Chapter 9
Sustainable City Planning and Management Strategies in Vernacular Settlement Patterns in Sri Lanka

K. K. Kamani Sylva and K. K. L. Aruna Sylva

Abstract Sri Lankan vernacular settlement patterns are mainly based on nature's circular metabolism. It is observed that most of the output discharged by one subsystem becomes an input for another, contributing to the sustainability of the entire ecosystem. These patterns were well-adapted to the ecology of a context with no recorded human-made disasters. But, with the increasing population and adoption of transferred alien practices in the recent past, this equilibrium has been adversely affected. Imbalances of new settlement patterns are triggering many natural, and human-made detrimental events, affecting the three pillars of sustainability: environment, society and economy of the country. This study focuses on examining the vernacular settlement patterns and architecture of Sri Lanka, aiming at identifying special features that could be adopted to the city planning in future. The qualitative study is based on interviews with people in villages where specific examples of sustainable practices prevail in settlements. Internal validity of data is met with observations. External validity is met by comparing the results with secondary information on vernacular settlements in Sri Lanka. The analysis was done by transcribing, coding and categorising data. Categories such as village planning and management, site selection, water efficiency, architecture and settlements, green material usage, and co-existence with nature and culture are developed during the analysis. Recommendations are made for future city planning in similar contexts as a result of this research. The output of this research would benefit the society, environment and economy, by adopting sustainable practices in future planning for highly biodiverse contexed nation such as Sri Lanka.

Keywords Sustainable city planning and management · Vernacular settlements · Water efficiency · Sustainable architecture · Co-existence with nature · Sri Lanka

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9.1 Introduction

With the increasing population, recent trends in unplanned settlement patterns are leading to detrimental effects, especially among developing nations. Problems such as filling of wetlands for settlements, mismanagement and dumping waste into wetlands are becoming common, making the wetlands less effective in natural pollution control. Flooding in cities has become a frequent disaster in Sri Lanka due to unauthorised as well as authorised fillings for settlements. Landslides are another unfavourable effect of settlements in highlands due to improper land-use patterns; cutting and filling of slopes. Use of advanced technology for cutting areas with slopes destroy the ecosystem in biodiverse contexts. Land-use patterns go through significant transformations, unplanned and inadequate for the increasing population, leading to human-made disasters and triggering natural disasters. In identifying the failures of sprawl development, although models such as Transit-Oriented Development (TOD) for settlements are being proposed in Sri Lanka (Udapitiya et al. 2020), these are mostly transferred concepts from foreign environments and may not harmonise with the context as expected or may be suitable for limited urbanised landscapes. These models do not address the concept of the whole system for sustainability. Most of the modern applications of sustainable practices in Sri Lanka are limited to technological concepts that are transferred, and poor attention is given to traditional and context-specific practices. The transferred technology may not adjust to the context. However, in most of the local settings, rich history of context-specific sustainable practises has been dominant in the past, which is rarely reconsidered in planning for the future.

Indigenous settlement practices have sustained communities for centuries, although modern measuring standards have not recognised the value of these sustainable practices. Such practices are regarded as undeveloped and backward (Dayaratne 2018). With the increasing concerns of sustainability, at present, there is a trend to reinvestigate the ancient practices for their sustainable properties (Dayaratne 2018; Sudha and Nishanth 2016). 'Traditional vernacular settlements are those formed by the people living and working in them by employing the wisdom, knowledge and practices handed down from generation to generation' (Dayaratne 2018, 334). There is an argument that 'sustainability should be generated holistically from within rather than from the outside' (Dayaratne 2018, 334). Sustainable practices from vernacular settlements include site selection, space utilisation, and usage of locally available material (Sudha and Nishanth 2016). Water efficiency, sustainable architecture and co-existence with nature have been identified as the main features of vernacular settlements that leads to sustainability.

Adopting alien practices introduces ecosystem conflict in agricultural-based societies in Sri Lanka as well as in many developing nations. For example, eco-strategies in farming systems responding to nature can be of three types, namely, the domination of nature, active adaptation to nature and passive adaptation to nature (Mendis 2003). Sri Lanka is moving forward with changes in irrigation practices towards the domination of nature. This movement is away from traditional practices, which were

an adaptation to nature. Experts implementing these plans see very little intrinsic worth in ancient irrigation systems (Mendis 2003). It is timely for the Sri Lankan decision-makers to reconsider the context-specific ancient practices which were not damaging the ecosystem. According to Mendis (2003), Western strategies in agriculture may only suit the seasonal summer–winter variation approaches and might not be good for wet and dry climatic changes.

