CHAPTER 8: APPLICABILITY OF THE METHODOLOGY FOR INTEGRATED ASSESSMENT OF SUSTAINABILITY LINKAGES IN OTHER COUPLED SYSTEMS

This chapter outlines the steps required for general application of the integrated assessment methodology in coupled human-nature systems and the direct application of the cognitive maps and the indicators in other agro-ecosystems.

8.1 Introduction

The methodology for integrated assessment of sustainability linkages can be applied to any coupled natural-social system. Since the methodology completely relies on step by step understanding of a coupled system through its inhabitants it can be applied to human-natural coupled systems of varied types and scale. As detailed in the previous chapter the application of the methodology will consist of the following steps:

- Preparation of overall sustainability linkage structure of the system
- Preparation of cognitive maps for individual livelihoods, sustainability components and sub-components through focus groups/ interviews
- Derivation of detailed list of indicators from the cognitive maps
- Formulation of rural sustainability linkage questionnaire
- Delineation of surrounding ecosystem into watershed zones
- Elicitation of status of indicators for sustainability components and sub-components along with zonal linkage of indicators
- Studying the functional aspects of linkages
- Analysis of distribution of indicator status and framing strategy for sustainability of the linkages
- Analysis zonal linkages to decide on land use and siting of developmental projects
The above steps needs to be followed for a detailed understanding of the sustainability linkages in a coupled system and to establish the base for sustainable management of the linkages. In situations requiring a rapid assessment in coupled systems similar to the agro-ecosystem presented in chapter 7.0 i.e. village of Kalaramapatti direct applicability of the cognitive maps and indicators with minor modifications will of good utility. The rest of this chapter is devoted to framing of direct application framework in similar agro-ecosystems.

8.2 Direct Applicability of Cognitive maps and Sustainability Linkage Questionnaire

In situations requiring rapid assessments in agro-ecological systems, the cognitive maps and the questionnaire developed in this study for Kalarampatti Village can be directly applied after modifications. The main aspect which allows for such application is the similarity in the socio-ecological linkage structure of agro-ecosystems throughout India and may be in other parts around the world. To verify the direct applicability of the cognitive maps and the questionnaire and to generate a framework for the same, it was applied to Srinivasapuram village of Ariyalur District, an agrarian village in close proximity to limestone mines. Based on this experience a framework for direct applicability of the cognitive maps and the questionnaire was developed.

Brief profile of the village: Srinivasapuram

The village of Srinivasapuram is situated in Ariyalur block of Ariyalur district (State of Tamil Nadu, India, 11°09’16” and N 79°07’08”E). The village is situated in the limestone mining belt with a limestone mine running through its farmland alongwith a cement factory located adjacent to the mines. The soil which is black black clayey type extends upto a depth of 1.5-2.0 meters, below which are the limestone deposits. Farming is the main occupation of the village, with the majority of the farms being un-irrigated
small holdings dependent on the rain. Families also depend on raising cows for milk and goats for their livelihoods. The total population of the village is 1140, out of which 31% belong to the marginalised category. The study was conducted during October 2007 to December 2007 and tools used in the study for understanding the zonal linkages were toposheets prepared by Survey of India in the scale of 1:50,000, landuse maps prepared by Institute for Remote Sensing, Anna University 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.

