Shinduvadi Village Ecosystem: State of Environment and Natural Resources 2007

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Preface

Natural resources in India are subjected to use and degradation due to high population density as well as poor management. With the population of India projected to increase over the coming decades, there would be increased dependence and stress on the resources and sustainable management of these resources needs to be ensured for sustained production and supply. Currently in India, there are a few efforts to monitor the natural resources, largely at macro level. Indian Institute of Science has developed a methodology and strategy for monitoring natural resources at the village level. However, institutional structure and arrangement for monitoring the natural resources at village ecosystem level are lacking.

Monitoring of natural resources and environment at decentralized level such as villages, panchayats and districts can be achieved only by involving local educational institutions, particularly Science and Arts colleges all across India where students reside and interact with the local environment. They are likely to be more aware about the status of environment and will be more responsive to the need for protection of the environment.

I am very happy to state that Sahyadri Science College of Shivamogga took initiative on their own to undertake monitoring and reporting of State of Environment and Natural Resources. The Sahyadri Science College, particularly the Pathways Unit took initiative to contact Village Natural Resource Monitoring Cell of Centre for Sustainable Technologies, Indian Institute of Science to learn from their experience of developing methodologies and approaches for monitoring the State of Environment and Natural Resources. Centre for Sustainable Technologies, Indian Institute of Science had a large project supported by India Canada Environment Facility and Ministry of Environment and Forests, Government of India to develop methodologies, approaches and strategies for developing a national programme for monitoring State of Environment and Natural Resources, based on agro-ecological zone approach.

My colleagues and I are highly appreciative of the efforts and dedication of the students, the teachers, the principal and most importantly, coordinator of Pathways unit, Dr. BC Patil. The students have really understood the need for monitoring the natural resources and also are highly appreciative of the needs for protection and conservation of the resources. I also would like to place on record the dedicated efforts of Rakesh Tiwari in particular and my other colleagues, who motivated, trained and worked with the students during the course of this monitoring, data analysis and report preparation. I acknowledge the assistance provided by Mythri DJ, Ajay GA, Rashmi Tiwari and Swarnima Singh. I would also like to thank Indu K Murthy, Dr. Sandhya Rao and Dr Ramakrishna Parama for their expert advice during the course of this exercise.

I would like this activity to be carried forward by educational institutions across India so as to generate State of Environment and Natural Resources Reports that could be used directly for decision making at the village level. Moreover such an exercise by students will sensitize them to the issues of the environment, livelihoods and sustainable development.

Prof. NH Ravindranath
Chairman, Centre for Sustainable Technologies
Indian Institute of Science
It is the youth, the students who will redefine the development of the country. This unique piece of work is an output of dedicated work carried out by the undergraduate students of Pathways Unit, Sahyadri Science College, Shivamogga. Students from varied streams put together their efforts and valuable time to understand the problems and issues related to natural resources and communities depending on them by interacting with the people of Shinduvadi. The students got an opportunity to learn basic research methodologies at a budding stage. The activity also sensitized the students to issues and problems of the farming community and the underlying causes. This coordinated work is a clear demonstration of research reaching the lowest of the economic strata. This endeavour by students is probably a first of its kind in the country where collaboration between a research institute and a college has produced an output which could be used for policy-making at the grassroots' level. This also sets an example for other colleges for taking up pro-society research initiatives.

VNRM cell
Centre for Sustainable Technologies
Indian Institute of Science
Acknowledgement

We would like to thank the people of Shinduvadi for extending support, without which this exercise would not have been possible. Thanks are also due to the following:

- Mr. Rudresh, Tahashildar and staff members, Thirthahalli taluk
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- Mr. Eshwar, Member of Gram panchayat, Shinduvadi
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Contents

Introduction 1
The village 3
Demography and rainfall 6
Land 8
Cropping pattern 9
Agro-forestry 12
Forest and wildlife 13
Livestock 16
Soil and water 18
Energy infrastructure and sanitation 20
Shinduvadi ecosystem—an overview 21
The status of natural resources is critical in determining the environment, economy and livelihoods of rural communities. Planning, management and developmental activities at the village level have to be done with in-depth understanding of the status of resources and their inter-linkages. The first step in promoting participatory natural resource management is creation of awareness and generation of basic information on the status of natural resources and factors contributing to changes in those resources. Periodic monitoring of resources facilitates understanding of the status of resources, trends, the drivers of change and environmental issues. Currently in India, efforts to monitor natural resources have been limited, and most of them are on a macro scale. There has been no institutional mechanism to monitor natural resources at the level of a village ecosystem. Indicator-based methods and guidelines for monitoring natural resources of a village, which have been developed by the Centre for Sustainable Technologies, Indian Institute of Science, provide a way to make an inventory of natural resources and to institutionalize the monitoring process so as to generate periodic data at grassroots' level, which will be useful for planning and research.