This qualitative research study examines the vernacular settlement patterns and the architecture of Sri Lanka to identify the special features to investigate concepts that could be reused for future sustainable city planning and management of agricultural-based environments. The study is based on interviews and observations as primary data. Secondary information was used for external validity. The concept of vernacular settlement patterns in Sri Lanka has been based on a dictum, 'Gamai, Pansalai, Wewai, Dagabai', meaning, 'village, temple, lake, and dagoba'. This has been a highly sustainable concept where the villages have been provided with spiritual help by the village temple. Cultivation has been secured with water efficiency and sustainability through the creation of a small lake at every village. Food security and economic stability have been met simultaneously. All other activities have been revolving around the agricultural practices, and no detrimental effects on the ecosystem have been recorded. Some of the practices that are used in these societies such as village planning, sustainable site selection, water efficiency and features of the sustainable architecture are discussed in this paper. The scientific trigger of the ancient practices and the possibility of using such practices in present-day sustainability considerations are discussed. Concepts extracted from vernacular practices that are reusable for sustainable city models are recommended as a result of the findings of this study.

9.2 Sustainability and Vernacular Settlements

The trends in sustainability adopt concepts related to social indicators and environmental indicators to be prevalent to economic indicators as 'tracking only economic growth has been detrimental to social and environmental progress' (Hicks et al. 2016). Besides, policies and practices to address the challenges of shaping a sustainable future must draw on social sciences combined with natural science and engineering. In the natural step framework presented by Robert et al. (2002), four system conditions are identified for sustainability. According to them, in a sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the Earth's crust, increasing concentrations of substances produced by society and degradation by physical means (over-harvesting, introductions, mismanagement or displacement) while meeting human needs worldwide. As presented by Korhonen (2004, 810), 'harvest rates of renewable resources should not exceed regeneration rates', 'waste emissions should not exceed the relevant assimilative capacities of ecosystems' and 'non-renewable resources should be exploited in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation

of renewable substitutes' for sustainability. In complying with the sustainability of the whole system, the actions of sub-systems, in whatever the context, matters a lot. Traditional vernacular settlements have been highly successful as self-sufficient communities by adopting the whole system thinking while getting the contribution from its subsystems (Dayaratne 2018; Piyadasa 2009; Mendis 2003).

9.3 Methodology

A qualitative research study was conducted initiating with interviewing people in villages where traditional sustainable practices yet prevail from Kakirawa and Galgamuwa divisions of Anuradhapura and Kurunagala districts respectively, in Sri Lanka. Snowball sampling method was used in identifying villages who could explain the traditional practices and 12 successful interviews were completed during the research. Interview guide was started with one question 'could you explain the traditional planning of a village and the settlement patterns of your village?' and continued with probing questions (Annexure). The probing questions were identified for the interview guide with a thorough literature search on concepts on sustainable practices for city planning. Site selection, village planning, water efficiency, features of sustainable architecture were taken as main areas to be verified during the interviews. Allowance was made for verification of other sustainable practices during the interviews. The information gathered through interviews is transcribed, coded and categorised. Findings of the interviews were supported through recorded observations for internal validity (Yin 2013). The results were then compared with the available literature on vernacular practices for external validity. A general model for a sustainable village was created using the results obtained. Results and discussion are presented together in the following sections owing to the nature of the qualitative analysis. Planning and management practices that are replicable in the present context are recommended for future sustainable planning of similar contexts.

9.4 Analysis

Qualitative data were analysed by transcribing, coding and categorising data gathered through interviews. The coding procedure was according to grounded theories suggested by Flick et al. (2004) and Strauss and Corbin (1990). In-depth interviews were transcribed, and coding was done using open coding to conceptualise data to maintain the qualitative research standards. According to Strauss and Corbin (1990) conceptualising data is taking apart an observation which could be a sentence, a paragraph after transcribing and giving each discrete incident, idea or an event, a name that represents a phenomenon. The second step of the coding procedure is the discovering categories, which is grouping the concepts around phenomena identified. Categories allow reducing the number of units for further working. Then the

categories developed were compared with observations and available literature on vernacular settlements as triangulation for the external validity of data.