**Table 8.1: Profile of Village Srinivasapuram**

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under panchayat (Sq. Km)</td>
<td>3.94</td>
</tr>
<tr>
<td>Cultivable farmland (Ha)</td>
<td>350</td>
</tr>
<tr>
<td>Population (2001)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1140</td>
</tr>
<tr>
<td>Marginalised (SC)</td>
<td>350</td>
</tr>
<tr>
<td>Drinking water</td>
<td></td>
</tr>
<tr>
<td>Dug Wells</td>
<td>3</td>
</tr>
<tr>
<td>Handpumps - mark 2</td>
<td>6</td>
</tr>
<tr>
<td>Pumpsets</td>
<td>1</td>
</tr>
<tr>
<td>Deep borewell pumpset</td>
<td>3</td>
</tr>
<tr>
<td>OverHead Tanks</td>
<td>3</td>
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<tr>
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<td>30</td>
</tr>
<tr>
<td>Roads (km)</td>
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</tr>
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<td>Water Bound Macadam</td>
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<tr>
<td>Bitumen black top</td>
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</tr>
<tr>
<td>Cement</td>
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</tr>
<tr>
<td>Gravel</td>
<td>1</td>
</tr>
<tr>
<td>Lakes (Nos)</td>
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</tr>
<tr>
<td>Ponds (Nos)</td>
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</tr>
<tr>
<td>Schools (Nos)</td>
<td></td>
</tr>
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<tr>
<td>Secondary</td>
<td>nil</td>
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### 8.2 Steps in direct applicability of Cognitive maps and Indicators

The steps required for the application of the cognitive maps and the indicators in other agro-ecosystems as found effective during its application in Srinivasapuram are as follows:

- Sketch socio-ecological structure of the village
• Verify cognitive map of overall sustainability interactions prepared for village-1 (Kalarampatti) and include/modify components and linkages
• Based on differences modify other cognitive maps for individual components
• Revise questionnaire based on modifications in cognitive maps
• Divide village area into watershed zones
• Conduct focus group discussions and interviews to elicit status and zonal linkage of indicators
• Study the functional aspect of linkages
• Analyse distribution of indicator status and frame strategy for sustainability of the linkages
• Analyse zonal linkages to decide on land use and siting of developmental projects

8.3.1 Sketch socio-ecological structure of the village

As the first step towards application of the assessment methodology, the model socio-ecological structure (figure 7.1) was modified to suit the village of Srinivasapuram and is shown in figure-8.1.

![Socio-ecological Linkage structure for Srinivasapuram Village](image)

Figure 8.1 Socio-ecological Linkage structure for Srinivasapuram Village
The key modifications made were the addition of components pertaining to limestone mines and the cement factory. These additional components exert considerable influence on the functioning of the socio-ecological system of the village of Srinivasapuram.

8.3.2 Verify cognitive map of overall sustainability interactions prepared for village-1

As the second step the cognitive map of overall sustainability interactions was analyzed for its applicability to this village. The main modifications were the addition of components (limestone mine and cement factory), modification of dug wells into bore wells and forest area into general watershed.

- Key differences identified in Srinivasapuram were:
  - There is no Forest range around the village
  - Key means of access for water is through deep bore wells > 300 feet
  - It has less area under irrigated farming
  - Dug wells are not useful as they do not hold water due to the porous limestone formation and because of mining activity in zone C
  - Mining activity in Zone C
  - Cement factory providing casual temporary labour

8.3.3 Based on differences modify other cognitive maps for individual components

The individual cognitive maps were discussed with members from individual livelihoods for their representation of the interactions in Srinivasapuram. The revised maps for the livelihoods, components and sub-components of sustainability are given in Appendix-C. The revisions carried out in the cognitive maps were mainly reflecting the change in the overall cognitive map for sustainability interactions and are as follows: the change in means of access for water from dug wells to bore wells; increased conversion of farmland due to mining and acquisition by cement companies; the absence of a forest
area and its subsequent linkages for fuelwood, grazing, biodiversity and the differences in the availability of physical infrastructure such as schools, hospitals, financial institutions, etc.

8.3.4 **Derive list of indicators and Revise questionnaire based on modifications in cognitive maps**

The list of indicators was revised as per the changes in the individual cognitive maps to arrive at the final questionnaire. Since the sustainability interactions in Srinivasapuram was similar to that of the model village of Kalarampatti, the revisions in the list of indicators were very low and pertained only to the removal of indicators pertaining to the forest range.