The state of environment and natural resources report is a synthesis of the inventory exercise, which presents the status and trends of natural resources based on the inventory as well as past data sources and the implications of the status and the trends for livelihoods, the environment and economy of the village. The current inventory exercise was aimed at demonstrating the feasibility of monitoring village ecosystems by local colleges with some inputs from experts. The Village Natural Resource Monitoring Cell at the Centre for Sustainable Technologies enlisted selected students of Sahyadri Science College, Shivamogga, in the exercise; trained them in basic monitoring techniques and involved them in sampling and field and laboratory measurements. Existing laboratory facilities of the college were used for conducting chemical analyses.

The Village Ecosystem
Natural resources are being continuously exploited and suffer degradation due to high human and livestock population density as well as poor management. This has adverse implications for stable food production, supply of fresh water, fish production, fodder, fuelwood, timber supply, etc. This study was conducted at the village ecosystem level for the following reasons.

- Villages function as ecosystems where there is functional interdependence between different natural resources.
Decision-making on the use and management of natural resources such as forest, biodiversity, grazing lands and irrigation water occurs at the village ecosystem level.

Participatory institutions such as water sanghas, forest protection committees and biodiversity management committees are organized, and function at the village level.

Agro-ecological Zone Approach
The AEZ (Agro Ecological Zone) approach was adopted for selecting the village taking into account the extent to which the village represented the features and general trends in resources of the AEZ sub-zone. The AEZ approach was adopted for the following reasons.

- AEZ stratification is widely used and accepted for studies and planning at both global and national levels. Institutions such as the Planning Commission of India, research institutions across the country, agricultural colleges and other institutions widely use the AEZ classification.
- Strong interdependence exists among the resources such as forests, grasslands, croplands, water bodies and livestock at the village ecosystem level.
- Overlaying the natural ecosystem boundary of an AEZ with administrative boundaries gives a unique combination of physical, biological and socio-economic aspects.

Utility of the Study
The report serves policy-making, planning and decision-making at various levels. Different categories of users of this report include the following.

- Village communities, including farmers, particularly women, to assist them in decision-making on the use and management of natural resources.
- Policy-makers at regional, state and national level to help them design strategies and policies to conserve natural resources.
- District/block/panchayat level planners and decision-makers.
- Development departments such as forest, agriculture, pasture development, water resource and the environment to promote sustainable practices.
- Educational institutions to create awareness.
Shinduvadi is a small village in the Western Ghats (locally called malnad) region of Karnataka spread over 503 ha. The village is part of Mandagadde panchayat of Thirthahalli taluk of Shivamogga district, about 4 km from River Tunga. The village falls in the Shettihalli forest range with characteristic moist semi evergreen—dry deciduous forest. The village is primarily an agricultural village with paddy and areca being the major crops. The nearest town is Thirthahalli, which is about 25 km away, although Shivamogga is approximately 23 km from the village (if the distance is measured radially).

Shinduvadi is surrounded by four villages: Haalaga to the north, Halasawala to the east, Hemmakki to the south and Ubbur to the west. Settlements are scattered but mostly confined to the central part of the village.

Shinduvadi is in AEZ sub-zone 8.2, the Central Karnataka Plateau with hot moist semi-arid climate, medium to deep red loamy soil, low available water holding capacity and length of growing period of 120–150 days (Figure 1).

Why Shinduvadi?
The following considerations make the village distinct and significant for monitoring.

► The village has features characteristic of malnad such as forests, grazing land and a paddy–areca-based agriculture.
► Although located in AEZ sub-zone 8.2, Shinduvadi is very close to sub-zones 19.2 and 6.4, ideally a transition zone between 8.2 and 19.2.
► Mandagadde bird sanctuary, part of Shettihalli forest, is about 4 km from Shinduvadi. The island formed in the middle of River Tunga provides habitat for migratory birds.
► The village, 650 m above the sea level, is about 4 km from River Tunga. Although the village is close to the river, rains and ponds are major sources of irrigation.

Resources Monitored
Major resources monitored and parameters studied in the village are listed below.

► Land: cropland and cropping pattern, wasteland, forest and plantations
► Vegetation: agro-forestry (extent, species composition and changes), forest and plantations (extent, types, composition, biomass, regeneration status and basal area)
Soil: types, distribution and soil organic carbon (SOC) status

Water: irrigation water (availability, seasonality and groundwater status), drinking water (availability or accessibility, seasonality, quality and effort involved)

Livestock: population, composition, grazing pattern, fodder availability and dung production

Wild fauna: composition of major birds and vertebrate pests

Apart from these resources, information was also gathered on parameters such as demography, land-holding and occupation pattern, rainfall pattern, sanitation, electrification status, use of energy devices, human effort involved in collection of drinking water and fuelwood and institutional status.

Methods

The following methods, which are based on the guidelines and protocols developed by the Centre for Sustainable Technologies, Indian Institute of Science, were adopted.

