, threshing and transportation. Bio-diesel as an alternative is yet to make its presence. With concerns of increasing green house gas emissions from farming, cattle and farm machinery it will be challenging to move towards sustainable energy for farming.

**Zonal Linkages:** the forest zones of ABCE have their high linkages with energy requirement as shown in figure-7.13. The current situation of healthy growing forest is mainly due to increase in number of households using LPG/kerosene for cooking. The intensive farming zone D has its linkage with respect to the type of crop cultivated. Crops like rice and onion which are major crops do not have the stalk residue which can supplement the need for cooking fuel. Whereas crops like sunflower, lentils, maize, etc provide stalks which are used for cooking purposes. Dried cow dung, Thorny scrub and other vegetation which grow on fallow land also provide a substitute for fuel wood for cooking. The government has initiated policy to support cultivation of crops which would produce bio-diesel. Hence land which is fallow and rain-fed currently holds promise of providing locally produced fuel for the machinery.

7.5.1.8 Forest

**Status of indicators:** The status of indicators for forest is shown in figure-7.13 and Appendix-B. The cognitive map for Forest is shown in figure-7.17. The health of the forest range which is of Dry tropical deciduous type beyond an elevation of 350m and mixed scrub below that, is better than it was about 5-10 years ago. This is due to reduction in collection of fuel wood as majority of households now use LPG/kerosene for cooking. The other factor is increased funding for afforestation to the forest
department through the Tamil Nadu afforestation Project (TAP) which was initiated in 1998 under funding from JBIC. Under this project various programs such as forest regeneration, watershed development, alternative livelihood schemes and village development programs are carried out. Further under the Joint Forest Management (JFM) program, village forest councils (VFC) have been formed comprising of members from the local villages which oversee the protection, extraction of NTFPs and grazing permits. These initiatives have contributed to the improvement in forest health, though at the cost of dependent linkages like grazing, fuel wood collection, and green leaf manure.

Figure 7.17  Cognitive Map for Forest

The big fauna such as wild boar and fox have been totally wiped out by the hill communities who hunted for food and the practice of electric fencing in the plains. The cultivation of tapioca by the hill communities has contributed to large scale erosion of the plateau. The eroded soil which silts up the lake and ponds in the plains was used by the farmers to enrich their farmland in the past. Presently this activity is very negligible owing to scarce and high labour cost. The forest department have been replanting saplings annually in addition to building check dams along stream courses. But the total ban imposed on grazing has affected the goat/ cattle population in the village community, thereby impacting on the availability of organic manure.
The local community has unrestricted access to sites of religious importance inside the forests. The reserve forest boundary on zone C has been specially drawn to exclude the temple on top of the hill which is frequented by the villagers for festive occasions. But the excluded zone has become devoid of vegetation in the absence of control by the forest department. Extraction of NTFPs such as honey and wild berries has also come down drastically owing to a decrease in the marginalised community who depended on that to earn an extra income. In the recent years pressure for farm land has resulted in conversion of fallow / grazing land right upto the boundary of the reserve forest. The sloping land is made flat by removing a portion of the sloping top soil which is then used for the manufacture of mud bricks. Lately licenses have been issued for quarrying blue metal for road construction mainly in Zone D. Though these quarries are located outside the reserve forest boundary, they are affecting the stability of hill slopes by quarrying at the bottom.

Zonal Linkages: the zones ABCE have their highest linkages due to the presence of reserve forests as shown in figure-7.13. The zone D which has a portion of its range outside the reserved forests, is witnessing quarry licences for extraction of blue metal for road construction. Zone B has the forest area with rich diversity among the flora with medicinal herbs being sourced from this area. Also zone B lies downstream from the tribal village and has the risk of being affected by their hunting & farming practices. Forest areas in Zones B & C have rich cultural linkages with a number of temples/worshipping areas.

7.5.1.9 Environmental Monitoring

Status of indicators: The status of indicators for Environmental Monitoring is shown in figure-7.18 and Appendix-B. The cognitive map for monitoring is given in figure-7.19.
There is no program for testing of various environmental media for toxic contaminants either at the village or national level. The drinking water is tested by Tamil Nadu Water Supply & Drainage Board (TWAD) for physico-chemical indicators only. The drinking source is a bore well located near the lake and the quality is suitable for drinking.