8.3.5 **Divide village area into watershed zones**

The area around Srinivasapuram was divided into four zones on the basis of a watershed. The zone A encompasses the area which contains a series of ponds crucial for storage and recharge of ground water. The zone B contains both irrigated and rainfed farms, the latter being predominantly owned by the marginalized community. The lakes which serve as a source of surface water are also located in this zone. The zone C mainly consists of rainfed farms and the limestone mine which influences the water availability in zone B & D. The zone D consists predominantly of irrigated farms belonging to the dominant upper caste community of Srinivasapuram. The ecosystem profile of Srinivasapuram village along with the watershed zones is shown in **figure 8.2**.
8.3.6 Conduct focus group discussions and interviews to elicit status and zonal linkage of indicators and Study the functional aspect of linkages

Focus group discussions were conducted among farmers and farm labourers for elicitation of status and zonal linkage of indicators. Individual interviews were conducted with persons dependent on goat herding for their livelihood.
8.4 Rural Sustainability Linkage Questionnaire (SLQ): what is the status of the linkages and its spatial distribution?

The results of SLQ for the village of Srinivasapuram are discussed in the following sections. The status of Indicators and their zonal linkages for the Village of Srinivasapuram is given in Appendix-B. Since the overall sustainability interactions displayed in figure-8.3 follows a similar pattern like that of Kalarampatti village discussed in Chapter – 7, only the key interactions in this village are highlighted.

8.4.1 Natural Component
8.4.1.1 Sub-Component: Land

Status of indicators: The land resource in the village is suitable for farming. The top soil cover is adequate ranging from 1.0 to 1.5m. But only around 50% of the farms are equipped with irrigation source (lake/ bore well). The area under double cropping is less than 50%, which are mostly equipped with deep bore wells. The land use has been under pressure from mining and land acquisition by the cement factories. 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 overall status of indicators for land is shown in figure-8.4.

Zonal Linkages: As shown in figure-8.4 the zones A&D exhibit high linkage 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 A & B. Single cropped rain-fed land are mostly in the Zones B & C.
Figure 8.3   Overall Sustainability interactions in Srinivasapuram

8.4.1.2  Component: Water

Status of indicators: As shown in Appendix-B and figure-8.4 the village has a fluctuating water table owing to the porous limestone formation. The mining activity has a major influence on the availability of water through the lakes and dug wells. Since the mines draw down the water available after the monsoon, the water table goes down quickly beyond the reach of the lake and the dug wells. Though the groundwater is available at a depth of 300-400ft throughout the year, the cost of developing a bore well of about 400 feet involves expenses in the range of INR 300,000 (USD 7500), which is beyond the reach of small and marginal farmers who depend on rain fed farming alone.
Figure 8.4  Natural Components – Status of Indicators and Zonal Linkages
With the monsoon’s increasing erratic nature, about 2-3 years of below average rainfall is interspersed between good monsoon years. The Small and marginal farmers dependent on rain fed farming are severely affected by this fluctuation and resort to migration to cities in search of steady employment.

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. Lack of surface water availability has affected the population of cattle and goats owned by persons without irrigated farms and landless labourers.

**Zonal Linkages:** The zonal linkages for water are shown in Figure-8.4. The zones ABD form the important linkages as they are the main catchment areas for the lake, ponds and subsequent ground water recharge. The zone B&D constitute the prime agricultural area owing to its irrigated farms with deep borewells. Zone C with its limestone mines exerts a negative influence on the surface water availability.

### 8.4.1.3 Fertility & Pests

**Status of indicators (Fertility):** Fertility as a sub-component best illustrates the changed scenario of farming altogether in this village also. The status of indicators for fertility and pests are shown in Appendix-B and Figure-8.4. Owing to the large percentage of marginal holdings used for subsistence farming, application of dung manure and green manure is still practised, but not to the level of inducing sizeable yields.

**Zonal Linkages (fertility):** zone ABD have their high linkages owing to the presence of farm side and road side vegetation, seasonal pasture interms of lake bed and rainfed farmland.

**Status of indicators (pests):** Monkeys and bird pests such as parakeets, etc. continue to remain a concern which requires continuous guarding during the day. Electric fencing
which kills all animals indiscriminately is not adopted in this region due to fear of misuse by miscreants. The control of weeds in fallow lands which were done through frequent ploughing has given way to spraying weedicides.