Secondary records were consulted to obtain general information about the village, including demography, rainfall, past land-use, cropping pattern, irrigation and livestock. The information was gathered from
different departments such as the Thirthahalli taluk office and Mandagadde panchayat. A cadastral map of the village, dated 1910, was used as the base map.

Field studies, which are given below, were conducted to gather information on different resource indicators of the village ecosystem.

- **Land survey** The land was surveyed to demarcate and map current land-use systems, cropping pattern and irrigation sources. A map prepared in 1910 was digitized and used as the base map to demarcate current land-use. Latitudes and longitudes of strategic locations were ascertained and recorded. Land history was recorded wherever available.

- **Vegetation survey** To understand the extent of different forest types, species composition, regeneration status and biomass composition, four sample plots measuring $50 \times 20$ m were laid out. Each plot was evaluated for trees with height above 130 cm and girth greater than 10 cm at breast height. In each tree plot, two shrub plots ($5 \times 5$ m each) and four herb plots ($1 \times 1$ m each) were laid.

- **Agro-forestry survey** The survey was in fact a census and was extended to trees above 10 cm in girth at breast height and 130 cm in height to study the non-forest tree cover of the village, especially cropland bunds and block plantations. Parameters considered include species composition and density.

- **Soil and water** Soil samples were collected representing major land use and cropping systems and samples of drinking water were collected from major drinking water sources.

- **Bird survey** An all-out search for terrestrial birds in different land-use systems (cropland and forest) was carried out during early monsoon (June) to understand the avifaunal composition of the village.

Household survey was undertaken to obtain additional information on cropping methods, fertilizer and manure application, water and fuel sources, consumption pattern, etc.

Participatory rural appraisal was carried out to understand community perception of the status and trends in various resources, the usage patterns and the factors for changes, if any.

Laboratory measurements were made to determine the status of soils from different land-use systems and the quality of drinking water from different sources.

The inventory was carried out from October 2007 to February 2008, which is referred as the current period in this report. The land-use and cropping particulars are of kharif, the main cropping season (conducted during the harvesting period). The bird survey was carried out in June 2008.
The current population of the village is 246, comprising 95 men, 98 women and 53 children in 42 households. There has been a decreasing trend (43%) in the population of the village over the past three decades. The number of households has also decreased by 44% over the past 25 years. This reduction is mainly driven by reduced returns from agriculture, abandonment of agriculture in a few cases and migration in search of livelihood opportunities (Figures 2 and 3).

**Land Holding and Occupation**

Agriculture is the primary occupation of about 45% of the households in Shinduvadi and 49% are involved in agriculture-related businesses. About 50% of the farmers are categorized as medium farmers (holding 3–10 acres); 17% are large farmers (holding more than 10 acres) and 14% are small farmers (less than 3 acres). About 20% of the households are of landless labourers. All men in the village are engaged in agricultural activities; about a third are labourers. Approximately 18% of the men are involved in secondary occupations such as fishing and other agro-based industries. About 75% of the women work: agriculture (31%), labour (39%) and others (5%).

**Trends and Implications**

The number of land-owning farmers has increased by 77% whereas that of landless labourers has decreased by about 25% over the past 15 years. The increase in the number of medium farmers can be attributed to fragmentation of land holdings. Migration for employment and better income has led to the decline in the number of agricultural labourers leading to labour scarcity (Figures 4 and 5).
Rainfall Trends

Most of the rainfall is received during the monsoon, July and August being the peak months. The rainfall is quite high since the village is located in the Western Ghats high-rainfall zone. The mean annual rainfall of Thirthahalli taluk is about 3000 mm and that of Mandagadde is 2000 mm. Annual peak over the years is showing shift towards September which is significant in year 2002 and 2004 (Figures 6 and 7).

The region experienced drought from 2001 to 2004, which affected agricultural activities in the region. However, above-average rainfall in the past couple of years has led to revival of agricultural activities.

The average minimum and maximum temperatures of the region are 13 °C and 38.1 °C.
Major land-use systems in the village include cropland, forest land, water bodies, wasteland and grazing land. Cropland (230 ha) accounts for 46% of the total area of the village. Forests and plantations (104 ha) account for 21%. Four ponds (71 ha) account for 14% and other land categories including wasteland (21 ha) and grazing land (15 ha) account for the remaining 20% of the total area (Figure 8).

**Trends in Land-use**

Past land-use data were obtained from secondary records collected from the revenue department. The data were available for 1987 and 1995. Figures related to cropping pattern and irrigation sources were also derived from past records.

Area under cultivation decreased by 50% between 1987 and 1995 to 147 ha; however, it increased later and measures 230 ha at present. Area under crops has decreased and in few cases, agricultural lands have been abandoned. Dedicated grazing lands are totally lost: in the past three decades, they have been either converted to tree plantations or abandoned.