9.5 Results and Discussion

Categories such as village planning and management, sustainable site selection, water efficiency, sustainable architecture and settlements, green material usage, and co-existence with nature and culture are developed for discussion. The categories developed are presented with a discussion in the following sections.

9.5.1 Village Planning and Management

Most of the people in rural settings yet live on agriculture as their main support for a living as indicated by many of the respondents. Planning of a village has been done considering the sustainability of the whole system, basically creating a lifestyle around water sources. Living styles with optimisation of water usage, while preserving hydrological systems and not damaging the ecosystems have been the goal of these settlements. Many such systems were observed during the research. The smallest unit of settlement is the village, and the entire system comprises of many such subsystems linking with each other through a larger hydraulic based network. This network is identified as the cascade system of tanks (Mendis 2003), which are functioning in many of these settings for decades. Planning of the village is around these small tanks, and the main source of livelihood is agriculture according to many of the respondents.

The village is planned in a manner that the essential items such as water storage for agriculture, vegetation cover, a temple for spiritual activities and settlements of people were within the reach of the community. The temples were made solid and are situated at a higher location in the terrain. People of the city gather at the temples for religious activities and also this space is used as evacuation centres for any natural disasters such as flooding during the monsoon season. Many other activities such as education, community meetings, and advisory services are linked to the temple of the village, and the priest is the main advisor for all religious activities.

The village houses are placed centrally to the village lake, paddy fields and the area that was used for Chena cultivation. This area is known as ‘Gammedda’, the centre of the village. The individual housing units are arranged in a cluster as observed, within an under-bushed common central courtyard known as the ‘Meda-midula’. The spaces with few trees are used to locate each householder’s grain stores known as ‘Atuwa’. This common space is also used to dry paddy, etc. and the children use these areas as play space. The courtyard of houses is well protected with a fence around the housing units. This fence protected the harvest from wild animals such as elephants. Figure 9.1 illustrates the components of a ‘Gammedda’, the centre of a

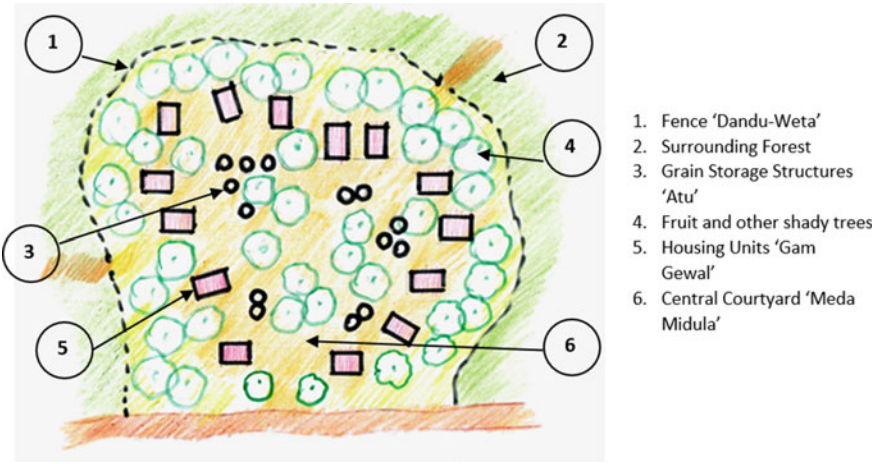

Fig. 9.1 Components of 'Gammedda', the Center of Village. *Source* Author K. K. L. A. Sylva

village. These concepts are supported by Dalupota (2003) where such clusters have been identified as 'Ihala Gammedda' (upper cluster), 'Meda Gammedda' (middle cluster) and 'Pahala Gammedda' (lover cluster) in relatively developed villages.

The 'Tisbambe' was a cleared area used for common gathering for the cultural activities and meetings of the villagers. It is located in the vicinity of the 'Gammedda' towards the forest. It also acts as a barrier between the forest and the 'Gammedda'. The traditional Sri Lankan village is always associated with a lake which is generally termed as 'Wewa'. In general, the name of the village is linked to the name of the lake, and this water source is the life-source of all activities of the village.

