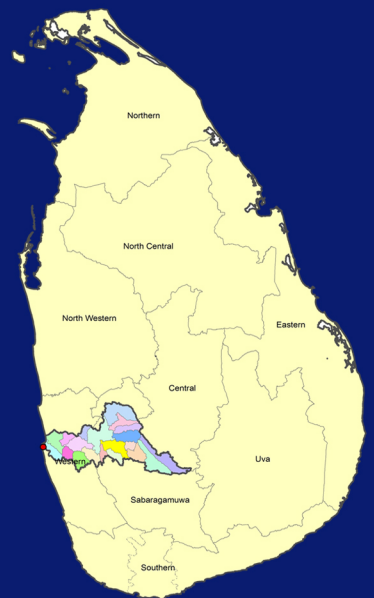


Natural Resource Profile



Medium to Long-term Multi-stakeholder Strategy and Action Plan for
Management and Conservation of the Kelani River Basin



Medium to Long-term Multi-Stakeholder Strategy and Action
Plan for Management and Conservation of the
Kelani River Basin
2016-2020

Natural Resource Profile of the Kelani River Basin

January 2016

This natural resource profile is developed to support the formulation of the “Medium to Long-term Multi-Stakeholder Strategy and Action Plan for Management and Conservation of the Kelani River Basin” developed by the Central Environment Authority (CEA) and International Union for the Conservation of Nature (IUCN) Sri Lanka Country Office, with the participation of a large number of stakeholder groups and technical inputs from the Ministry of City Planning and Water Supply and the United Nations Children’s Fund (UNICEF).

Acknowledgement:

Ms. Chandani Edussuriya, Research and Development Division, CEA, Ms. Sandamali Pathirage and Ms. Darshani Wijesinghe, IUCN Sri Lanka provided the maps and data for the natural resource profile. Ms. Kushani de Silva supported in coordination of the compilation of information. Ms. Dinithi Samarathunga and Ms. Padmini Meegoda supported in edits. Mr. Suranga De Silva, UNICEF Sri Lanka and Mr. Ajith Rodrigo, CEA supported in the project management.

Compilation:

Mr. Sampath de A Goonatilake

Mr. Naalin Perera

Mr. Gyan De Silva

Prof. Devaka Weerakoon

Dr. Ananda Mallawatantri

Editor: Dr. Ananda Mallawatantri, IUCN

ISBN: 978-955-0205-41-7

Citation:

Goonatilake, S. de A., N. Perera, G.D. Silva, D. Weerakoon and A. Mallawatantri. 2016. Natural Resource Profile of the Kelani River Basin. International Union for Conservation of Nature Sri Lanka Country Office and Central Environment Authority, Colombo. 38 pp.

Compilation of this Natural Resource Profile was carried out as a part of the development of the “Medium to Long-term Multi-Stakeholder Strategy and Action Plan for Management and Conservation of Kelani River Basin.”

Preface

Understanding of the Natural Resources in the Kelani River Basin is a primary need for developing management and conservation plans for the basin. This Natural Resource Profile was, therefore, compiled to generate a database on nature, climate and resource uses in the Kelani River Basin. With more knowledge on the value of natural resources and their historical and ecosystem services, it will be easy to justify and support policy decisions required to conserve the natural resources and promote nature based solutions in the development processes in a meaningful manner.

The compilation was carried out as an in house exercise in IUCN Sri Lanka using its experts in different subject areas along with literature material. This profile highlights the potential of using the nature to create employment opportunities in the Kelani River Basin that is important for drinking water and ecosystem services while minimizing the industrial base.

Information herein was used to strengthen the “Medium to Long-Term Multi-Stakeholder Strategy and Action plan for the Management and Conservation of the Kelani River Basin” or the “Kelani River Multi-Stakeholder Partnership (KRMP) approach” developed by IUCN with the involvement of over 50 state sector agencies, non-state sector agencies, private sector, communities, international agencies, universities, media and others.

UNICEF funding support and encouragement and the contributions of Mr. Suranga Silva, Water Sanitation Specialist is recognized along with the support provided by Mr. Ajith Rodrigo, Director, Natural Resource Management Unit of the Central Environment Authority.

List of Abbreviations

CEA	-	Central Environment Authority
CC&CRMD	-	Coast Conservation and Coastal Resource Management Department
CR	-	Critically Endangered
DCS	-	Department of Census and Statistics
DMC	-	Disaster Management Centre
DWC	-	Department of Wildlife Conservation
EN	-	Endangered
FD	-	Forest Department
GSMB	-	Geological Survey and Mines Bureau
IUCN	-	International Union for the Conservation of Nature
IWMI	-	International Water Management Institute
JICA	-	Japan International Cooperation Agency
KRB	-	Kelani River Basin
KRBP	-	Kelani River Basin Plan
KRMP	-	Kelani River Multi-Stakeholder Partnership
LUPPD	-	Land Use Policy Planning Unit
MC	-	Municipal Council
MCM	-	Million Cubic Metres
NBRO	-	National Building Research Organization
NWSDB	-	National Water Supply and Drainage Board
R&D	-	Research and Development
SD	-	Survey Department
SLLRDC	-	Sri Lanka Land Reclamation and Development Corporation
TMEF	-	Tropical Montane Evergreen Forests
TWEF	-	Tropical Wet Evergreen Forests
TSEF	-	Tropical Submontane Evergreen Forests
UC	-	Urban Council
UDA	-	Urban Development Authority
UNICEF	-	United Nations Children's Fund
VU	-	Vulnerable
WL	-	Low Country Wet Zone
WM	-	Mid-Country Wet Zone
WRB	-	Water Resources Board
WRMP	-	Western Region Megapolis Plan
WU	-	Up Country Wet Zone

Contents

Preface	iii
List of Abbreviations	iv
List of Tables	vi
List of Figures	vi
1.0 Introduction.....	1
2.0. Features of Kelani River Basin	2
2.1 Administrative areas	2
2.2. Landforms	3
2.3 Geology.....	4
2.4. Sub-basins	5
2.5. River Morphology.....	5
2.6. Soils	6
2.7. Slope Steepness.....	6
2.8. Rainfall.....	7
2.9. Agro-ecological Regions	7
2.10. Protected Areas (PAs).....	9
2.11. Biodiversity.....	11
2.11. Heritage.....	21
2.12. Environmentally Sensitive Areas.....	22
2.12. Natural Disaster Potential	23
3.0. Resource use	23
3.1. Types of green cover.....	24
3.2. Roads and Streams	25
3.3. Industries.....	26
3.4. Water.....	26
3.5. Agriculture and Animal Husbandry	27
3.6. Tourism	27
3.7. Mineral Resources	28
4.0 Key Issues	29
4.1. Lack of detailed inventories in Natural Habitats.....	29
4.2. Encroachment and land degradation	29
4.3. Industrial Pollution.....	29
4.4. Non-point source pollution	30
4.5. Ground water pollution	30
4.6. Impact of water diversion and impounding	30
4.7. Poor service delivery.....	31
4.8. Impact of Climate Change	31