* non-arable drylands
Cropping pattern

Cropping Calendar
The cropping pattern of the village consists of both perennial and annual crops. Perennials or plantations mainly include areca. Paddy is the major annual crop. Currently paddy is cultivated as a kharif crop, dependent mainly on rains. Due to non-availability of irrigation during summer, paddy is not cultivated in the second season i.e., rabi.

Current Status
Paddy is the major crop of Shinduvadi, currently grown on 128 ha (55% of the total). The crop is primarily rainfed and cultivated during kharif with ponds as an additional source of irrigation. Areca is the second major crop, currently cultivated on 94 ha (41% of the total); 27 ha of these support such intercrops and mixed crops as paddy, banana, vanilla, turmeric and coffee (Figure 9).

Trends
Agricultural activities in Shinduvadi have been fluctuating over the past two decades. In a few cases, agricultural lands have been abandoned and plantations established (about 132 ha of coffee plantation has been abandoned). Such changes may be due to factors such as shortage of labour, increased cost of cultivation and price fluctuations.
Area under areca has increased threefold over the past three decades. Areca is fast replacing paddy, area under which has been fluctuating owing to non-availability of irrigation. About 20 years ago, paddy was cultivated twice a year, as a rainfed crop in kharif and irrigated with pond water in rabi. Currently the ponds are silted and farmers are forced to depend on rains and harvest only one crop a year. Coffee, which was introduced during early years of the 20th century, was the major crop during the 1980s. Cultivation of coffee was completely abandoned in the past decade mainly because of lack of a good market, fluctuating prices and labour scarcity, although such factors as inadequate rainfall and lack of transport also played a role. Farmers are currently introducing rubber in an effort to stabilize returns from agriculture (Figure 10).

Crop Varieties
Paddy varieties currently cultivated include Jaya, Jyothi, BGM Sona, IT and Bhagyajyothi. Areca variety cultivated is local. There has been a gradual change in the varieties of paddy being cultivated. Varieties cultivated 10–15 years ago included Jyothi, 1001, 1010 and Intan; farmers now prefer improved varieties for higher yields and returns.

Pests and Pest Control
Blast of paddy, a fungal disease, is the major disease; it was reported by 52% of the cultivating households. Aphid infestation was reported by 9% of the responding households whereas 22% of the responding households reported no pests. The major disease of areca is koleroga, a fungal disease, which was reported by 87% of the cultivating households; 9% reported other diseases as well.

Control measures adopted for blast of paddy include application of pesticides such as enosan and democran. Bordeaux mixture (1:1:1 ratio by weight of copper sulphate, lime and adjuvant) is applied to control koleroga of areca at the rate of 25–40 barrels (3100–4600 litres) per ha annually. Usually a precautionary spray is given before the rains and once infection is observed, three to four rounds of bordeaux application are undertaken. Organic pesticides such as neem cake and neem oil are also used for koleroga in a few cases.
Fertilizer and Manure Application

Fertilizers are applied in larger doses for areca (0.6 t/ha) than for paddy (0.4 t/ha). On the other hand, paddy gets greater quantities of organic manure (4.8 t/ha) than areca (2.9 t/ha).

There has been a drastic reduction (about 90%) in the application of organic manure to the croplands. Although there is land legally earmarked as soppinabetta for supplying green manure for areca, neither green leaves nor dry leaves from forest are used as manure, and gliricidia, which exists in abundance on bunds and is a good source of leafy manure, is hardly used.

Trends in Crop Yields

Half of the areca-cultivating households reported reduction in yield over the past 5–10 years, 38% reported an increase and the rest reported no change. The reduction in yield can be attributed to koleroga infection, which can reduce yields by up to 21%. In the case of paddy, 36% households reported increased yields, an equal proportion reported no change and the rest 28% reported reduction. Increase in yield can be attributed to such high-yielding varieties as Jaya and Bhagyajyothi.

Wild boars are a major vertebrate pest, which can cause losses of paddy yields from 50% to 100%. Monkeys are a menace to areca, and can cause losses up to 50%.
Agro-forestry includes trees outside forests (non-forest tree cover in the village), on cropland bunds and also block plantations on cropland. In Shinduvadi, about 230 ha of the croplands have tree cover. Gliricidia and acacia dominate, accounting for 23% and 20% of the total respectively. Other species include Artocarpus heterophyllus (6%), Terminalia tomentosa (4%), casuarina (4%), teak (4%) and fishtail palm (3%); 90 other species make up the rest 36% (Figure 11).

Twelve introduced tree species dominate the ecosystem, accounting for 53% of the total. Of this, gliricidia and acacia make up 82%. About 85 traditional tree species account for 47% of the total agro-forestry tree cover, the dominant among them are Artocarpus heterophyllus, Terminalia paniculata and Caryota urens (fishtail palm).
Natural Forests
There are 19 tree species represented by 245 individuals/ha in the natural forests of Shinduvadi. Syzygium cumini, an evergreen tropical tree, is the dominant species, accounting for almost a quarter of the total number of individual trees. The other dominant species include Erythrina suberosa (20%), Ficus glomerata (8%), Vitex altissima (8%) and Ficus infectoria (6%). Almost one-third of the total number of individuals are in the largest girth class of >40 cm, followed by 21% in the 30–40 cm girth class. This indicates that regeneration in natural forests is affected, given that larger trees outnumber smaller trees. The diversity index of the forest is 2.46, indicating a larger diversity.