The village lake, 'Wewa', is protected by a forest patch surrounding the upper catchment area of the lake. This area was known as 'Ihaththawa', and no constructions or clearing of land was allowed except for the village temple. Lately, developments in these areas are observed in some of the villages considered for the research. The temple is usually located on a small hillock adjacent to the lake on firm ground. The most prominent structure of the temple is its stupa known as the 'Dagaba', Hence, the four main features: 'Gamai' (village), 'Pansalai' (temple), 'Wewai' (lake), 'Dagabai' (Stupa), are always linked in famous dictums associated with ancient Sri Lankan villages.

Apart from the temple, the 'Devalaya' (shrine) devoted to the Gods, believed to be protecting the lake, and the village is located near the lake bund sometimes adjacent to the temple. The lake bund is known as the 'We-kanda', and the shrine is known as the 'Sanhinda Devalaya'. This shrine is located under a large tree on the lake bund and may or may not have any prominent structures associated with it. With the village irrigation system, the whole network is known as an 'Elangawa' system. Figure 9.2 depicts a Model Village of a Vernacular Settlement which illustrates the 'Elangawa' system.

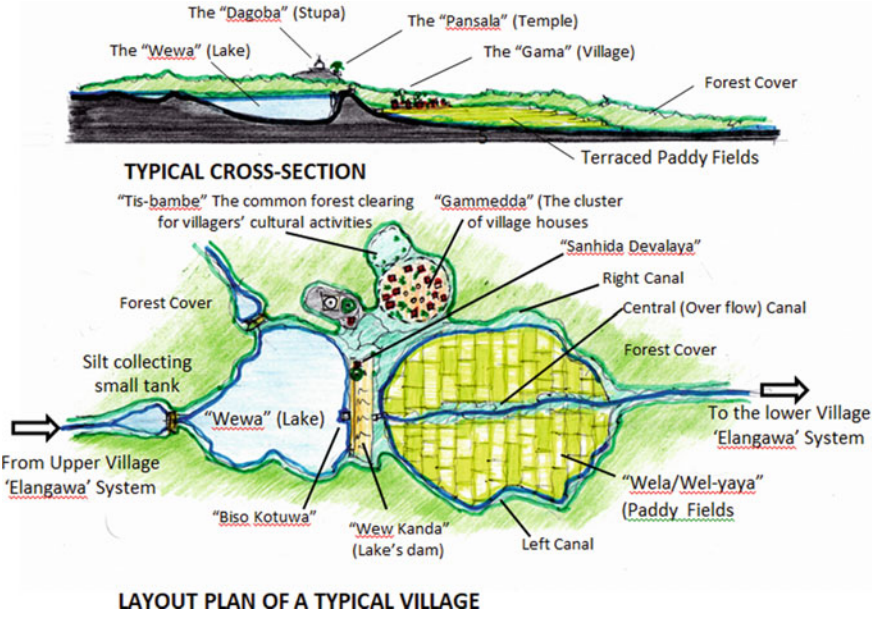

Fig. 9.2 A model village of a vernacular settlement. *Source* Author K. K. L. A. Sylva

According to many respondents, the main feature of a settlement was its lake as depicted in Fig. 9.2. The lake was designed and built in a way that it looks as a part of its natural eco-system with time. According to one respondent 'that is why after thousands of years, some lakes still exist even though no traces of the settlements supported by them are to be found'. Land sustainably in Chena cultivation has been maintained by the use of alternative plots and rotation of type of crops.

These findings are supported by many other authors who have reported the Sri Lankan indigenous communities to be conspicuously prosperous, and self-sufficient and have been an agricultural-based society mastering the art of managing water, land, vegetation, and settlements (Dayaratne 2018; Piyadasa 2009; Brohier 2000). The typical village, 'gama', 'consists of one large rice field, with its appurtenant high lands, used as Chena, and its group of small houses, for the most part, thatched huts of clay surrounded by gardens of various sizes' (Hayley 1923 cited in Mendis 2003, 211).

9.5.2 Sustainable Site Selection

Mostly the valleys were selected as villages near to water sources. The land selected was almost flat, avoiding any harm to the sloping grounds by cutting and filling of slopes. The bottom of the hills is taken as water collection tanks where the upstream

has been secured with forest cover for the sustainability of water through water conservation. A forest cover would provide water conservation through rainfall interception, soil water storage and freshwater provision (Biao et al. 2010). The selection of the bottom of the hill with the upstream forest cover ensured clean water for the lake.