Zonal Linkages (pests) – In terms of control of insect pest suitable vegetation to support nesting communities of insect eating birds play an important role. Hence the zones ABD with their farm periphery vegetation and native vegetation along the waterways have their high linkage.

8.4.1.4 Farming Practices

Status of Indicators: The status of indicators for this sub-component is shown in Appendix-B and Figure 8.4. Intercropping in the village is restricted to marginal rainfed farms. The cropping diversity has reduced and the main crops cultivated are maize for its less labour requirement and reduced loss to birds, and traditional Jowar for its use as cattle fodder. More than 50% of the farms are not making any profit and the real income has not grown much to enable adoption of technology to enhance usage of water and land.

Zonal Linkages: sustainable farming practices have their presence in the zones of ABD, mainly in the marginal holdings through reduced usage of fertilizer and pesticides because they cannot afford them. While in the irrigated farms in zone BD, intensive routine of mainly sugarcane, rice and maize are followed. In terms of high productivity and profitability the farms are mainly concentrated in the zones of B&D. The zonal linkages are presented in figure 8.4.

8.4.1.5 Livestock

Status of indicators: Goat/sheep herding: The status of indicators for Livestock is shown in Appendix-B and figure-8.5. The number of goat herds in the village has come down in this village also over the years due to acquisition of land for mining and cement
factories. This has affected the activity of direct manuring of farmland. Hence the sustainable transfer of nutrients from the surrounding vegetation onto the farm land through goat manure has been totally reduced. 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.

**Cattle:** The situation of cattle in this village is similar to that of Kalarampatti. As shown in [figure-8.5](#), the reduction in cattle numbers has affected the availability of organic manure. Apart from scarcity of farm labour, 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. The animal husbandry infrastructure in this village is also far from satisfactory.

**Zonal Linkages:** linkages with respect to this sub-component as shown in [figure-8.5](#) are pointed out based on grazing land (permanent/ seasonal) and roadside vegetation. Zones ABD have their high links owing to availability of fodder from farmland, farmside & roadside vegetation and engaging of goat herds for manuring. Zone ABD have their high links owing to the presence of lake beds which provides pasture ground after monsoon.

### 8.5.1.6 Bio-diversity

**Status of indicators:** The status of indicators for Bio-diversity is presented in [figure-8.5](#) and Appendix-B. 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 maize, rice and sugarcane. The reduction of crop diversity has contributed to low nutritional diet mainly of rice.
Figure 8.5  Natural Comp. – Indicators and Zonal Linkages (Contd.)
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 and the farm hedges.

Zonal Linkages: The zonal linkages are presented in figure-8.5; zones ABD have their highest linkage for floral diversity in the native vegetation along the road edges and also high links in terms of farm trees for fruit and timber. The rainfed farms of Zones ABCD have their links in terms of traditional varieties of coarse grains which are cultivated. The farm side vegetation in the zones of ABD is the sourcing areas for medicinal herbs.

8.5.1.7 Energy
Status of indicators: The status of indicators for Energy is presented in figure-8.5. The situation on the lighting front is negative as the adoption of solar/ renewable energy is absent. Bio-diesel as an alternative fuel is yet to make its presence. The village community is very reliant on agro-residue for their cooking requirements.

Zonal Linkages: the zones of ABD have their high linkages with energy requirement as shown in figure-8.5. Dried cow dung, Thorny scrub and other vegetation which grows on fallow land also provide a substitute for fuel wood for cooking.

8.5.1.8 Forest: there is no forest area around this village.

8.5.1.9 Environmental Monitoring
Status of indicators: The status of indicators for Environmental Monitoring is shown in figure-8.5. The status of environmental monitoring in this village is similar to Kalarampatti. Though the village is affected by mining and emissions from the cement factory, there is no program either by the government or the factory/ mine operators to systematically record the environmental impact. 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 TWAD for physico-chemical indicators only. The drinking source is a bore well located near the lake and the quality is suitable for drinking. 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-8.5. The zones of ABCD which all have their linkages in farming activity are to be monitored for contaminants moving up the food chain. The zone ABD are the main catchment areas for the drinking water source i.e. Lakes & ponds. Application of pesticides and fertilizers in the zones ABCD needs to be monitored. Zone C is the worst affected by limestone mines which are likely to expand into zone A, threatening the flow of water onto lakes in zone B.