Plantations
Tree density in the plantations is 645 trees/ha belonging to 12 species. The plantations are, however, predominantly a monoculture of Acacia auriculiformis with about 550 individual trees/ha. Naturally regenerated species in the plantation include Diospyros montana, Terminalia bellerica, Elangium lamarkii, Ervatamia heyneana and seven other species (Table 1).

The number of trees in the 10–20 cm girth class is maximum, followed by that in the 20–30 cm girth class. Girth class of >40 cm accounts for the least number, indicating recent efforts to raise plantations. The diversity index of the plantations is low at 0.75, indicating dominance of a single species, in this case Acacia auriculiformis (Figure 12).

Figure 12: Composition of trees—girth wise
Biomass Stock
Basal area is an indicator of the growing stock and biomass production of a forest. The basal area recorded in natural forests and plantations are comparable at about 26 m²/ha. *Acacia auriculiformis*, the dominant species in the plantations, contributes 67% of the total basal area in plantations. However, in the natural forests *Vitex altissima* (25.3%) and *Syzygium cuminii* (23.6%) together contribute about 50% of the total basal area in natural forests. The total biomass is higher in the plantations (162 t/ha) than in natural forests (107 t/ha).

<table>
<thead>
<tr>
<th></th>
<th>Plantation</th>
<th>Natural forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of species observed</td>
<td>2 + 10 naturally existing</td>
<td>19</td>
</tr>
<tr>
<td>Stem density (number/ha)</td>
<td>645</td>
<td>245</td>
</tr>
<tr>
<td>Diversity index</td>
<td>0.75</td>
<td>2.46</td>
</tr>
<tr>
<td>Basal area (m²/ha)</td>
<td>26.51</td>
<td>25.59</td>
</tr>
<tr>
<td>Biomass (t/ha)</td>
<td>162.30</td>
<td>106.60</td>
</tr>
</tbody>
</table>

Disturbance
Cut stems in a forest or plantation are an indicator of the level of disturbance or extraction. Of the cut stems in the plantations of Shinduvadi, 94% are of *Acacia auriculiformis*. Other species that have been cut include *Terminalia paniculata* and *Xylocyta xylocarpa*.

Wild Fauna and Birds
The village is close to a bird sanctuary in the Shettihalli forest range. The Mandagadde area, which was declared a sanctuary in 1974, is part of the adjacent Lingapura village. The sanctuary is in fact a small island in River Tunga. The peak season is monsoon (June–October), when migratory birds arrive and breed in the wetlands spread over 1.5 acres. Three major species congregate in the sanctuary for breeding, namely median egret, darter and little cormorant. The sanctuary also harbours such predators as the civet, the mongoose and monkeys. Major bird species in the sanctuary include non-migratory birds such as little egret, smaller egret, little cormorant, darter and pond heron. Among them, egret is the major breeding bird during the monsoon. White ibis is the only local migratory bird. Other resident land species include brahmini kite, rose-ringed parakeet, barred jungle owlet, small blue kingfisher, Indian pitta, black drongo, common myna, house crow, red-whiskered bulbul, large pied wagtail, house sparrow, crow pheasant, Tickell’s flowerpecker, black-headed bunting and golden oriole.

Shinduvadi, which is only 4 km from the sanctuary, reveals a marked impact of the birds in the sanctuary. The major birds sighted in the sanctuary are usually observed in the village. Nearly 21 species of birds other than the
birds of the sanctuary were observed in the croplands and forests of Shinduvadi. Common avifauna such as red-whiskered bulbul, red-vented bulbul, myna and babblers are sighted very frequently. House sparrow population has declined since two decades according to community perception (Table 2).

Other than birds, the ecosystem sustains diverse populations of insects (including moths and butterflies) and amphibians.

<table>
<thead>
<tr>
<th>Common</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashy prinia</td>
<td>Jungle myna</td>
</tr>
<tr>
<td>Asian koel</td>
<td>Lesser golden-back woodpecker</td>
</tr>
<tr>
<td>Black drongo</td>
<td>Loten’s flowerpecker</td>
</tr>
<tr>
<td>Bramhini kite</td>
<td>Pied bushchat</td>
</tr>
<tr>
<td>Crow pheasant</td>
<td>Peafowl</td>
</tr>
<tr>
<td>Common iora</td>
<td>Purple-rumped sunbird</td>
</tr>
<tr>
<td>Common myna</td>
<td>Red-vent ed bulbul</td>
</tr>
<tr>
<td>Gold-fronted chloropsis</td>
<td>Red-whiskered bulbul</td>
</tr>
<tr>
<td>Grey tit</td>
<td>Scarlet minivet</td>
</tr>
<tr>
<td>House crow</td>
<td>Small blue kingfisher</td>
</tr>
<tr>
<td>House sparrow</td>
<td>Southern hill myna</td>
</tr>
<tr>
<td>Indian peafowl</td>
<td>Spotted dove</td>
</tr>
<tr>
<td>Indian robin</td>
<td>Spotted munia</td>
</tr>
<tr>
<td>Indian treepie</td>
<td>White-breasted waterhen</td>
</tr>
</tbody>
</table>
| Jungle babbler |"
Livestock