Figure 7.19  Cognitive Map for Monitoring

There are no industries impacting the environmental quality of the area. The village has a rice mill, which mainly uses agro-residue for boiling of paddy and the emissions are made up of carbon particulates. There is no mining activity in the area. Quarrying operations for blue metal is a major extractive activity in the region. The hilly ranges outside the reserve forest boundary have been leased for extraction of blue metal to feed the massive highway construction program of the country. These quarry operations are also responsible for dust emission, increase in noise level, and increased movement of heavy vehicles and degradation of watershed. Brick industry is another extractive activity making use of the red topsoil which is removed from sloping ground near the foothills and in the process making the land flat & suitable for farming. Change in climate is felt mainly in summer where an increase in temperature and an extended duration is felt. No
change on account of rainfall is discernible as the monsoon is known to be erratic by itself.

**Zonal Linkages:** The zonal linkages are presented in **figure-7.18.** The zones of ABCDE which all have their linkages in farming activity are to be monitored for contaminants moving up the food chain. The zone AB are the main catchment areas for the drinking water source i.e. Lake. Application of pesticides and fertilizers in the zones AB both in the foothills and the upper plateau by the hill communities needs to be monitored. The western part of zone D which contains a portion of the hilly range outside the reserve forest is the scene of quarry activity which though has been temporarily suspended, has damaged the watershed by stripping off the vegetation. Recent conversion of fallow land near the foothills mainly in zones ABCE have given rise to brick making units involving loss of topsoil and increase in heavy vehicular movement.

![Figure 7.18 Monitoring and Marginalised – Indicators and Linkages](image-url)
7.5.2 Marginalised

**Status of indicators:** The status of indicators is presented in Appendix-B and figure-7.18. The cognitive map for the marginalised community is given in figure-7.7. The marginalised community derive their livelihoods by depending on agricultural labour and to a lesser extent on goat herding. As discussed in section 7.4.4 they lay at the bottom of all development indicators. The women have their direct links with the ecosystem in terms collecting firewood, wild fruits and berries, medicinal herbs, etc. which supplement the meagre income earned by the men. The women also form an important part of agricultural labour engaging in planting, weeding, harvesting and threshing. This community lives almost in a separate world apart from the main village society with their own culture.

**Zonal Linkages:** The zonal linkages for the marginalised community are shown in figure-7.18. Zone B has its high linkages for the collection of NTFPs, although this activity has diminished owing to younger generation migrating to the town for work and strict enforcement of restrictions by the forest department. Zones C & D have their linkages in terms of availability of agricultural labour since the irrigated farms are concentrated here and access to contract farming. Most of the small land holdings are in the zones of A and E in the form of rain fed farmland, which also enables them to graze their goats during the fallow period of the year. Their cremation grounds are restricted to zone E so as to be far away from the main village, which is also used for grazing their goats, collecting firewood and for open yard defecation.

7.5.3 Social, Financial & Physical Components

7.5.3.1 Importance of social capital for sustainability

It would not be far fetched to point out that Social capital is what decides how a society optimises its available resources to get a sustainable return. Though traditional
knowledge was sufficient for subsistence farming, in today’s market oriented farming, education endows the farmer with the knowledge in terms of cropping decision and inputs based on the markets. The village under study can be said to be in transition from an era of traditional decision making in cropping for internal consumption to educated market based cropping. A generation of farmers who went on to graduate in the hope of employment in public offices have since taken up their family farms and are making a difference mainly in their use of institutional credit. But this group is still a minority dominated by under educated traditional farmers with fragmented marginal holdings due to division among successive generations. The status of social indicators is presented in figure-7.20.

The population growth is still exerting a negative influence in fragmenting the farms into marginal holdings. Health care is restricted to what is provided by public hospitals with their poor staffing and infrastructure. Health insurance is still an alien concept even in cities in India. Water borne and vector borne diseases are still prevalent owing to open defecation and stagnant wastewater in newly built but poorly maintained drains inside the village. Nutritional requirements are barely satisfied owing to reduction in cropping diversity. High prices of pulses, milk, fruits and vegetables have reduced per capita consumption of these items among the rural inhabitants. Educational expenses for the children consume a high proportion of income on the hopes of a better future and even result in selling of land and property to pay off high tuition fees for professional courses. There is high out migration among the higher castes as their children get jobs in the cities, while their farms are bought by local farmers mainly by those earning through employment in foreign countries. Farm prices have continuously gone up which indicates that people are still optimistic about farming futures. As indicated earlier the drastic reduction in availability of farm labour has affected cropping decisions to a major
extent in favour of crops with minimal labour requirement. The market has stepped in to a major extent providing mechanised options for harvesting and threshing. But since holdings are small and due to increase in fuel prices, input costs have shown an increasing trend. The cognitive map for social component is given in figure-7.21.