**8.5.2 Marginalised**

**Status of indicators:** The status of indicators is presented in Appendix-B and figure-8.6. The plight of marginalised community in this village is worse than that of kalarampatti village. Though they derive their livelihoods by depending on agricultural labour and to a lesser extent on goat herding, the extent of irrigated farms in this village does not provide enough employment and income. The majority of men are employed in cities or abroad as casual labourers and the family depends on their remittance. The women have their direct links with the ecosystem in terms collecting firewood, wild fruits and berries, medicinal herbs, etc. The young girls are mostly employed as salespersons in the nearby town 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.
Zonal Linkages: The zonal linkages for the marginalised community are shown in figure-8.6. Zones ABD 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 B & C in the form of rain fed farmland, which also enables them to graze their goats during the fallow period of the year. Their govt. allotted row houses and other activities are restricted to zone B so as to be away from the main village, which is also used for grazing their goats, collecting firewood and for open yard defecation.

8.5.3 Social, Financial & Physical Components

8.5.3.1 Importance of social capital for sustainability

The social capital in this village is among the lowest range in the state of Tamil Nadu. The educated are a minority exclusively from the dominant upper caste. They are employed in the cement factory and that steady income enables them to afford deep borewells in their farms concentrated in zone D thereby further enhancing their income and social status. The status of social indicators is presented in figure-8.7 and Appendix-B. The population growth in the village is still exerting a negative influence in fragmenting the farms into marginal holdings. Health care is restricted to what is provided by public hospitals in Ariyalur town about 5 kms away, 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. 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 as it is elsewhere, 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. Farm prices have continuously gone up owing to large scale acquisition by cement factories in the region. This has resulted in temporary availability of cash, with little prospects of a secure future. 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 increase in fuel prices input costs have shown an increasing trend.

Cohesion across community is still a concern in the village as the bonds are caste based. The village being reserved for the marginalised community for panchayat leadership has ensured that the village council is headed by a person from the marginalised community. This has ensured that the concerns of the marginalised are considered while decisions are made regarding usage of welfare funds. Crime rates are low and do not constitute a problem.

8.5.3.2 Financial Component

The status of financial indicators for the village is shown in figure-8.7. and Appendix-B. The village contains 41% of families classified as living below poverty line (BPL).
The govt. is targeting these BPL families through a variety of welfare measures such as the national rural employment guarantee scheme (NREGA) which provides a minimum
of 100 days of employment. Most of the rainfed farms are held by farmers who cannot afford a bore well which can allow irrigated farming with greater returns. But absence of institutional credit is responsible for their continued precarious dependence on rainfall alone. The BPL families are either dependent on the casual labour available in the village and the cement factory, but the majority are dependent on the remittances sent back by the men working at industrial centres such as Tiruppur and Chennai in Tamil Nadu. In times of need the families rely on money lenders for cash at exorbitant rates. The prices of farm inputs have steadily risen while the price of farm produce have either stagnated or have risen only marginally.

8.5.3.3 Physical Component

The status of physical indicators is shown in figure-8.7 and Appendix-B. The physical component of sustainability in this village is very poor in all respects. The road link which the village has with the district headquarters Ariyalur has been cut off by the limestone mine in zone C. This has severely disrupted the bus service to the village, which is now dependent on a private mini-bus service which visits thrice a day. Hence the villagers including school going children have to walk around 2 kms to the nearest village of Kallankurichi to catch a bus to Ariyalur. Since that have to rely on Ariyalur town for all aspects such as Hospitals, schools, market, etc. the lack of transport infrastructure affects all aspects of sustainability.

The irrigation infrastructure consisting of pond, lakes and the connecting channels need desilting to ensure their effectiveness. The expansion of mines into zone A severely threatens the flow of water. 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 in
ration shops. 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. 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. The water tank in the marginalised colony is in a dilapidated condition and requires repairs. The power supply is irregular mostly requiring farmers to irrigate the fields at night.