Composition and Trends
The current livestock population of the village is 254, comprising cows (72%), bullocks (9%) and buffaloes (19%). There are no cross-bred cattle or sheep or goats in the village. The population of livestock has decreased drastically, by over 40%, during the past two decades, driven mainly by reduced agricultural activity, decreased population and conversion of dedicated grazing lands to plantations leading to reduced availability of fodder (Figure 13).

Grazing Pattern and Dung Production
Grazing is practised mainly in the forest (54%) and soppinabetta (20%). The key grazing location for livestock during the cropping season is the acacia plantation. After the crop is harvested, livestock depends on the harvested croplands or on stall feeding. Paddy straw is the major source of fodder in the village after the harvest. Annually about 3.5 tonnes of dry fodder is required per head of cattle. Although no fixed hours are allotted for grazing, cattle usually graze for about 8 hours a day.

Each cow and buffalo produces on an average 23 and 20 kg of dung a day respectively whereas each bullock produces about 4 kg. There is very little scope to establish a community-scale biogas plant in the village. However, where there are enough animals to meet the minimum dung requirement of a biogas plant, a few home-scale units can be established.
Betta or soppinabetta (soppina means leaves and betta means an area or hillock with vegetation) is the local name for a protected forest, and the term is used in the Indian Forest Act. The betta forests were assigned to farmers for the purpose of supplying organic matter in the form of green and dry leaves to areca gardens. The British extended this special privilege to areca farmers during 1867 with some regulations facilitating optimal and sustainable use of the forest resources. The farmers were given the privilege of collecting green leaves for the purpose of mulch, fuelwood, grass, NTFPs and small timber for their bonafide use. About 6–9 ha of betta lands were assigned to each hectare of areca garden. Any type of commercial-level extraction is banned in these forests. Area under betta forests has been declining over the decades and in Shinduvadi, these lands are being either protected completely (no extraction allowed) or are being converted to plantations. Moreover, labour scarcity has led to a decline in the practice of using organic matter from soppinabetta. As a consequence, green leaves are never used as manure in Shinduvadi.

*Traditional forest categories

Extent of different forest categories in 1910
Soil Quality
Soils of Shinduvadi are mainly a mix of black soils and red soils. In paddy and areca lands, organic carbon content was medium. Lower levels of organic carbon in croplands can be attributed to intensive cultivation practices, whereas forests recorded higher levels (1.5%) due to undisturbed soils. The abandoned coffee plantations also recorded high levels (1.4%).

Soils under both areca and paddy recorded comparable bulk densities, pH values, and available potassium content. Bulk density ranged from 1.36 to 1.37 g/cc. The soils are moderately acidic, with areca recording 5.9±0.4 and paddy, 5.6±0.5. Soils are rich in available potassium: 271.81 and 276.31 kg/ha in areca and paddy soils respectively (Table 3).

Irrigation Sources
Agriculture in Shinduvadi is mainly rainfed. Canals and streams form the major irrigation sources. Groundwater sources such as open wells and bore-wells meet 8% of the irrigation requirements. Pond water irrigates another 8% of the croplands. The community is, therefore, dependent on rains and alternative sources such as canals and streams for irrigation, which makes agriculture vulnerable to water stress. Paddy is basically rainfed in kharif, and rabi paddy is dependent on pond irrigation. Bore-wells and open wells meet the water requirements of areca in summer.

Net irrigated area has been decreasing over the past three decades owing to decrease in agricultural activities and water scarcity. Ponds, which used to be a major source of irrigation (102 ha) until 1995 have silted up and currently irrigate only about 18 ha of croplands (80% reduction). The extent of land dependent on rain has also decreased substantially (by 60%) over the same period and is currently 98 ha. Ponds and rainwater are used equally as sources of irrigation during kharif but ponds serves as the sole source in rabi and summer. Although groundwater is plentiful, its use for

---

**Table 3: Cropland nutrient status**

<table>
<thead>
<tr>
<th></th>
<th>Areca</th>
<th>Paddy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent organic carbon</td>
<td>0.46</td>
<td>0.55</td>
</tr>
<tr>
<td>Bulk density in g/cc</td>
<td>1.36</td>
<td>1.37</td>
</tr>
<tr>
<td>pH</td>
<td>5.87</td>
<td>5.55</td>
</tr>
<tr>
<td>Available potassium in kg/ha*</td>
<td>271.81</td>
<td>276.31</td>
</tr>
<tr>
<td>Available sulphur in kg/ha</td>
<td>14.83</td>
<td>14.68</td>
</tr>
</tbody>
</table>

* <50, low; 50-120 medium; >120, high.
irrigation is very limited and is currently restricted to kharif as a supplementary source. It is most likely that in future, people will have to switch over to groundwater sources or desilt the ponds to sustain the returns from agriculture.