Figure 7.21  Cognitive Map for Social Component

Cohesion across community is still a concern in all villages as the bonds are caste based. But when it comes to inter village resource problems cohesion among inhabitants can be strong. In terms of sharing best practices in farming, channels of communication are strong and a positive aspect. Crime rates are low and do not constitute a problem. But as traditional values are being eroded through exposure to cable television induced materialism, spending on consumer durables are increasing at the cost of other important aspects like nutritious food. Television is also having an impact on social activities by restricting interaction among neighbours who are glued to programmes on all evenings.
Figure 7.20  Social, Physical and Financial Components – Status of Indicators and Zonal Linkages
Equity as pointed out earlier is one issue which is posing the biggest challenge to not only the future of the village but the nation as a whole. Right now India is banking on high economic growth to close the gap with its own attendant problems of pollution and crass consumerism. Participation in panchayat is showing a growing trend with people showing awareness of their rights. But the negative aspect is the resigned acceptance that panchayat members are there primarily to make money through corrupt means as elections are held amidst furious vote buying with cash.

7.5.3.2 Financial Component

Sustainability of any endeavour requires financial viability and when it comes to farming with all its uncertainty, this component assumes paramount importance. The current trend of compromising long term sustainability by choosing short term viability is purely a financial decision. The village under study does not suffer the extreme situations of farmers in parts of India who are committing suicide in large numbers. It is well known that farming in developing nations is a high risk occupation and the changing climate has only increased the risk. The govt. of India has initiated various strategies such as crop insurance, kisan credit cards, free electricity, farmer markets, etc. but these have not arrested the declining farm incomes. The produce prices have been erratic providing profits one season only to wipe it out for the next two. The inputs such as fuel, fertilizer, pesticides and seeds have been increasing steadily. The status of financial indicators for the village is shown in figure-7.20.

Banking institutions have been historically negligent of the farm sector and the co-operative banks setup by the government for the farmers is mostly sick. The prime minister of India recently pointed out that farming decline is due to ‘investment and
credit deficit, infrastructure deficit, market economy deficit, and knowledge deficit’. Whatever the allocation of funds for loans is overwhelmed by the sheer number of farmers, herders and agri-labourers. With the entry of corporate sector it is expected that the farmer might get better price by selling to them, as the corporates can get a better return through warehousing, value addition and exports.

Figure 7.23 Cognitive Map for Financial Component

But this is jeopardising the lives of traders in grains and vegetables who are involved in the farm to table chain right now. Rural agricultural income is exempt from income tax and tax subsidy is offered to machinery used in agriculture like tractors, pumpsets, threshers, etc. Most of the rainfed farms are held by farmers who cannot afford to dig wells which can allow irrigated farming with greater returns. But absence of institutional credit is responsible for their continued precarious dependence on rainfall alone.
7.5.3.3 Physical Component

The irrigation infrastructure in the village consists of sluices controlling the flow of water from the lake to the farms through unlined channels. The surplus water during monsoon flows through these channels to recharge the ponds situated down stream amidst the zone D. The status of physical indicators is shown in figure-7.20. These facilities were being renovated during the study involving repair of surplus weir, sluice gates, desilting of irrigation channels, and removal of encroachments in the lake bed and desilting of the ponds. As discussed in water sub-component component of Natural resources, well irrigation plays a major role throughout the year and the responsibility of maintaining them falls on the land owners who spend a large portion of their income or incur heavy debts while deepening them.

The government runs fair price provision shops popularly called as ‘Ration shops’ through which they ration specific amounts of rice, wheat, sugar and kerosene depending upon the economic status of a family at subsidized rates. In Tamil Nadu state where the village is located rice is supplied at a low price of Rs.1/kg. Though this has resulted in misuse for purposes like cattle/ chicken feed, it has immensely benefited the labourers who are reported to be even reluctant to work for more days than before. Physical infrastructure in households relating to Sanitation like toilets, sewers/ drains continues to be deficient. As per the census in 2001, around 92% of households in rural and 63% of households in urban areas in the district of Perambalur lacked toilet facility. The government supplied ceramic toilet pans free of cost and constructed mini-septic tanks for each family but this effort has failed to change the practice of open defecation.

The panchayat has built drains recently in the village to channel the wastewater away from the village centre. But due to poor construction (without proper slope) and maintenance they have led to stagnant wastewater breeding mosquitoes.
Water is sourced from deep borewells near the lake and is supplied to households through public taps in the streets and individual connections to those who can afford them. Though the water is not treated the quality indicators are within safe limits and there has not been any reported incidence of supply getting contaminated through defective pipelines.