Radio remains the main channel of market information, weather, farming news and technology updates. The village does not have cable TV connection as the number of families able to pay monthly subscription is very less. The increase in density of mobile phone connections have also improved access to information relating to markets. Housing comprises of concrete or tiled structures for the dominant community with the marginalised mainly living in thatched huts and govt. allotted tiled row houses. There is no manufacturing/ value addition activity even at the cottage industry level such as snacks, cooking ingredients, etc.

8.6 Overall results and distribution of indicator status for sustainability components

The key findings from the SLQ is summarised in Table-8.2. The overall percentage distribution of status of indicators for sustainability component is shown in figure-8.8.
From the figure it can be observed that the majority of indicators for basic resources such as land and water are in either neutral (0) or negative (-0.3) status. Water has over 50% of its indicators in neutral category and over 40% in negative and highly negative category. Land has 18% of its indicators in positive category and an equal percentage in neutral category, but the majority of 64% is in highly negative category. This indicates that the basic resources for farming in this village are not conducive for intensive farming. As the water is accessible only through deep borewells, the marginal farmers without this means of access are only dependent on the rainfall. Hence the other sub-components dependent on land and water such as fertility, livestock, energy and biodiversity show significant negative status.

The marginalised category is very much on the negative side (85%) 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 education. The positive and neutral status of 40% in social component is related to aspects such as the care of old age/destitute, crime free environment in the village, etc. The financial component shows the worst distribution on the whole with a highest highly negative (35%) and negative (45%) 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 which is normally relatively better than social and financial components in all villages due to govt. efforts is also poor in this village with 48% under neutral & positive status and 52% on the negative side. This positive status is mainly due to absence of homeless families, success of immunization programs and free electric supply to BPL homes.

8.6.1 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-8.9. Considering that water comes first for its crucial role, zones A and D which have higher ‘high linkages’ (25% and 21% of all zonal linkages with water) will have to be assigned positions of high ranking. Zone A will have to be ranked first for its highest proportion of high linkages (20%) for all the sub-components and B & D would be second for having the second highest (16% & 17%).

Next of the two zones (B&D), zone B has the highest proportion of high linkages (31%) for sub-component land, which can be considered second in importance after water, but when compared for linkages with marginalised community, Zone B has the edge over D in terms of its higher ‘high linkages’ for the marginalised community (21% over 9%).

Hence the final ranking of importance for practical purposes would be: 1-Zone A, 2-Zone B, 3-Zone D, 4-Zone C.
### Table-8.2: Brief summary of Results for Srinivasapuram Village

<table>
<thead>
<tr>
<th>No</th>
<th>Compon./ sub-comp.</th>
<th>Key Indicator status</th>
<th>Implications for sustainability</th>
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<th>Highly linked components</th>
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<td></td>
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<td>neutral</td>
<td>negative</td>
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<td>A</td>
<td>Natural Component</td>
<td></td>
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<td></td>
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<tr>
<td>1</td>
<td>Land</td>
<td>Depth of top soil</td>
<td>% under farming</td>
<td>Availability per capita, farm size.</td>
<td>Fragmentation of farmland</td>
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<td>2</td>
<td>Water</td>
<td>nil</td>
<td>Water availability</td>
<td>Water table decline, use efficiency</td>
<td>Ground water withdrawals, mining</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>
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<td>3b</td>
<td>Pests / weeds</td>
<td>Pest outbreaks, Weedicides, electric fencing</td>
<td>ploughing</td>
<td>Increased use of Pesticide, natural pesticides</td>
<td>Toxic buildup, loss of species</td>
</tr>
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<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>nil</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>Absence of electric fencing</td>
<td>hiring of farm machinery</td>
<td>fuel charges, availability of farm machinery</td>
<td>Dependence of external fuel</td>
</tr>
<tr>
<td>8</td>
<td>Monitoring</td>
<td>nil</td>
<td>Water quality</td>
<td>Mining, cement factory, monitoring program</td>
<td>Build-up of toxins in food chain, water depletion</td>
</tr>
<tr>
<td>B</td>
<td>Marg’d Section (labour)</td>
<td>Subsidized food rations</td>
<td>Wage levels, panchayat membership</td>
<td>Discrimination, lack of health care, employment</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, education</td>
<td>Increasing population, erosion of values, change in lifestyle</td>
</tr>
<tr>
<td>D</td>
<td>Financial</td>
<td>Free electricity, subsidised fertilizer</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</td>
<td>Access to markets, communication</td>
<td>Sanitation, roads, housing, hospitals, schools</td>
<td>wastage of resources, uninformed decisions</td>
</tr>
</tbody>
</table>
Based on the ranking it can be considered that 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 C which is already under the impact of limestone mines. It is important to remember that activities which involve heavy extraction of ground water will have it serious impact while being located in any of the zones unless its influence is restricted to a local confined aquifer.