4.9. Chemical accidents and response capacity	31
5.0. In conclusion	31
6.0. References	33
Annexure 1: Areas under 20 sub-basins	35
Annexure 2: Distribution of soil types in major sub basins	36
Annexure 3: Slope steepness classes within sub-basins	37
Annexure 4: Distribution of A, B and C type industries in 20 sub basins	38

List of Tables

Table 1: Districts and Divisional Secretariat divisions in the Kelani River Basin	2
Table 2: Stream order characteristics	5
Table 3: Climate conditions in agro-ecological zones	8
Table 4: Protected Areas under agencies	9
Table 5: The list of threatened Dragonflies	14
Table 6: List of threatened Butterflies	15
Table 7: List of threatened freshwater fish	16
Table 8: List of threatened frogs	17
Table 9: List of threatened Reptiles	18
Table 10: List of threatened Bird species	18
Table 11: List of threatened Mammals	20

List of Figures

Figure 1: Kelani River Basin	1
Figure 2: Provinces and Districts of Kelani River Basin	2
Figure 3: Municipalities, Urban Councils and Pradesheeya Sabas	3
Figure 4: Digital Elevation Model of Kelani River Basin	4
Figure 5: Twenty sub-basins in the Kelani River	5
Figure 6: Soils and distribution	6
Figure 7: Slope Steepness	6
Figure 8: Mean annual Rainfall Distribution (mm)	7
Figure 9: Agro Ecological Regions within the Kelani River Basin	8
Figure 10: DWC managed Protected Areas	10
Figure 11: Existing and Proposed Forest Reserves	11
Figure 12: Extinction Risk of Species	12
Figure 13: Biodiversity locations	13
Figure 14: Known Archaeological Sites	22
Figure 15: Environmentally Sensitive Areas	22
Figure 16: Areas with landslide potential	23
Figure 17: Flood Inundation Areas 2010	23
Figure 18: Land use pattern in the Kelani River Basin	24
Figure 19: Road network in the Kelani River Basin	25
Figure 20: Stream Network with reservoirs	25
Figure 21: Industry categories and distribution	26

Natural Resource Profile of Kelani River Basin

1.0 Introduction

The Kelani River originates from the Western face of the central highlands located in the Horton Plains National Park and Peak Wilderness Sanctuary. It drains approximately 2,292 square kilometres of land area (Survey Department, 2007). It is the second largest river basin and fourth longest river in Sri Lanka. Lower and middle reaches of the Kelani river flows through Colombo and Gampaha districts, which have the highest population density and the highest density of industries.

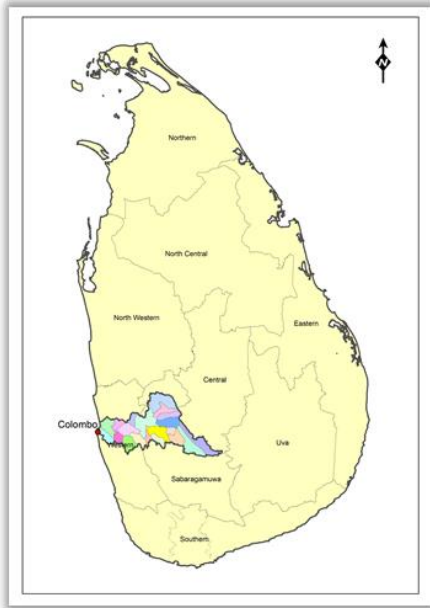


Figure 1: Kelani River Basin

The basin contains some of the most picturesque landscapes in Sri Lanka, offering a high potential to be developed as tourist destinations (Red Dot Tours, 2015 and Gordon, 2014), probably offering an alternative to the present industrial based economy.

Lowland, Submontane and Montane forests that are located in the middle and upper reaches of the Kelani River Basin are inhabited by a large number of endemic and threatened plants and animals (Jayasuriya et.al., 2006 and Perera et. al., 2014).

At the same time the Kelani River is known for its increasing pollution as a result of industrial discharges, poor local authority service delivery, weak environment management and governance (Arewgoda, 1986; Illeperuma, 2000; and CEA, 2014).

This Natural Resource Profile was compiled to support the Kelani River Basin Multi-Stakeholder Partnership (KRMP) approach (Mallawatantri, et. al., 2016) developed with the participation of over 50 agencies to

make the Kelani River Basin sustainable and resilient.

A better understanding of the natural resources in the basin is expected to help strengthen the KRMP approach while ensuring the optimum long-term functionality of the Kelani River Basin ecosystems, which is a balancing act in terms of conservation and economic development. In addition, the KRMP approach is designed to facilitate the promotion of green jobs using Kelani River Basin natural resource base as an alternative to industrial growth with industries.

As the population in the western parts of the basin is expected to increase with the new development initiatives including the Western Region Megapolis Plan. Sustainability of the natural resources and ecosystem services of the Kelani River Basin could be of critical importance for the sustainability of the new initiatives too. Above all the natural resource knowledge is expected to improve the educational and awareness programmes aimed for a transformational change in the way we think of natural resources and their uses.

2.0. Features of Kelani River Basin

2.1 Administrative areas

The Kelani River Basin includes parts of three provinces in the country. Western Province covers 34% (800 sq. km); Central Province covers 47% (1,100 sq. km.) and Sabaragamuwa Province covers 19% (430 sq. km.). Kelani River flows through Nuwara Eliya, Kandy, Ratnapura, Kegalle, Kalutara, Colombo and Gampaha Districts that are comprised of 37 Divisional Secretariat areas (Table 01).



Figure 2: Provinces and Districts of Kelani River Basin
(Source: Department of Census and Statistics)

Table 1: Districts and Divisional Secretariat divisions in the Kelani River Basin

District	DS divisions	Names of Divisional Secretariat Areas
Gampaha	8	Gampaha, Attanagalle, Dompe, Biyagama, Mahara, Wattala, Kelaniya, Ja-Ela
Colombo	10	Hanwella, Padukka, Homagama, Kaduwela, Maharagama, Sri J'pura Kotte, Kolonnawa, Thimbirigasyaya, Colombo, Kesbewa
Kalutara	2	Horana, Ingiriya
Kegalle	9	Kegalle, Aranayake, Bulathkohupitiya, Yatiyantota, Deraniyagala, Galigamuwa, Warakapola, Ruwanwella, Dehiovita
Ratnapura	4	Rathnapura, Eheliyagoda, Kuruwita, Imbulpe
Kandy	2	Ganga Ihala Korale, Pasbage Korale
Nuwara Eliya	2	Ambagamuwa, Nuwara Eliya
Total	37	

Also there are 37 local authority areas within the Kelani River Basin comprising of three Municipalities (Colombo, Sri Jayewardenepura- Kotte and Kaduwela), five Urban Councils (Maharagama, Wattala-Mabole, Peliyagoda, Seethawaka and Hatton-Dickoya) and 29 Pradesheeya Sabas.

Local Authorities mainly play a key role in service delivery and issuing permits for Small and Medium industries. At the same time District Secretaries also play a significant role in development work within the basin. The Local Authority areas overlap with District Secretary Areas in most cases requiring the attention of both district and local authority officials in development or environmental management activities.