Agricultural land is just below the lake where gravity flow of water is used in supplying water for Chena cultivation and paddy lands. These patterns of agriculture are yet prevailing in the villages observed. The gravity flow system minimises the use of energy for the provision of water for the paddy lands. Wetlands for water purification were available in the downstream area, and any contamination was not flowing to another subsystem from one 'Elangawa' subsystem. No additional effort or energy has been used to clean water which flows out of the systems other than wetlands. Observation of the settlements around one or two small village tanks is supported by other authors (Mendis 2003).

As stated by Brohier (2000, 18) 'mastery over climate and terrain was chiefly achieved by the ingenuity of the ancient people, aided by bounteous care of their sovereigns'. This sustainable subsystem was not disturbing another subsystem downstream as nature's circular metabolism, where almost all the output discharges of one system becomes an input for another system, has been used at every possible level in planning. The smooth flow was ensuring the sustainability of the entire living ecosystem.

9.5.3 Water Efficiency and Hydraulic Structures

The stored water by blocking the streams with earth dam constructions and the rainwater collection during monsoons have been sufficient for the entire period of cultivation. Such storage is used for other human activities while allowing the wildlife and ecosystem to sustain. Conservation of water was secured by not damaging the upstream forest cover. Since, the circulation of water after using for agriculture was ensured, the downstream demand was not disturbed by one 'Elangawa' subsystem.

The distribution of the water in large lakes had been done through a unique invention of the traditional Sri Lankan irrigation design known as the 'Bisso-Kotuwa'. The role of the 'Bisso-Kotuwa', queen chamber, had been to reduce the water pressure applied to its main sluice (the king) known as the 'Sorowwa'. In many modern irrigation reservoirs, the water released by its sluice discharges the layer of water at its base. But in the traditional 'Keta-Sorowwa', where a series of short cylinders are stacked vertically on top of the other, the topmost layer of the lake is discharged first by removing the top cylinder. As the respondents explained, the topmost layer of water has more exposure to the sunlight and mixes with more oxygen in the air, and it is more nutritious for crops than the water at the deeper levels of the reservoir.

The water released from the lake is fed to the paddy fields through canals. There are either one or two such main canals, on each side of the lake. They are referred to as the 'Dakunu-Ela' (right canal) and 'Wam-Ela' (left canal). These canals have

been constructed along the highest contours surrounding the paddy fields. The water has been tapped out of the canal system artificially and allowed to cascade down the paddy fields. Water flows through the terraced paddy fields and collected at the bottom to a central canal to diverted to the village below. Only one bank has been built in the left and right canals, allowing the outer bank of the water stream to flood and blend into the forest adjacent. The blending allows the surface water from the forest to enter the canal freely and allows the wild animals' safe and free access to drinking water.

The main livelihood of the historical Sri Lanka community is known to be agricultural and associated supporting industries. Water was stored in the village tank (lake) and used effectively for irrigation through canals before it was released back to the downstream. Series of such small tanks were distributed throughout the countryside finally collecting into large reservoirs in the dry zone. The large reservoirs are filled during heavy rainfalls and serve the paddy cultivation during drought. This principle has been adopted following water management practice introduced by the King Parakrama Bahu I '…let not a drop of the rain that falls on this fair land flow to the sea without having served the people' (Mendis 2003, xvii).

Many authors support the observations and findings of this research. As a typical agricultural society, the Sri Lankan settlers located the village or city concerning the availability of water and rich soil for agriculture (De Silva 1996). Landscaping the cities according to their ecology and availability of local resources has been observed in almost all the settlements (Madduma Bandara 2007). According to De Silva (1996), the nine months of dry spell demanded a system of water storage for agriculture and the topography of the island has been used effectively for water storage by constructing earth dams across rivers and seasonal streams. As Brohier (2000) points out, human-made tanks to guard against extraordinary emergencies of the season were made by building intricate systems of dams and dykes in the shallow valleys of the plains. Water 'was stored during the heavy rainfall and used to irrigate a thirsting land during the drought' (Brohier 2000, 18). The feeder canal to the larger tanks has been fed by perennial rivers which are flowing from the central mountains. The canals have been performing a dual role: keeping the tanks full supplied and supplying water for 'ribbon cultivation' (Brohier 2000, 19). River diversion structures are found to divert water into dry zones. Although the dams of the small tanks are made of the earth soil, the river diversion structures are found to be made of stone (Mendis 2003). As stated by Mendis (2003, 97) 'water was first diverted into the permeable soils on the valley sides for the cultivation of non-rice perennial and seasonal other field crops, and drainage water re-used for the cultivation of rice in the impermeable low humic gley soils in the valley bottoms'. According to them, this represents a water and soil conservation system for a wet-dry seasonal tropical environment, comparatively quite different to the summer–winter alternative of temperature agriculture what was directly transferred from the West by agri-business demands in the recent past in the country.