![Cognitive Map for Physical Component](image)

**Figure 7.22  Cognitive Map for Physical Component**

The power supply is adequate even though it is given only at specific time of the day. Farmers have adapted to the low duration and voltage supply and have little difficulty in ensuring proper irrigation. But the supply of free electricity for farming is mainly possible as the industry & services are doing well in the state enabling improved revenues through which the Government has subsidized it. However as of March 2009, electricity supply was getting erratic and the farmers were finding it difficult to adjust to the changing timing and duration of supply.
The recent thrust given by the state and central governments to road networks have resulted in improved village to farm and farm to market connections. Increased availability of vehicular loans on low interest rates has improved transport of farm produce at affordable rates. Radio remains the main channel of market information, weather, farming news and technology updates. The increase in density of mobile phone connections have also improved access to information relating to markets. The main produce of the village is small onions (shallots) whose price in the market decides the profitability of the farms. Once in 3-4 seasons they get a bumper prices which keeps them going through the price crashes in the other seasons. This fluctuation never allows the farmers to raise their real incomes. There are no avenues for value addition or to process the onion produce when ever the supply is high and prices crash.

Housing comprises of concrete or tiled structures for the dominant community with the marginalised mainly living in thatched huts. Assessing the suitability of housing presents a dilemma in terms of deciding whether local sourcing of material for thatched houses (which is good from a sustainable point of view) is better than external sourcing for concrete/ tiled houses (though durable require materials which are energy intensive to manufacture). There is no manufacturing/ value addition activity even at the cottage industry level such as snacks, cooking ingredients, etc. The village is entirely made of Hindus with two temples worshipped by the dominant population and the other two sections of marginalised community having their own temples. Annual festivals are held regularly for the Mariamman temples on the lake shore and on the surrounding hill on the belief that it is necessary to ensure good rainfall and crops. Apart from these the village inhabitants regularly visit popular temples in the nearby districts depending on their ability to spend for the travel and other expenses. Attitude regarding the police and judiciary is very negative and are accessed only as the last measure.
7.6 Overall results and distribution of indicator status for sustainability components

The key findings from the RLQ is summarised in Table-7.3. The overall percentage distribution of status of indicators for sustainability components is shown in figure-7.23. From the figure it can be observed that the basic resources such as land and water are in either positive (0.3) or highly positive (0.5) status. Water has over 40% of its indicators in positive and highly positive category and 30% in neutral category. Land has 55% and 27% of its indicators in positive and highly positive category respectively and forests has 40% of indicators in positive category. In spite of the basic resources showing good status it is interesting to note that other sub-components fertility-pests, livestock population and cropping diversity show significant negative status and the scarcity of farm labour is cited as the main reason for this situation.