Due to paucity of irrigation water, people raise a single crop such as paddy in a cropping year, which is badly dependent on rainfall and alternative sources. This has lowered the dependency on irrigated annual crops and encouraged the shift to perennial crops and, in a few cases, to agriculture being abandoned.

**Drinking Water**

**Sources and Consumption Pattern**

Groundwater is the major source of water for drinking and for other domestic needs. A third of the households depend on open wells. There are 6 open wells and 4 hand pumps in the village, which serve as sources of drinking water. Mini water supply taps, fed by an overhead tank, are used by 46% households. All the sources are easily accessible to the households within a range of 0.5 km. Communities spend on an average about 1.5 hours to a maximum of 2.5 hours daily for collecting water.

Average daily per capita water consumption for drinking, bathing and cooking is 2, 30 and 4 litres respectively. Per capita consumption of water from ponds is maximum (41 litres), followed by open wells (27 litres) and taps (24 litres); water from hand pumps is used the least (15 litres).

**Water Quality**

Chemical quality of water from major sources of drinking water in the village was studied. All parameters except nitrate were within the permissible limits laid down by the Bureau of Indian Standards. The nitrate content can be attributed to contamination with bird droppings or leaching of water from manure pits (Table 4).

**Table 4: Drinking water quality status**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Desirable limits</th>
<th>Permissible limits</th>
<th>Tap</th>
<th>Over head tank</th>
<th>Open well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity as NTU</td>
<td>5.00</td>
<td>10.00</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>500.00</td>
<td>2000.00</td>
<td>160.00</td>
<td>170.00</td>
<td>220.00±197.98</td>
</tr>
<tr>
<td>Total hardness as CaCO₃⁻</td>
<td>300.00</td>
<td>600.00</td>
<td>100.00</td>
<td>100.00</td>
<td>103.00±60.81</td>
</tr>
<tr>
<td>Total alkalinity as CaCO₃⁺</td>
<td>200.00</td>
<td>600.00</td>
<td>100.00</td>
<td>100.00</td>
<td>76.25±51.26</td>
</tr>
<tr>
<td>pH</td>
<td>6.5-8.5</td>
<td>No relaxation</td>
<td>6.55</td>
<td>6.30</td>
<td>6.70±0.14</td>
</tr>
<tr>
<td>Iron as Fe⁺</td>
<td>0.30</td>
<td>1.00</td>
<td>0.06</td>
<td>0.06</td>
<td>0.07±0.014</td>
</tr>
<tr>
<td>Chloride⁻</td>
<td>250.00</td>
<td>1000.00</td>
<td>14.18</td>
<td>10.63</td>
<td>38.22±41.19</td>
</tr>
<tr>
<td>Calcium as CaCO₃⁺</td>
<td>75.00</td>
<td>200.00</td>
<td>24.04</td>
<td>22.44</td>
<td>22.44±16.43</td>
</tr>
<tr>
<td>Sulphate as SO₄²⁻</td>
<td>100.00</td>
<td>400.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00±14.14</td>
</tr>
<tr>
<td>Nitrate as NO₃⁻</td>
<td>45.00</td>
<td>No relaxation</td>
<td>7.34</td>
<td>11.51</td>
<td>34.15±31.59</td>
</tr>
<tr>
<td>Fluoride⁻</td>
<td>3.00</td>
<td>1.50</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10±0.0</td>
</tr>
<tr>
<td>Magnesium⁺</td>
<td>10.00</td>
<td>100.00</td>
<td>9.72</td>
<td>10.69</td>
<td>11.42±4.80</td>
</tr>
</tbody>
</table>

* in mg/L * Bureau of Indian Standards * in the absence of alternative sources

Above desirable standard
Most (96%) households in Shinduvadi are electrified and 35% have improved stoves while the rest use traditional stoves. Households with improved stoves recorded fuel savings of up to 62%. Daily consumption of fuelwood is 5–6 kg per capita. The annual biomass required for the village for fuel, excluding the requirements for areca and other agricultural processing, is about 495 tonnes.

Of the households that are electrified, 88% use electrical appliances. Out of 47 households, 20% own a bullock cart. In terms of the type of construction, 91% houses are *pakka* houses; the rest are *kaccha*.

Primary health centre facility is available at Mandagadde. Schooling is available until seventh standard and until matriculation in Mandagadde. The nearest towns, namely Thirthahalli and Shivamogga, have facilities for higher education.