As reported by other authors, most of the large reservoirs have been built in dry valleys away from perennial rivers and interconnected with channels to maintain water supply throughout seasons for agriculture in dry zones (Mendis 2003). A

chain of small village tanks which presently termed as 'cascades', were fed by the overflow from a relatively large tank higher up on each chain in the dry zone. Lately, the four-stage hypothesis of R. L. Brohier, which has been influenced by Kennedy's concept of the less efficiency of small tanks, had led to submerging of the small village tanks for the evolution and development of irrigation systems replacing with large tanks or reservoirs (Mendis 2003). The traditional village life connected with these small village tanks has been ignored during this change. As stated by Mendis (2003, 100) 'irrigation engineers, however, chose to ignore these other aspects of traditional village life in which the village tank had a central place, and focused their attention on the hydraulic and hydrologic aspects that they understood best'. The inefficient small tanks, as identified by the recent concepts, were replaced by more efficient large reservoirs in some parts of the country. The submerged small tank cascade system is a sustainable system that has survived political and social upheavals and in continuous operation for over 2000 years (Mendis 2003).

9.5.4 Sustainable Architecture and Features of Settlements

In the sustainability of vernacular settlements, architecture plays a major role. Moving from hunting to agriculture, the dwelling place of humans changed from cave to house. The very first shelter built is believed to be simply a supported roof at the entrance of the caves they already lived.

The first houses in villages are simple rectangular buildings with four or six timber posts and a two-way sloped roof which are yet visible in some locations. The plinth was made high to prevent creeping or crawling wild animals from entering the houses. The raised plinth around the house was known as the 'Pila' meaning a long narrow verandah and traditionally used for sitting and sleeping. The traditional people lived outdoors mostly as their living was based on farming. According to the respondents, they did not 'live-in' their houses, but, rather 'lived-around' their houses. This type of living didn't need large spaces inside houses. Building a house was generally known as building a 'Geyak-Dorak' which means a house-door combination where the door included the outer space of the house. The inner house which was normally a dark space used only for the females and the children for sleeping purposes at night. Figure 9.3 illustrates the components of a village house.

9.5.5 Green Material Usage

All the materials used in village constructions were found from the vicinity of the village. As the need for such material was minimal due to the slow growth of the villages, and the simple, competition-less lifestyles of its people, the effect on the environment in using raw material was negligible. All the materials used are

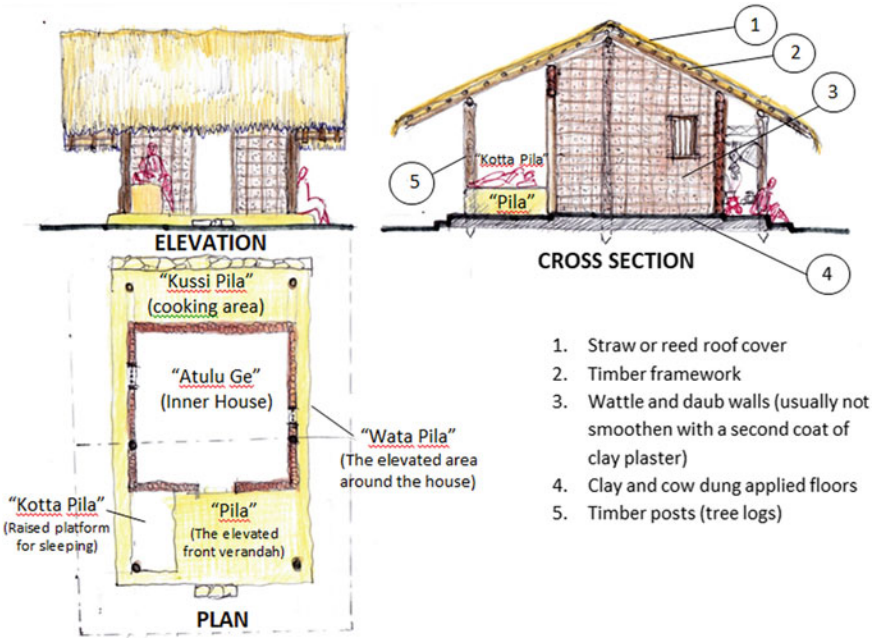

Fig. 9.3 Components of a village house. *Source* Author K. K. L. A. Sylva

biodegradable, and there is no environmental pollution associated with this lifestyle of people.