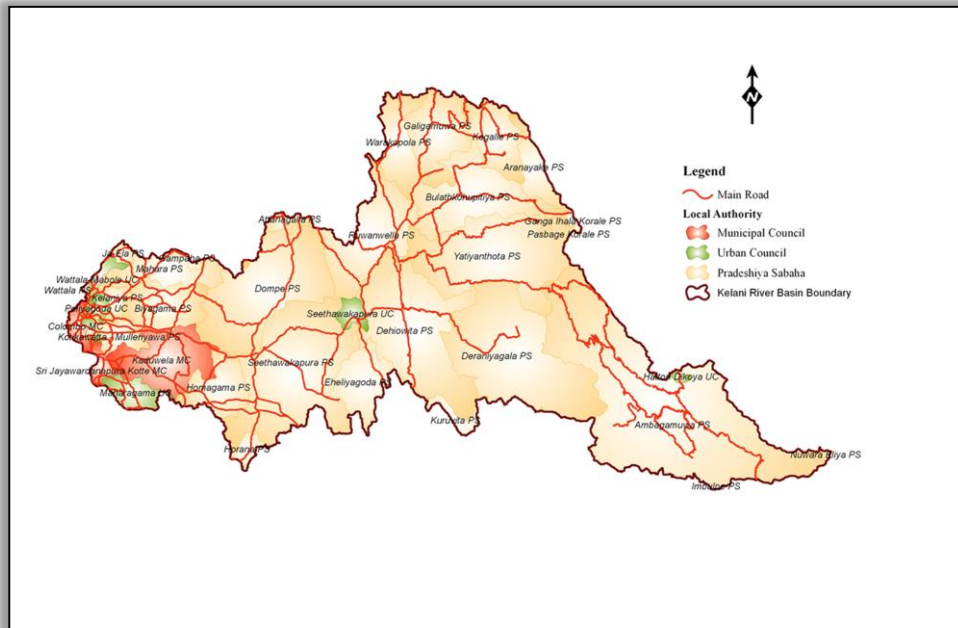


Figure 3: Municipalities, Urban Councils and Pradesheeya Sabas
Source: R&D division of CEA

The water discharges from municipalities and urban areas poses special challenges due to concentrated human activity in MC and UC areas. Sources of pollution may include industry, businesses, municipal wastewater, storm water, spills, septic systems and many other sources. In addition, the urban populations next to the river add pollution from households such as cleaning materials, paints, motor oil, fertilizers, among other things. These pollutants cause many problems to the Kelani River Basin natural resources. In addition, the pollution results in contamination of fish-growing areas; water unsafe to swim in; and toxic substances entering the food chain through drinking water and absorbed into aquatic plants etc.

2.2. Landforms

The topography of the basin includes three peneplains, namely, the first peneplain (lower and mostly flat), second peneplain (middle starting around 100 meters of elevation and extending to about 300

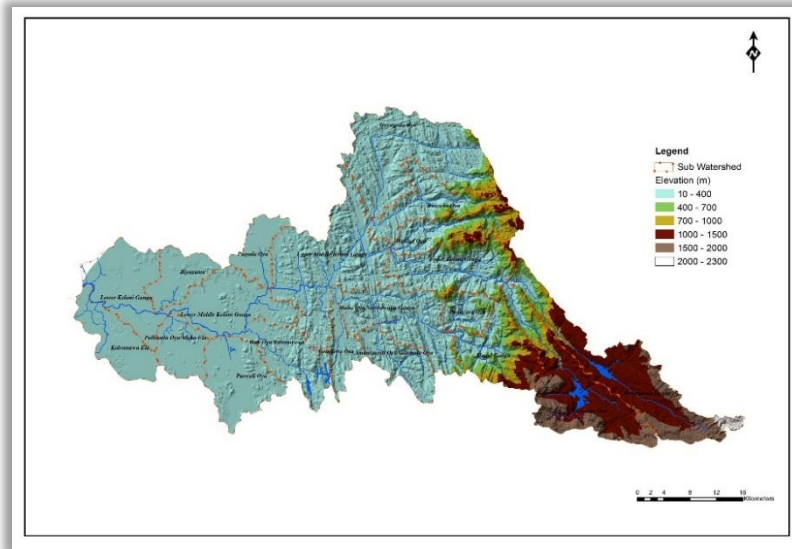


Figure 4: Digital Elevation Model of Kelani River Basin

roots of the great mountain chains that once existed now remain. Further, the processes of erosion have not only destroyed most of the hills but have also filled the intervening valleys with detrital material. In the lowest Peneplain, there are also, thousands of low, bare rock mounds or turtle back, whose form is due largely to the weathering process known as exfoliation (Cooray, 1984).

Second Peneplain: Inland from the coast, the land rises very gradually to about 100 m until it reaches the base of an escarpment generally about 300 m high, which separates the lowest Peneplain from the middle Peneplain. The escarpment is continuous in many places, as in Minipe and Kongala areas in Sri Lanka, but elsewhere it is deeply indented and irregular where rivers have cut back into the wall and destroyed its continuity while enlarging their drainage basins (Cooray, 1984).

Third Peneplain: It is a complex of plateaus, mountain chains, massifs and basins. Within each of these formations a general erosion pattern can be recognized. High Plains is made up predominantly of easily weathered, feldspathic metamorphic rocks and this is the cause of the soft, rounded landforms, and the deep, clayey soil found here. The appearance of “flatness” of the Hatton Plateau is largely due to the nearly horizontal attitude of the rocks within much of the area (Cooray, 1984).

The Kelani River Basin landforms vary significantly and includes 11 landforms, namely, Mountain, Escarpment, Hill and Ridge, Ridge and Valley, Hill and Valley, Mantled Plain (gently undulating to rolling plains), Rock Knob Plain (rough and broken relief of extensive tracts), Erosional Remnant (isolated, steeply rising bedrock controlled hills and ridges), Flood Plain, Coastal Plain, Sand Dune and Beach (Cooray, 1984).

2.3 Geology

The River basin lies across the Southwestern Group and the Highland Series. The Highland Series is “composed of meta sediments and closely associated charnockite gneisses”. The meta sediments comprise of quartzites, fine grained acid gneisses, granulites, calc gneisses, marble and khondalite, which is a sillimanitic-garnet-graphite schist”

The Southwestern Group “is made up of schists, gneisses, and granulites of metasedimentary origin, as well as migmatite and granitic gneisses. Both its lithology and metamorphic history differentiate it from the Highland series (Panabokke, 1996).