The marginalised category is very much on the negative side (77%) and does not have avenues inside the village domain to help itself towards the positive side. The social component excluding the marginalised section shows a major portion of indicators on the negative status (59%) mainly due to poor health care and corrupt panchayat system. The positive and neutral status of 40% in social component is due to the care of old age/destitute and the crime free environment in the village. The financial component shows the worst distribution on the whole with a highest highly negative (33%) and negative (43%) status. This is inline with numerous studies which have pointed out the drastic reduction in availability of credit for small and marginal land holders and the complete lack of insurance for all aspects of life, health and property. The physical component is relatively better than social and financial components with 48% under neutral & positive status and 52% on the negative side. This positive status is mainly due to better roads and free electricity supply.
<table>
<thead>
<tr>
<th>No</th>
<th>Compon./sub-comp.</th>
<th>Key Indicator status</th>
<th>Implications for sustainability</th>
<th>High zonal linkages</th>
<th>Highly linked components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>positive</td>
<td>neutral</td>
<td>negative</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Natural Component</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Land</td>
<td>Area under cultivation</td>
<td>nil</td>
<td>Availability per capita, farm size.</td>
<td>Fragmentation of farmland</td>
</tr>
<tr>
<td>2</td>
<td>Water</td>
<td>Water availability</td>
<td>Rainfall, water quality</td>
<td>Well deepening, use efficiency</td>
<td>Ground water withdrawals,</td>
</tr>
<tr>
<td>3a</td>
<td>Fertility</td>
<td>Composting of available waste</td>
<td>Availability of fertilizers</td>
<td>Farm Labour, Organic manure</td>
<td>Sustainability of farming</td>
</tr>
<tr>
<td>3b</td>
<td>Pests/weeds</td>
<td>nil</td>
<td>Pest outbreaks</td>
<td>Increased use of Pesticide. Electric fencing</td>
<td>Toxic buildup, loss of species</td>
</tr>
<tr>
<td>4</td>
<td>Farming practices</td>
<td>Seed availability</td>
<td>Crop productivity</td>
<td>Intercropping, crop rotation, seed exchange</td>
<td>Seed security, loss of biodiversity</td>
</tr>
<tr>
<td>5</td>
<td>Livestock</td>
<td>Economic contribution</td>
<td>Productivity</td>
<td>Decline in population, grazing area</td>
<td>Reduced organic manure, cycling of nutrients</td>
</tr>
<tr>
<td>6</td>
<td>Biodiversity</td>
<td>Flora in forest</td>
<td>Native vegetation on farm edges</td>
<td>Cropping diversity, medicinal knowledge</td>
<td>Loss of resilience, nutritional deficiency</td>
</tr>
<tr>
<td>7</td>
<td>Energy</td>
<td>Adoption of LPG cooking</td>
<td>hiring of farm machinery</td>
<td>Wastage of free electricity, fuel charges</td>
<td>Dependence of external fuel</td>
</tr>
<tr>
<td>8</td>
<td>Forest</td>
<td>Regeneration</td>
<td>Access to NTFPs</td>
<td>Farming in hill communities</td>
<td>Climate change</td>
</tr>
<tr>
<td>9</td>
<td>Monitoring</td>
<td>Absence of industry/mining</td>
<td>Impact of climate change</td>
<td>Lack of monitoring program</td>
<td>Build-up of toxins in food chain</td>
</tr>
<tr>
<td>B</td>
<td>Marg’d Section (labour)</td>
<td>Subsidized food rations, education</td>
<td>Wage levels, panchayat membership</td>
<td>Discrimination, lack of health care</td>
<td>Intra-generational equity, social instability</td>
</tr>
<tr>
<td>C</td>
<td>Social and institutional capacity</td>
<td>Care for the aged, security</td>
<td>Political activity, panchayat</td>
<td>Casteism, malnutrition, corrupt panchayat</td>
<td>Increasing population, erosion of values, change in lifestyle</td>
</tr>
<tr>
<td>D</td>
<td>Financial</td>
<td>Free electricity, subsidised fertilizer, LPG</td>
<td>Welfare schemes</td>
<td>Institutional credit, insurance, produce prices</td>
<td>Migration to cities, reduction of food production</td>
</tr>
<tr>
<td>E</td>
<td>Physical</td>
<td>Drinking water, rural roads</td>
<td>Access to markets, communication</td>
<td>Sanitation, housing, food processing</td>
<td>Wastage of resources, uninformed decisions</td>
</tr>
</tbody>
</table>
7.6.1 Zonal linkages and ranking methodology: How are the linkages distributed in terms of its spatial occurrence?

The distribution in terms of percentage of high zonal linkages for individual sub-components is given in **Figure-7.24**. As the linkages have been constructed across various sub-components under natural component and also for marginalised section, the ranking of zones at times becomes a necessity to take decisions both by external authorities and internal village council. It would be a crude way to look at sheer number of linkages in trying to figure out the relative importance of the zones. The ranking of zones – even though purists would scoff at the idea of judging the importance of segments of complex ecological systems based on our imperfect understanding- becomes a necessity to satisfy the decision makes who appreciate things in black & white. The right way of judging the zones would be to adopt a hierarchical approach of considering linkages with the crucial sub-components. The adoption of various multi-criteria methods will be logical to study the data generated in terms of linkages and arrive at a practical ranking.
Based on the ranking of zones impact of an activity can be considered and decisions made based on the potential of the proposed activity to alter existing linkages and the importance of the zone for the overall ecological integrity of the village. However this exercise of ranking the zones based on the linkages is proposed to be an information base on which we can frame the terms of reference which will be meaningful for the EIA/ Sustainability Assessment (SA)/ Strategic Environmental Assessment (SEA)/ Social Impact Assessment (SIA) studies. Further it is to be understood that the ranking has to be attempted by considering the linkages that the zones have with all villages near them.

Considering that water comes first for its crucial role, zones B and C which have their greater high linkages (both with 23% of all zonal linkages with water) will have to be assigned positions of high ranking. The percentage of high linkages of individual sub-components is presented in figure-7.24. Zone C will have to be ranked as first for its highest proportion of high linkages (17%) for all the sub-components and B would be...
second for having the second highest (16%). Next of the remaining zones, zone D has the highest proportion of high linkages (19%) for sub-component land, which can be considered second in importance after water. Now of the remaining zones of A and E, both have similar proportion of linkages (20 &15% respectively) for all sub-components. When compared for linkages with marginalised community Zone A has the edge over E in terms of its greater high linkages for the marginalised community (15% over 5%). Hence the final ranking of importance for practical purposes would be: 1-Zone C, 2-Zone B, 3-Zone D, 4-Zone A and 5-Zone E.