In Shinduvadi, 70% of the households have toilets, indicating that people are aware of the importance of health and hygiene. Of the households that have toilets, 64% use them regularly. Of the households that own livestock, 83% have cattle sheds as part of the house. Kitchen waste is mainly disposed of as farmyard manure.
Shinduvadi agricultural ecosystem has undergone significant changes owing to changes in availability of water for irrigation, labour scarcity and deficient rainfall over the past 5–10 years. Coffee, a commercial crop cultivated in the past, has been abandoned as a result of deficient rainfall and labour scarcity. Dependence on agriculture as a primary occupation has declined over the years. Population of Shinduvadi has decreased and people are looking for alternative sources of income. Parallely, due to decrease in the population, there is labour scarcity within the village and people depend on labour from neighbouring villages paying them higher wages. There have been significant changes in land-use over the past three decades with fluctuations in net area cultivated, which is largely driven by deficit rainfall and loss of grazing lands. Monoculture plantations of acacia have been raised on lands that were set aside for grazing in the past. The traditional practice of using green and dry leaves from soppinabetta for improving soil quality has been discontinued as it requires dedicated labour, which is scarce currently. Gliricidia species, which dominates the non-forest tree cover, is not being used efficiently as green leafy manure. Livestock population has declined significantly, again as a result of decreased availability of labour, smaller population and, of course, loss of grazing lands. Soils are acidic and generally low in organic carbon, indicating intensive cultivation and disturbance.

Paddy is mainly dependent on two factors, adequate rainfall and availability of labour for transplanting. Often the high cost of labour makes paddy cultivation a difficult proposition for small farmers. Areca, the second major crop, is largely affected by koleroga, which usually occurs in high-rainfall years and results in significant losses. Farmers are resorting to intercrops and new crops such as rubber.

Although groundwater is not used to a large extent for irrigation at present, scarcity due to deficit rains and siltation of ponds, which once used to be the major source for rabi paddy, are most likely to make farmers turn to groundwater as a source of irrigation. All the four ponds in the village need to be desilted to support any agricultural extension.

Communities have adopted fuel-efficient stoves. However, there is increasing pressure on forests, given the reduction in availability of crop residues, which are popularly used as fuel, especially for processing of areca, which is fuel-intensive.

Forests and plantations in Shinduvadi harbour significant biodiversity. Mandagadde bird sanctuary, close to Shinduvadi, makes the village more attractive as the major birds in the sanctuary can be seen in the village as well. There is no conflict between birds, or the fauna of the ecosystem in general.

Environmental Issues
- Siltation of ponds
- Increased pressure on forests
- Poor soil quality
- Eupatorium weed infestation which may affect grazing.
### Human effort involved in the inventory

<table>
<thead>
<tr>
<th>Study / activity</th>
<th>Total extent / sample size / particulars</th>
<th>Total time spent in hours</th>
<th>Number of individuals involved</th>
<th>Total human hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land survey</td>
<td>230 ha cropland and 273 ha non-cropland</td>
<td>190</td>
<td>4</td>
<td>760</td>
</tr>
<tr>
<td>Agro-forestry</td>
<td>230 ha cropland</td>
<td>152</td>
<td>5</td>
<td>760</td>
</tr>
<tr>
<td>Vegetation survey</td>
<td>4 sample quadrats</td>
<td>6</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>Soil sampling</td>
<td>50 sample locations</td>
<td>25</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Drinking water sampling</td>
<td>3 sources</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory measurements</td>
<td>50 soil samples</td>
<td>100</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>Bird survey</td>
<td>Croplands, forest and settlement</td>
<td>5</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Household survey</td>
<td>40 households</td>
<td>30</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>Participatory rural appraisal</td>
<td>Discussion with the communities represented by 15 men and 4 women of the village</td>
<td>4</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>Secondary data collection</td>
<td>Past data pertaining to resources such as land use, livestock, cropping pattern, sanitation etc.</td>
<td>20</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>Data entry</td>
<td>Land survey, agro-forestry, household survey, vegetation and soil data</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Map generation</td>
<td></td>
<td>6</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>549</strong></td>
<td><strong>62</strong></td>
<td><strong>2130</strong></td>
</tr>
</tbody>
</table>

- Assuming complete involvement of 15 students, working 6 hours per day, the inventory was completed in about 24 days. However, since the students involved in different groups and worked during their weekends, holidays and spare time during week days, the inventory took about 4 months.

- Almost 60 hours of training as well as field demonstration was conducted by three experts from the VNRM cell of Centre for Sustainable Technologies, Indian Institute of Science.

- Expenses pertaining to travel and transportation of the students were borne by Pathways project of Sahyadri Science College, which is funded by Ford Foundation.
Shinduvadi Village Ecosystem
Shivamogga District, Karnataka

State of Environment and Natural Resources 2007

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