2.4. Sub-basins

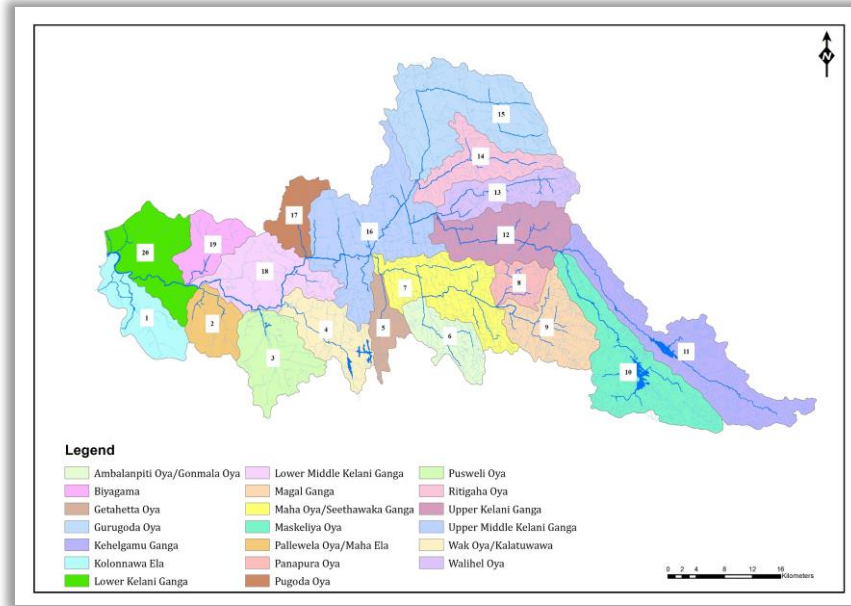


Figure 5: Twenty sub-basins in the Kelani River
Source: Survey Department

Survey Department has divided the Kelani River Basin into 20 sub-basins. The sub-basins are of different sizes varying from about 4,000 ha to 120,000 ha (Annexure 1). The main river is fed with tributaries and streams originating from sub-basins.

2.5. River Morphology

Kelani River related morphological characteristics (Survey Department, 2007) indicates that it has a relatively higher drainage density of 1.788 km for square kilometre indicating lower permeability of the landscape leading in to higher runoff volumes. This is further indicated by a relatively high bifurcation ratio of the Kelani River Basin reported at 4.09 where flood peaks will be low but longer. The other morphological characteristics of the Kelani River are:

- Catchment Area : 2,292 sq. km
- Perimeter : 357 km
- Axial length : 102 km
- Basin width : 22.5 km
- Circular Ratio : 0.23
- Elongation Ratio : 0.53

Table 2: Stream order characteristics

Stream	Number of	Mean length
1	4,490	0.51
2	1,112	0.79
3	296	1.69
4	70	2.69
5	15	8.98
6	4	18.41
7	1	55.18

2.6. Soils

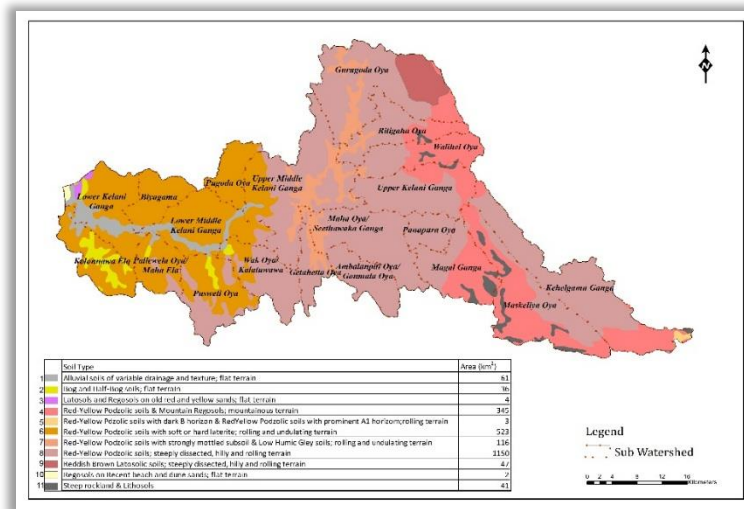


Figure 6: Soils and distribution

Source: National Atlas

In the Colombo and Gampaha districts the river floodplain contains Alluvial Soils of variable drainage and texture in the flat terrain, Red-Yellow Podzolic Soils with soft or hard laterite in the rolling and undulating terrain and patches of Bog and Half bog Soils in the flat terrain (Panabokke, 1996). Different types of soils in each sub-basin (20 basins) of the Kelani River is provided in Annexure 2).

2.7. Slope Steepness

Slope steepness in the Kelani River Basin ranges from steep slopes with 25-30% slopes in the eastern parts to flat terrain in the lower western portions. The slope steepness contributes to the land slide potential, erosion and other environmental processes, therefore, plays a key role in management and conservation efforts in the basin. The distribution of slope steepness classes in the 20 sub-basins are provided in Annexure 3.

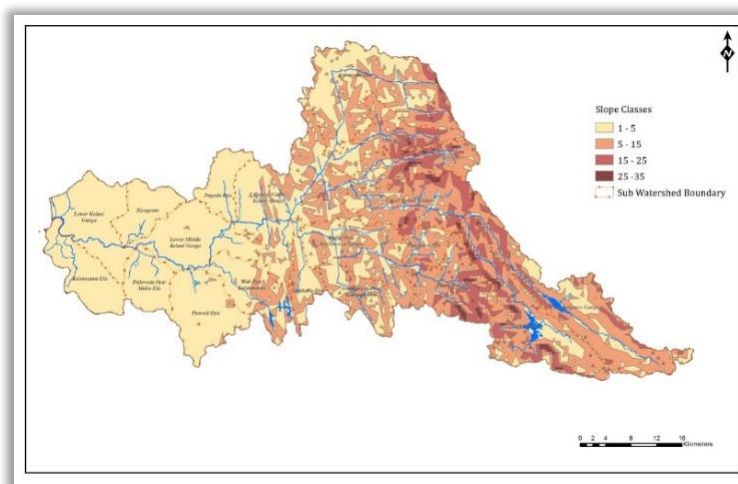


Figure 7: Slope Steepness

Source: IUCN based on Survey Department contour data

2.8. Rainfall

The annual rainfall distribution in the basin varies from 500 mm to 5,000 mm with an average mean annual rainfall about 3,450 millimetres. The watersheds in the middle of the Kelani River Basin receive the highest rainfall. The total volume of water falling within the basin is estimated at 7,865 Million Cubic Meters (MCM) with about 43% of rainfall ending in the Indian Ocean (Survey Department, 2007).