Based on the ranking it can be considered that certain developmental activities which have the potential to alter existing ecological interactions would have the least impact on the overall socio-ecological regime of the village if it is undertaken in zone E. it is important to remember that activities which involve heavy extraction of ground water will have a serious impact while being located in any of the zones unless its influence is restricted to a local confined aquifer. Further the ranking involves consideration of linkages only for the village of Kalarampatti, it is quite probable that zone E might have a high ranking with respect to linkages of another adjacent village as villages tend to have overlapping common pool resource base. Hence as this activity is proposed to be undertaken by all village panchayats, ranking consideration will ultimately involve linkages that the zones have with all villages near them.

7.6.2 What are the Functional aspects of linkages?

The functional aspects of the linkages provide information regarding the dynamic exchanges between the various ecological and social components which reveal more information for enhanced understanding of the linkages.
Internal and External Linkages provides information related to vulnerability to external factors. For example, the village was linked more internally for its energy needs in the past in the form of crop residue and wood fuel from the forest. Currently, it is more externally linked to LPG and kerosene. Hence, the forest regeneration has been successful in the face of reliable and affordable supply of LPG and kerosene. It is obvious that there is a clear possibility of price rise in these fuels leading to renewed pressure on the health of the forests. Hence, the cognitive maps provide useful information regarding internal linkages which are crucial to sustainability and external linkages which can be potentially destabilising.

Hierarchy of linkages is the key to understand the importance of components for the overall stability of the system. The cognitive maps provide a sound information base to assess the hierarchy of components. Logically, components from which the downward linkages originate and propagate through the map (such as the forest area) occupy higher positions in terms of number of components connected to it. This way, the extent of impact of any action on all the components through various pathways illustrated in the cognitive map can be understood.

From the cognitive map for irrigated farming (figure 7.5), the hierarchy of components can be deduced as follows: Forest area forms the base of the system inducing and channelising the rainfall into the lakes and ponds to recharge the ground water. Hence, the primacy of water for any ecosystem makes the preservation of forest area important. Adequate fertile land area is a requisite to translate the available water into productive food crops. The village which is endowed with fertile soil had been practising mixed cropping with cattle as a sustainable system which was enhanced by the green revolution in the 1970s. The mixed cropping plus cattle system also ensured diversity in crops providing resilience against failure, insuring against market crashes and satisfying
nutritional requirements. But the cattle system which was affected by reduced labour availability shifted towards 1-2 milch cattle per household stall fed by crop residue and grazing on fallow field. These remaining cattle which provides organic manure needs to be nurtured with effective policy to provide support in marketing of milk and veterinary services. Even when the farmers experience good harvest in the times of general crop failure in competing regions they do not get a good price due to liberalised market for produce. Though the social component is better in terms of awareness and keenness to adopt better technology, the financial component which is crucial in the scenario of increased external inputs is woefully inadequate.

**Interaction between livelihood systems under various resource conditions**

There are a number of situations which define inter livelihood interactions depending on the natural fluctuations in resource availability. There are two specific resource situations which define the inter livelihood interactions: water availability through normal or above normal rainfall and water scarcity due to deficient rainfall. Under the normal rainfall conditions farming activity will be undertaken in both irrigated and rain-fed farms. This creates competition for hiring of farm labour and decisions regarding type of crop and extent of cropping are made based on labour requirement. Hence farmers with irrigated farms actually prefer a season with deficient rainfall which they reason will lead to reduction in the cropping area in irrigated farms and low cultivation in rainfed farms. This as per their observation leads to better availability of farm labour as marginal rainfed farmers also join the labour pool and also leads to lower produce output leading to better price. Though this is the preference of the dominant farmers, it is obvious that it pushes more families onto labour dependent poor livelihoods. The scenario encountered during the study was that of surplus water availability after one year of surplus rainfall
followed by two years of normal rainfall which had increased cropping, labour scarcity and depressed prices of farm produce.

During this situation the goat herding livelihood is also affected as they cannot have a free reign over the cropped lands. They have to restrict themselves to field edges, roadside vegetation and the portion of lake bed not covered with water. Before the ban on grazing was enforced they used to graze in the forest ranges during this situation which is not possible now. However farming families from both categories which own 1-2 milch cattle are able to provide sufficient fodder though of low quality and at times with water availability, crop a certain area of their land with coarse grains mainly to feed their cows with fresh green stalks.