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 study. Further the ranking involves consideration of linkages only for the village of Srinivasapuram, it is quite probable that zone C might have a high ranking with respect to linkages of adjacent villages, 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.

**8.6.2 Functional aspects of linkages for Village of Srinivasapuram**

*Internal and External Linkages* provides information related to vulnerability to external factors. The village is still linked more internally for its cooking energy needs in the form of crop residue and wood fuel from the common areas. It is also externally linked to LPG and kerosene, but the usage is still a minor percentage of total use. The external linkages for inputs have continued to grow in the form of seeds, fertilizers and pesticides. Due to scarce farm labour it is much more dependent on farm machinery which in turn is linked to the volatile fossil fuels. Since the village is fully reliant on deep bore wells, the external factors of cost of bore well pumps and electricity play a major role in the success of crops. Since the village does not have adequate infrastructure for education and healthcare, it is externally linked for these with Ariyalur town. The majority of the marginalised families are dependent on the remittances sent by the men who are working in the industrial centers of the state, country and abroad.

*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. The watershed 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 these watersheds in zones of A & D important. The remaining cattle which provides organic manure needs to be nurtured with effective policy to provide support in price of milk and veterinary services.
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. The key livelihood interactions in this village are among farming, labour and goat herding as is the case in all villages. The marginal farmers being dependent on cows and goats as a source of regular income rely on the fallow lands for grazing and surface water sources for drinking water. The mining activity influences the water availability in the lakes and thereby affects the farming & herding livelihoods to a major extent.

Means of access and Level of entitlement to a resource

Understanding the linkages through the means of access enables us to better estimate the impact of any activity on the linkages. The means of access affected in the village are: the common surface water resource which is affected by depletion due to mining and the main road link with Ariyalur town which has been cut off due to the mines. The increased buying of farmland by cement companies will exert a negative impact on all livelihoods in future.

Temporal aspect of linkages

Availability of water in the lakes, ponds and the borewells in the village fluctuates according to the season of the year. The summer months being the period of water stress, which is accentuated by the withdrawal of ground water by the cement factory and its township.

Ongoing interventions and socio-ecological changes

In this village external intervention from government is in the form of subsidized rations, housing for the marginalized, public primary school, and welfare schemes for the BPL families. The socio-ecological changes occurring at the village are the changes in the
well being of the marginalized mainly due to migration and remittances, the selling of farmland to cement companies which gives the families immediate short term liquidity at the expense of long held farmland and the education of the girl child.

8.7 Conclusions on direct applicability of Cognitive maps and Sustainability Linkage Questionnaire

The methodology for integrated assessment of sustainability linkages can be applied to understand any coupled human-nature system. The step by step procedure outlined in this chapter for its general application will help in detailed understanding of the linkages. However in situations requiring rapid assessment of linkages, the cognitive maps and the linkage questionnaire can be used after suitable modifications as per the steps outlined in this chapter. Considering that the socio-ecological linkage structure of agrarian villages in India exhibit remarkable similarity in terms of its farming community, the marginalised agri-labour and the sustainability components, the direct applicability of the cognitive maps and linkage questionnaire has the potential to be of significant utility.