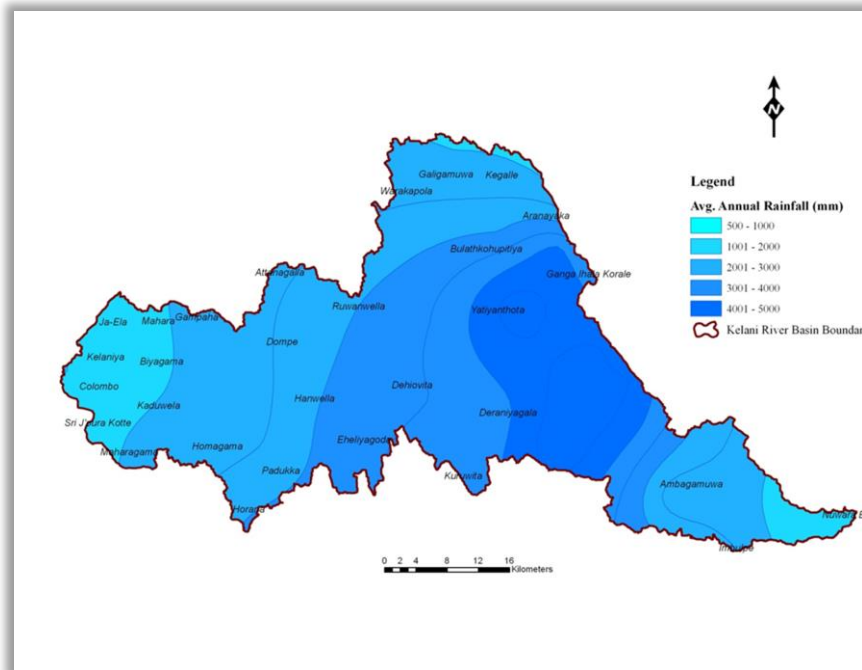


Figure 8: Mean annual Rainfall Distribution (mm)

Source: R&D unit CEA based on Met. Dept. data

2.9. Agro-ecological Regions

The Kelani river passes through the Up Country Wet Zone (WU), Mid-Country Wet Zone (WM) and Low Country Wet Zone (WL). Within these zones the basin is divided into a number of agro-ecological regions starting from hills towards the coastal area WU₃, WU₂, WU₁, WM₁, WL₁, WL₂ and WL₃ (Panabokke, 1996). Later the same regions were further subdivided into 10 agro-ecological regions. Climatic conditions for agro-ecological regions within the Kelani river basin demonstrates variations in mean temperature and annual rainfall while the humidity level remains almost same (Punyawardena, 2004).

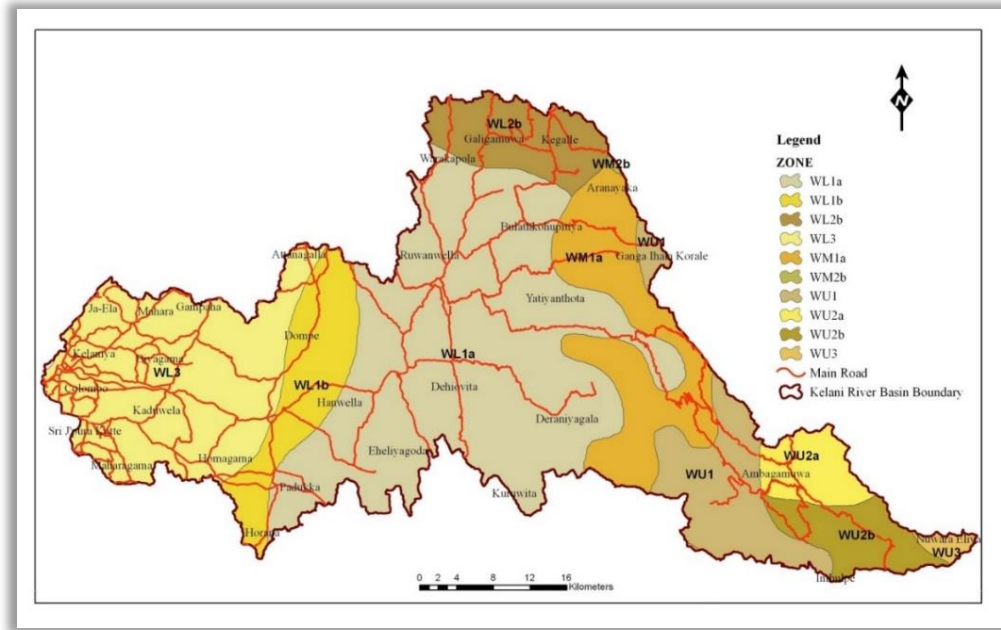


Figure 9: Agro Ecological Regions within the Kelani River Basin
 Source: R & D Unit, CEA based on Agriculture Department data

Table 3: Climate conditions in agro-ecological zones

Agro-ecological region (AER)	Mean Temperature	75% Expectancy of Annual Rainfall (Panabokke, 1996)	Day time relative Humidity
WU ₃	13-16 ⁰ C	> 3,175 mm	-
WU ₂	13-16 ⁰ C	> 1,900 mm	-
WU ₁	13-16 ⁰ C	> 1,400 mm	-
WM ₁	23-28 ⁰ C	> 3,150 mm	55-80%
WL ₁	27 ⁰ C	> 2,525 mm	60-75%
WL ₂	28 ⁰ C	> 1,900 mm	60-75%
WL ₃	-	> 1,525 mm	60-75%
WL ₄	29 ⁰ C	> 1,525 mm	60-75%

2.10. Protected Areas (PAs)

Within the Kelani River Basin a number of Protected Areas are managed by the Department of Wildlife Conservation (DWC) and Forest Department (FD). These include, three wildlife sanctuaries (7,518 ha), 16 proposed forest reserves (11,423 ha), 13 forest reserves (2,585 ha) and a catchment area of 2,304 ha allocated for drinking water reservoirs.

Table 4: Protected Areas under agencies

Protected areas managed by the Department of Wildlife Conservation		
No	Name	Area (ha)
1	Welhella-Kategilla	59.09
2	Sri Jayewardenepura Kotte Sanctuary	797.55
3	Peak wilderness	6,661.89
	Total	7,518.53
Protected areas managed by the Forest Department		
No	Proposed forest Reserves	Area (ha)
1	Agra Bopats P.R	968.63
2	Alapalawala P.R	198.36
3	Amanawala Ampana P.R	471.50
4	Badullawala P.R	52.70
5	Bogawantalawa P.R	1,723.24
6	Debatagama Bossella P.R	215.10
7	Eppilegala P.R	52.30
8	Eraboduwala P.R	6.04
9	Getamawara P.R	87.38
10	Humpitikanda P.R	28.79
11	Indikada Mukalana P.R	769.87
12	Kelani Valley P.R	3586.40
13	Kitulgala P.R	567.12
14	Peak Wilderness P.R	2,603.64
15	Yalapitiya P.R	58.70
16	Not record	33.32
	Total	11,423.09

Forest Reserves		
No	Name	Area (ha)
1	Aturupana F.R	48.03
2	Eluwana F.R	150.95
3	Imbulpitiya F.R	19.07
4	Kananpella F.R	298.56
5	Kelani Valley F.R	633.01
6	Lenagal F.R F.R	38.06
7	Lewala F.R	27.02
8	Maniyangama Timbiripola F.R	212.14
9	Mitirigala F.R	500.10
10	Pallepattu F.R	416.04
11	Paradeniya F.R	38.92
12	Taranagala F.R	38.68
13	Welhellaketagilla F.R	164.62
	Total	2,585.22
	Other state forests	Area (ha)
	Labugama - Kalatuwawa	2,034.27