Under the reverse situation of low water availability apart from the above mentioned advantage to irrigated farms, goat & sheep herds and cows owned by landless are able to graze them on increased land which has been left fallow. This situation degenerates when the water becomes scarce even for farms with dug wells i.e. when the water table goes down beyond the depth of most of the wells after continuous deficient rainfall for 2-3 years as it happened during 2000 to 2003. In this situation all the livelihoods in the village come under stress with families desperately deepening their wells by selling their cattle, jewellery or borrowing from money lenders at exorbitant rates. Many farmers are yet to recover fully from their spending during the previous dry spell of 2000 to 2003. Hence there can be a number of situations based on other resources such as forest access, grazing land, etc. which needs to be identified as information can prove useful in considering the impact of an activity not only on current interactions but also probable ones.
Means of access and Level of entitlement to a resource

The means of access to a resource can be classified into horizontal and vertical means of access. The means and access and level of entitlement to a resource for the village of Kalarampatti is given in Table-7.4. Water the basic resource is accessed by both horizontal (lake/ponds for direct drinking, bathing, and water for livestock) and vertical means (dug wells/bore wells which reach below the water table).

Table-7.4: Functional aspect of linkages

<table>
<thead>
<tr>
<th>Resource</th>
<th>Level of Entitlement/ usage</th>
<th>Means of Access</th>
<th>factors Influencing level of resource availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water in Lake/ pond</td>
<td>Full for farming</td>
<td>Partial – restricted usage</td>
<td>Irrigation channels, Direct, Watershed in the forest, annual rainfall</td>
</tr>
<tr>
<td>Water well</td>
<td>Full for farming</td>
<td>Partial with permission for drinking/bathing</td>
<td>Dug well, Annual rainfall, depth of Water table</td>
</tr>
<tr>
<td>Farmland irrigated</td>
<td>full</td>
<td>nil</td>
<td>Roads, footpaths, contiguous fallow land, Fragmentation among successive generations, water availability and extent of cropping</td>
</tr>
<tr>
<td>Farmland rain fed</td>
<td>full</td>
<td>nil</td>
<td>Roads, footpaths, contiguous fallow land, Fragmentation among successive generations, water availability and extent of cropping</td>
</tr>
<tr>
<td>Fallow public land/ dry lakebed</td>
<td>Govt.</td>
<td>Partial -Grazing of cattle, sheep/goat during fallow period</td>
<td>Roads, footpaths, fallow land, Forest, Encroachment by dominant villagers, landless, lease for brick making, allotment to landless.</td>
</tr>
<tr>
<td>Tamarind plantations along the road</td>
<td>Only through auctioned leases</td>
<td>Only through auctioned leases</td>
<td>Roads, Rainfall, cutting for widening the roads, consumption by monkeys.</td>
</tr>
<tr>
<td>Lake/ pond fisheries</td>
<td>Free for all community event</td>
<td>Free for all community event</td>
<td>Roads/ footpaths, Rainfall, restocking of fishes, extent of dry spell.</td>
</tr>
</tbody>
</table>
Land is mainly accessed horizontally through roads, footpaths and other farms and is used according to the level of entitlement. Understanding the linkages through the means of access enables us to better estimate the impact of any activity on the linkages. Any activity which has not been previously practised in the village has the potential to impact the linkages and sustainability of the existing livelihoods. The impact can be easily understood by its effect on the means of access and level of entitlement for various resources. For example an activity which involves use of water for purposes other than agriculture (physical transport of water outside the ecosystem or processing resulting in embodiment) will result in extraction of water which even when within the safe extractable limit for the aquifer will depress the water table to a depth beyond the dug wells (means of access for farmers) and hence lead to collapse of farming. As happened in the case of Plachimada panchayat Vs Coke involving extraction of water for sale as purified water and soft drinks (Anon, 2005). This sort of an impact has never been accounted or recognised by the institutions involved in EIA in India.

The traditional concern of figuring out how an activity will have a qualitative impact on water by discharge of its pollutants though well known and accounted for by ensuring that the proponent submits an environmental management plan, has not prevented such a pollution owing to inadequacy of water pollution control framework in India (Rajaram & Das, 2007a). Moreover resource extraction for commercial purposes other than agriculture is not sensitive to seasonal fluctuations in resource availability such as water. They simply enhance the means of extraction like digging a deeper bore well without concern of depleting the water table further. Building constructions and townships which are exempted from EIA under 2006 would involve resource depletion and discharge of sewage resulting in impacts and conflict.
Similarly any activity even when it does not extract water to cause a negative impact, but involves enclosure of a substantial area of land, cuts off the linkages which the landless livelihoods such as livestock herding and marginalised community have without actually owning the land. This seemingly insignificant impact sets of a chain of impacts in terms of reduction in livestock numbers, organic manure, fertility, food production, sustainability of farming and increases migration to urban areas. In the ongoing process of land acquisition in India for setting up of SEZs little regard is given to how it might impact the existing linkages of the surrounding villages which are primarily dependent on the ecosystem. Worse still only the land owner is eligible for compensation and the marginalised community who are landless and livestock herders are being ignored as if they do not come under the purview of Indian government and will vanish without any problem. As it was rightly pointed out that, “Almost 80% of the agricultural population owns only about 17% of the total agricultural land, making them near landless farmers. Far more families and communities depend on a piece of land (for work, grazing) than those who simply own it. However, compensation is being discussed only for those who hold titles to land. No compensation has been planned for those who don’t”. (CRC, 2007)