The walls are built with clay reinforced with bamboo. The common village house walls are not smoothened, exposing the bamboo sub-frame. Referring to the roughness of the walls, they are called 'Katu-Meti' walls. Rarely a second layer of mud plaster is applied on to the 'Katu-Meti' walls to make the walls smooth and even. According to many respondents, only religious buildings and houses of the elite are smoothened and whitewashed. The roofs of the houses are covered with straw or reed. Cadjan, woven coconut leaves, are also used to cover the roofs. Clay roof tiling was used only for public and religious buildings. The floors of the houses are finished by applying a mixture of clay and cow dung, which is found to be providing a healthy environment for the occupants (Ghamande et al. 2016). Seneviruwan (1998) supports the above observation of house building. As recorded by Seneviruwan (1998), the wooden posts to support the walls are selected from special types of timber to prevent any attacks from white ants and insects. According to Seneviruwan (1998), the timber is taken from trees cut on days where there is no moonlight to have the maximum strength of the tree. Different types of trees such as 'Hora' for water-logged areas, 'Wal-del' for wooden members exposed to diverse weather conditions and Milla less damage from termites and decay are selected appropriately.

9.5.6 Co-existence with Nature and Culture

Similar to the architecture in the ancient lifestyle of the vernacular settlements, all other activities such as transportation, farming, etc. have been highly eco-friendly. The traditional farming practices have been co-existing with nature. While preventing any ill effects, the ecosystem has also been preserved to the fullest potential for the survival and sustainable lifestyles of people and wildlife. The village lake and associated irrigation system have been designed to function as a separate eco-system, that gradually blends to nature. It has its catchment area, ancillary tanks and canals that fed the main lake. Finally, allowing water to flow to another sub-system without contamination by cleaning water through wetlands. Water efficiency and life built around water systems are dominant in Sri Lankan settlements. Throughout history, many examples could be found on active and passive adaptation to nature although the initiating of activities to use resources effectively seems as the dominating nature.

In village planning, special attention has been given to preserve nature by allowing forest reservations for the conservation of water and wildlife habitats. Most of the maintenance work related to the irrigation system and water management has been done collectively, with the participation of all the villages. According to Dalupota (2003), the managing and diverting of water from stretches of paddy fields to another system has been monitored and administrated by the chief of the field 'Vidane'. To secure the harvest from invading flocks of birds, a special area of paddy fields has been reserved and collectively cultivated by all farmers know as then 'kurulu paluwa'(Dalupota 2003; Leach 1961), to be used by the birds. 'Kurulu' is birds and 'paluwa' means destruction; allowance for the destruction by birds. This area was generally located at the upper edge of the paddy fields, adjacent to the forest patch. The Vidane, after observing the migration patterns of the flocks of birds flying out of the forest, decides the location of the part for the birds. Although the villages mention reservations, the management practises are not very visible at present.

Another common paddy field that all the villagers worked together has been the 'pin kumbura', the paddy field for charity, of which the harvest was sent to the village temple. A part of the village chief's job was also to manage the water and land resources during the dry period. According to the availability of water stored in the lake, and the seasonal predictions of the monsoon rains, the Vidane decides on what type of paddy to be sewed, on what areas of the paddy field. Once renowned, the granary of the east (Lankanewpapers 2008), around 2000 varieties of paddy has been available in the past. Their time to harvest and the amount of water required during the process has been varying according to the types of paddy. The agricultural chief, Vidane, was responsible to preserve seeds of such paddy varieties and distribute them among farmers.

When the amount of water was not adequate to cultivate the whole filed, the Vidane is supposed to intervene and redistribute the paddy fields closest to the canal among all farmers proportionately to their original owned or cultivated land areas. When the lake went almost dry, the Vidane had even the right to demarcate and distribute the land within the dried-up lake among the farmers of the village. This

type of cultivation done in the mud –plains of a dried-up lake is known as 'Mada-Thaulu' paddy cultivation. Anyway, considering the needs of water, for people and wild animals, the Vidane also had the right and responsibility to declare the deepest area of the dried-up lake as a protected area, prohibiting anyone from using that water for cultivation, or catch the last few fish trapped in the last puddle of water. This declaration of the prohibited area is made by erecting three posts with a particular type of twig tied to the upper end of these posts; the process is known as the 'Ana-Bole', restriction order (Dalupota 2003).