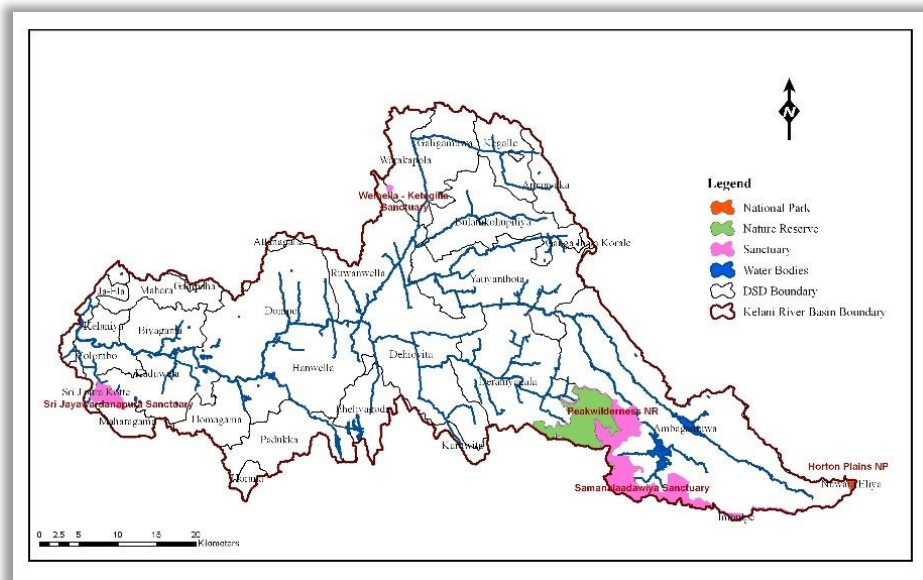


Figure 10: DWC managed Protected Areas
 Source: R & D, CEA based on Department of Wildlife data

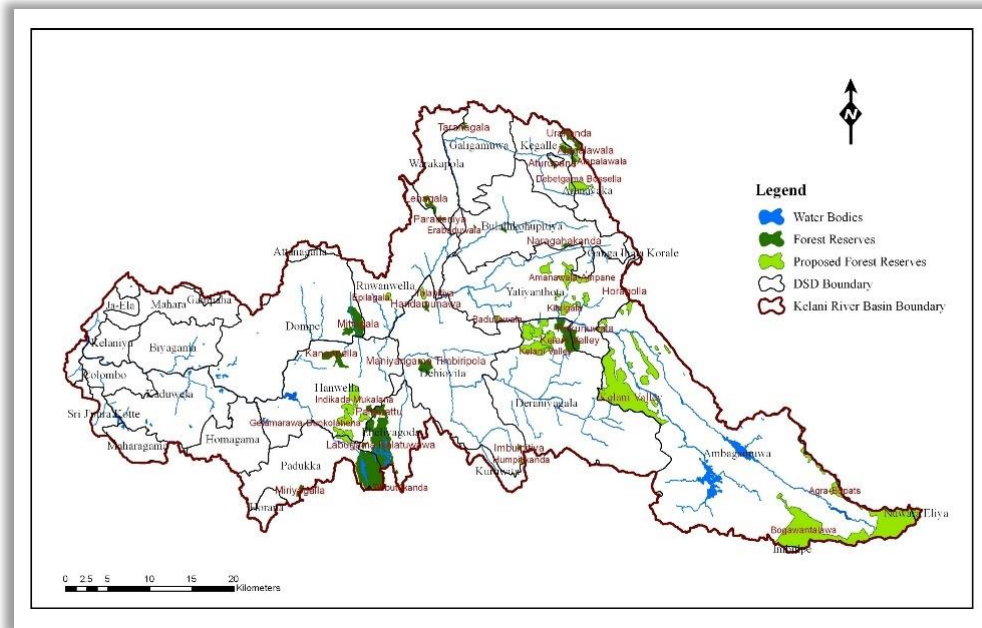


Figure 11: Existing and Proposed Forest Reserves

Source: R & D Unit, CEA based on Forest Department data

Forests in steep areas of the KRB are highly prone to soil erosion and land degradation unless proper land use management practices are employed. In addition, in some of the forested areas have cultivations that are not optimal for the land characteristics – for example the pine plantations. Land ownership in sensitive areas with high eroding potential is managed by the Forest Department but owned by the Land Reform Commission that may not be the optimal management for better land management towards pollution prevention.

2.11. Biodiversity

The Kelani River Basin lies within three major floristic regions, namely Northern Wet lowlands, Foothills of Adam's Peak and Ambagamuwa, Adam's Peak. These floristic regions sustain three major vegetation types such as Tropical wet evergreen forests, Tropical montane forests and Tropical submontane evergreen forests (Jayasuriya, Kichener & Biradar, 2006).

2.11.1. Tropical Wet Evergreen Forests (TWEF)

TWEF is the widespread matrix vegetation in the low to mid basin sector of the Kelani River Basin occurring in the wet lowlands up to an elevation of 900 m. TWEF is markedly stratified and characterized by a tall and dense canopy that reaches about 30m in height with emergents reaching 45 m or more above the canopy line with their characteristic cauliflower or mushroom-like crowns. A broad sub-canopy of 15-30 m and a sparse shrub layer, which consists mostly of tree saplings, and a scanty herbaceous ground flora complete the forest profile. Lianas are an essential component while epiphytes, mainly composed of ferns, orchids, lichens, fungi and bryophytes, are also abundant in the TWEF. Numerous epiphyllous mosses and liverworts add diversity to its plant life forms.

2.11.2. Tropical Submontane Evergreen Forests (TSEF)

This is essentially a transitional vegetation type between TWEF and TMEF found in the Kelani basin, occurring between 900-1400 m in the third Peneplain of the island. The nature of the structure and physiognomy of the TSEF is intermediate between the TWEF and TMEF. The forest profile is less distinctly stratified compared to that of TWEF. The canopy reaches generally 15-20 m in height without emergents, although in dipterocarp-dominated stands some *Doona* species emerge up to about 30 m. The sub-canopy and the shrub layers are less distinct; nevertheless, they can be recognized in undisturbed sites.

2.11.3. Tropical Montane Evergreen Forests (TMEF)

The TMEF occurs above 1500 m in the central highlands in the upper Kelani River Basin. Thus cool and wet conditions that prevail here along with abundant mist, relatively strong winds and elevated solar radiation determine the nature and form of the plant life in TMEF.

These forests are characterized by a relatively low canopy between 8 and 10 m in typical stands at higher altitudes, and they may grow higher to about 15 or even 20 m on leeward slopes or at lower altitudes within the range. The trunks and branches of the trees that make up the canopy are twisted and gnarled and their crowns are flat-topped; the leaves are microphyllous and leathery to withstand strong wind. The forest profile is not clearly stratified, but the lower strata consisting of tree and shrub species are very dense. The trees and shrubs are covered with epiphytes, lichens and bryophytes, while the leaves harbour many epiphyllous mosses and liverworts indicating copious moisture condensation.

2.11.4. Point endemics and restricted species to Kelani River Basin

Detailed biodiversity surveys have not been conducted throughout the Kelani River Basin to document its biodiversity. However, there are few random surveys carried out by researchers to fulfill various

objectives and these data was used to construct the biodiversity profile of the Kelani River Basin. Therefore, it should be noted that the information presented below is based on a limited data set and that the biodiversity of Kelani River Basin could be much higher than what is presented here.