The complex linkages which have been brought out with every ecosystem component around the village, do not mean that any activity which impacts these linkages have to be shelved. But what is expected is the increased recognition of the need to structure alternative relief measures for the section of the population who lose out on the ecosystem benefits which they had been deriving and are not compensated currently owing to lack of formal ownership. Even in the event of compensating those who own the land, attention is not focussed on how a change in the existing usage of the ecosystem
in a particular zone will affect the integrity of linked ecosystem functions in other zones which carry on with their normal activity.

**Temporal aspect of linkages**

Socio-ecological interactions do not follow a linear or a steady path throughout the course of a year. They have a rhythm established through centuries of experience in adapting to the behaviour of ecological components such as change in seasons and resource availability and also go through phases of stability and collapse (Holling, 1995). As the society activates adaptive sustenance strategies such as crop selections based on water availability, projects such as manufacturing facilities situated or EIA studies for proposed ones need to be sensitive to such fluctuations and frame mitigation strategies which need to be adaptive. Noble (2000) detailed the need and advantages of adaptive EIA which is yet to materialize in the EIA domain.

**Ongoing interventions and socio-ecological changes**

Every socio-ecological system is always under the influence of interventions initiated either internally or from external institutions. Internal interventions to correct the trajectory of resource utilization or social trends from traditional institutions take the form of taboos and more formal restrictions/ rights. External interventions from governing institutions involve regulations/ restrictions on the use of resources such as water, land, forest products and social interventions such as subsidized rations, housing, education, health care & loans for the poor/ marginalized. These changes help us understand the socio-ecological processes which are already underway and effectively frame impact assessment terms of reference for the new intervention under question.
7.7 Conclusions

The role of Environmental assessment in India and other developing nations has assumed greater significance due to rapid economic growth especially involving large scale land acquisition without regard to its impact on existing sustainable agrarian activities. The re-engineered EIA 2006 in India has merely turned out to be a power sharing agreement between the state and the central government and has been regressive in terms of giving more avenues for participation of the affected public. The crucial scoping stage of EIA has been introduced for the first time though without any mandatory requirement for consulting with stakeholders and other relevant institutions. The method of understanding the sustainability (ecological, social, physical and financial) linkages though participatory cognitive mapping and questionnaire presented in this paper is intended as a step towards integrated assessment of sustainability components in the agrarian villages. The example of Kalarampatti village has brought out the utility of the methodology in understanding the linkages between the various sustainability components, interactions among the livelihoods, importance of considering means of access and level of entitlement for each resource and most importantly the plight of marginalized community. Though the methodology might be considered as linear and strait jacketed, the information generated through this methodology will go a long way in strengthening the scoping scenario and contribute to effective EIA/ SIA/ SA/ SEA studies in India and other developing nations which do not have the resources and capacity required for a site specific rigorous EIA/SIA for major to minor projects of varied types.

The results generated from the methodology were appreciated by the village council members and has enabled them to analyse the ongoing activities around the village such as quarrying (in zone A) and removal of top soil for brick making (zone A, B, and C) in a new light and understand the extent of their impact on the village as a whole. Even if the
lists of indicators derived in this study are directly used for any village in India it will generate more useful information for effective framing of terms of reference for impact assessments. The challenge is in implementing the methodology, can the consultants be trusted to do a fair job, and are there enough NGOs who can take up the job until capacity building at the village level attains acceptable standards. Currently in India, in almost all the cases of conflict with the local population, it is the NGOs who have been active in organising opposition to the projects and initiating legal suits in the courts. Considering the number of villages (630,000) and the multitude of projects it is difficult for a single authority to find expertise for the SLD study and since the track record of consultants are not trustworthy, NGOs remain the last option. Hence training them to do the job would be effective as they can be expected to act as a counter balance to the Impact Assessment Authority.

EIA practitioners need to be trained to consider coupled natural-human systems (such as villages) as a whole as against the current way in India of considering only the end of pipe emissions and impacts on the environmental media. It would be beneficial if additions are made to existing impact assessment curricula at university level to affect the changed thinking. In the face of increasing delegation of powers to the village councils in India i.e. panchayatiraj system, capacity building becomes important among stakeholders for effective participation in EIA process from scoping to follow-up. The linkages brought out by the methodology have the promise of being a stepping stone to bring sustainability considerations into the EIA domain and move towards realizing its substantive purpose.