9.6 Recommendations

Many aspects of vernacular settlements discussed in this paper provide evidence for sustainable settlement patterns of the ancient people. Some concepts could be extracted and reconsidered for future planning and management of cities. The main feature of these settlements that could have ample benefits for future planning is the 'whole-system-thinking' rather than planning for isolated units. It is observed that the inputs and outputs of one subsystem relate with the predecessor and successor subsystems using the nature's circular flow of metabolism. The collection of water at a later channel from one subsystem and cleaning through natural wetland systems before diverting to the next subsystem is a very important phenomenon that could be reframed in modern systems.

Green material usage, such as cow dung, observed in vernacular settlements, is supposed to have many health and environmental benefits. According to Ghamande et al. (2016), cow dung is found to help kill microbes and bacteria, and helps in keeping warm in winter and cool in summer, due to this antibacterial property it helps killing microorganisms, is heat resistant and considered antiseptic, purify the environment, protects from UV radiation, acts as a coolant in addition to its cost-effectiveness in using as paint. Using appropriate wood types for different climatic and contextual conditions without contaminating the environment by wood preservatives are noticed.

Future planning of cities could adopt co-existence with nature from vernacular settlements. Having streams around the villages would allow wildlife to access water sources and prevent them from entering the residential zones. Concepts such as 'Kurulu Paluwa' will prevent the birds from attacking the main harvest. Reserving a share of the harvest for wildlife at the boundary of villages or settlements will maintain the balance of the ecosystem while people have their share for survival. Protecting the wildlife would protect the biodiversity of the Asian region as well as contributing to the eco-balancing of the whole system. Maintaining the topography would preserve the ecosystem by not disturbing habitats living in the zones of rich biodiversity.

Many other features of vernacular settlements can be taken as a model for future city planning. The 3R concept (Reduce-Reuse-Recycle), Zero-waste concept, could be traced in vernacular systems. The respect for nature and natural resources have

been the main feature in traditional systems. In modern days, worshipping the sun, trees and stones may be considered primitive. Worshipping the natural phenomena kept the human close to nature. Collective decision making, following social structure and order, obeying the experienced chief and teamwork are observed in these settlements. Setting examples for future generations, considering not only physical and economic development but spiritual development are a special feature to reconsider. Simplistic, minimal lifestyles, the wisdom of living with 'natures-laws' maintained the sustainability of the communities in traditional settings.

9.7 Conclusions

Sustainable vernacular settlements with a rich history of civilisations could provide context-specific examples for future development. However, at present, with the application of transferred practices and technology in these contexts, many detrimental effects have been noticed. Most of these technologically advanced applications are not verified for context-specific factors for appropriateness. This research study reinvestigates sustainability concepts in city planning such as village planning and management, sustainable site selection, water efficiency, sustainable architecture and settlements, green material usage, and co-existence with nature and culture in vernacular settlements. The most eminent features in vernacular settlements, such as whole system thinking, using circular metabolism of nature for resource reduction and pollution prevention, green material usage and coexistence with nature, could be highlighted for future planning of cities.

Annexure: Interview Guide

Interviews were started with one question for the qualitative study and then continued with probing questions as and when required.

Primary Question:

Could you explain to us the traditional planning of a village and the settlement patterns of your village?

Probing Questions:

1. How old do you think your village is?
2. Do you know why this particular site has been selected for the village?
3. How important is the village tank for your village's lifestyle?
4. Do you know who built the village tank?
5. Who is responsible for the water distribution and maintenance of the tank?
6. Are you aware of any external water management systems that affect you?
7. If yes, Are they functioning well yet & are you a part of its management?
8. How is the land divided and zoned in your village?

9. Could you explain how the houses of your village are constructed?
10. Are there any specific standards you follow in putting up these structures?
11. What are the materials commonly used in constructions?
12. Have these construction methods been the same during your past generations?
13. Is there any specific person leading the common activities of the village?
14. What is the purpose of having a village temple?
15. Is there any connection between the village tank and the Dageba of the temple?

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