According to previous surveys a number of point endemic, endemic and threatened fauna and flora are present within the Kelani Basin. A single point endemic plant species, *Balanocarpus kitulgalensis* is recorded in the Kelani river basin. *B. kitulgalensis* was described from the Parawatenna forest reserve (on the opposite bank of the Kitulgala rest house) and it is only known from this site with limited number of individuals.

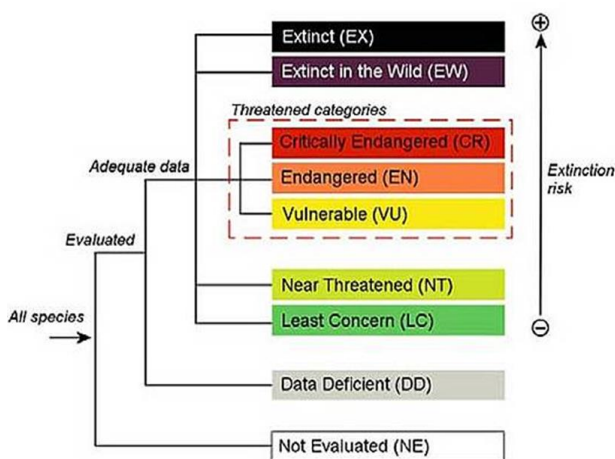


Figure 12: Extinction Risk of Species
Source: IUCN Red Listing Categories

Another plant species, *Vatica lewisiana* that was earlier recorded from Kiribatgala and Hunuwela in the Kalu River Basin but no longer found in this site since 1880s was recently (in 2008) discovered from the Halgolla estate near We Oya, a tributary of the Kelani River Basin. At present this plant is known from less than 10 trees.

Several point endemic fauna are also found in the Kelani River Basin. This includes *Pethia bandula* that is restricted to a small stream that drains into Gurugoda Oya, a tributary of Kelani River. The population size of this fish is less than 1,500. *Systemus asoka* is another point endemic fish restricted to the Kelani basin. It can be found in the main river closer to Kitulgala and Malimboda area in the Seetawaka tributary. In addition, several other invertebrate point endemic species are recorded in the Kelani river basin. These include a damselfly species *Archibasis oscillans* (found in the Hanwella area) and three species of freshwater crabs, *Perbrinckia cracens*, *Ceylonthelphusa nata* and *Clinothelphusa kakoota*. All of these species are listed as a Critically Endangered (CR) species in the National Red list (except *Archibasis oscillans* as it is a new discovery for Sri Lanka) due to their limited distribution.

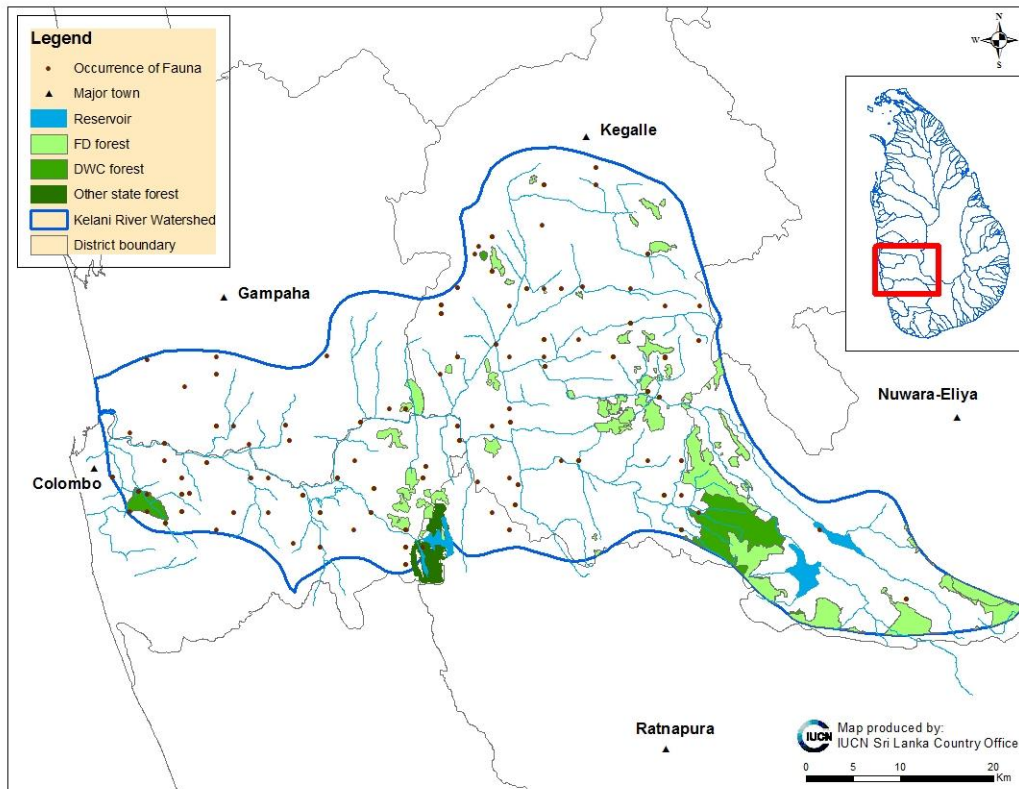


Figure 13: Biodiversity locations

Source: IUCN

2.11.5. Threatened species found in Kelani River Basin

Dragonflies – Total of 16 nationally threatened species were recorded within the Kelani valley basin. Among them eight species are listed as critically endangered (CR) seven species as endangered (EN) and one species as vulnerable (VU). The list of threatened dragonflies recorded in the Kelani river basin is given in the following table.

Table 5: The list of threatened Dragonflies

	Scientific Name	English Name	SpS	CoS
1	<i>Agriocnemis femina</i>	Whitebacked Wisp	Indigenous	CR
2	<i>Mortonagrion ceylonicum</i>	Sri Lanka Midget	Endemic	EN
3	<i>Onychargia atrocyana</i>	Marsh Dancer	Indigenous	VU
4	<i>Drepanosticta anamia</i>	Ana Mia's Shadow damsel	Endemic	CR
5	<i>Drepanosticta bine</i>	Bine's Shadow damsel	Endemic	CR
6	<i>Drepanosticta digna</i>	Nobel Shadow damsel	Endemic	CR
7	<i>Drepanosticta nietneri</i>	Nietneri's Shadow damsel	Endemic	CR
8	<i>Drepanosticta tropica</i>	Dark-shouldered Cornuted Shadow damsel	Endemic	CR
9	<i>Elattonneura oculata</i>	Two-spotted threadtail	Endemic	EN
10	<i>Elattonneura tenax</i>	Red-striped Pinfly Threadtail	Endemic	EN
11	<i>Cyclogomphus gynostylus</i>	Transvestite Clubtail	Endemic	CR
12	<i>Gomphidia pearsoni</i>	Rivulet Tiger	Endemic	EN
13	<i>Heliogomphus lyratus</i>	Lyrate Grapple tail	Endemic	CR
14	<i>Macrogomphus lankensis</i>	Sri Lanka Fork tail	Endemic	EN
15	<i>Microgomphus wijaya</i>	Wijaya's Scissor tail	Endemic	EN
16	<i>Cratilla lineata</i>	Pale-faced Forest skimmer	Indigenous	EN

Source: IUCN data base

Butterflies- Altogether 23 nationally threatened species of butterflies are recorded within the Kelani river basin. This includes one critically endangered (CR), 10 endangered (EN) and 12 vulnerable (VU) species. The list of threatened butterflies recorded in the Kelani River basin is given in the following table.

Table 6: List of threatened Butterflies

	Scientific Name	English Name	Sinhala Name	SpS	CoS
1	<i>Graphium antiphates</i>	Five bar swordtail	Pancha Iri kaga-waligaya	Indigenous	EN
2	<i>Pachliopta jophon</i>	Ceylon rose	Lanka rosa papilia	Endemic	EN
3	<i>Papilio helenus</i>	Red helen	Maha kela papilia	Indigenous	VU
4	<i>Cepora nadina</i>	Lesser gull	Heen Punduru-sudana	Indigenous	CR
5	<i>Argynnis hyperbius</i>	Indian fritillary	Indiyanu alankarikya	Indigenous	EN
6	<i>Discophora lepida</i>	Southern duffer	Dumburu kewattaya	Indigenous	VU
7	<i>Euploea phaenareta</i>	Grait crow	Yoda kaka-kotithiya	Indigenous	EN
8	<i>Idea iasonia</i>	Tree nymph	Pawenna	Endemic	VU
9	<i>Ideopsis similis</i>	Blue glassy tiger	Maha nil-kotithiya	Indigenous	VU
10	<i>Kallima philarchus</i>	Blue oakleaf	Nil kela-kolaya	Endemic	EN
11	<i>Lethe daretis</i>	Ceylon treebrown	Lanka gas-dumburuwa	Endemic	EN
12	<i>Lethe drypetis</i>	Tamil treebrown	Maha gas-dumburuwa	Indigenous	EN
13	<i>Lethe dynaste</i>	Ceylon forester	Kala gas-dumburuwa	Endemic	EN
14	<i>Libythea myrrha</i>	Club beak	Dandu dumburu-thuduwa	Indigenous	VU
15	<i>Mycalesis rama</i>	Cingalese bushbrown	Lanka panduru-dumburuwa	Endemic	EN
16	<i>Parantica taprobana</i>	Ceylon tiger	Lanka nil-kotithiya	Endemic	EN
17	<i>Rohana parisatis</i>	Black prince	Kalu kumaraya	Indigenous	VU
18	<i>Vanessa cardui</i>	Painted lady	Vichitra alankarikya	Indigenous	VU
19	<i>Jamides coruscans</i>	Ceylon cerulean	Lanka Seru-nilaya	Endemic	VU
20	<i>Celaenorrhinus pilothyrus</i>	Black flat	Kala-kunchika	Endemic	VU
21	<i>Matapa aria</i>	Common red eye	Ratasiya	Indigenous	VU
22	<i>Notocrypta paralysos</i>	Common banded demon	Iri dassa	Indigenous	VU
23	<i>Tagiades litigiosa</i>	Water snow flat	Diya-kunchika	Indigenous	VU

Source: IUCN data base

Freshwater fish – 27 nationally threatened fish species are recorded and included eight critically endangered (CN), 15 endangered (EN) and four vulnerable (VU) species (IUCN database).

Table 7: List of threatened freshwater fish

	Scientific Name	English Name	Sinhala Name	SpS	CoS
1	<i>Ophisternon bengalense</i>	Swamp eel	Potta aandha	Indigenous	CR
2	<i>Amblypharyngodon grandisquamis</i>	Large Silver carplet	Gangiliya	Endemic	EN
3	<i>Garra ceylonensis</i>	Stone sucker	Gal panderuwa / Gal Pandiya	Endemic	VU
4	<i>Laubuca varuna</i>	Western laubuca	Varuna karaedaya	Endemic	CR
5	<i>Pethia bandula</i>	Bandula barb	Bandula Pothaya / Jayanthiya	Endemic	CR
6	<i>Pethia nigrofasciatus</i>	Black ruby barb /	Bulath Hapaya / Manamalaya	Endemic	VU
7	<i>Pethia reval</i>	Redfin Two-banded carplet	Rathu varal Depulliya / Potaya	Endemic	EN
8	<i>Puntius kamalika</i>	Scarlet banded barb	Mada ipilla/ Ipili kadaya	Endemic	EN
9	<i>Puntius kelumi</i>	Kelums Long snouted barb	Katu Pethiya / Rathu waral pethiya	Endemic	EN
10	<i>Puntius titteya</i>	Cherry barb	Le Titteya	Endemic	EN
11	<i>Rasbora wilpita</i>	Wilpita Rasbora	Wilpita Dandiya	Endemic	EN
12	<i>Horadandia atukorali</i>	Horadandia	Horadandiya	Endemic	VU
13	<i>Rasboroides vaterifloris</i>	Vateria flower rasbora	Hal Mal Dandiya	Endemic	EN
14	<i>Systemus asoka</i>	Asoka barb	Asoka Pethiya / Ranmanissa	Endemic	CR
15	<i>Systemus pleurotaenia</i>	Black lined barb / Side-striped carp	Heeta Massa	Endemic	EN
16	<i>Acanthocobitis urophthalma</i>	Tiger loach / Striped loach	Pol Ahirawa / Viran Ahirawa	Endemic	EN
17	<i>Mystus ankutta</i>	Yellow catfish	Path ankutta	Endemic	EN
18	<i>Wallago attu</i>	Shark catfish	Walaya	Indigenous	EN
19	<i>Aplocheilus dayi</i>	Day's killifish	Uda handeya	Endemic	EN
20	<i>Schismatogobius deraniyagalai</i>	Redneck goby	Kata rathu weligouva	Indigenous	EN
21	<i>Sicyopterus griseus</i>	Stone goby	Gal weligouwa	Indigenous	CR
22	<i>Sicyopterus halei</i>	Red-tailed goby	Maha Gal weligouwa	Indigenous	CR
23	<i>Sicyopus jonklaasi</i>	Lipstick goby	Thol rathu weligouwa	Endemic	EN
24	<i>Malpulutta kretseri</i>	Ornate paradisefish	Malpulutta	Endemic	CR

25	<i>Macrogathus pentophthalmos</i>	The Sri Lankan spiny eel	Bata kola theliya	Endemic	CR(PE)
26	<i>Channa ara</i>	Giant snakehead	Gan ara	Endemic	EN
27	<i>Channa orientalis</i>	Smooth-breasted snakehead	Kola Kanaya / Gas Kanaya	Endemic	VU

Amphibians – A total of nine nationally threatened species are recorded within the Kelani valley basin. This includes six endangered and three vulnerable species. The list of threatened frogs recorded in the Kelani River Basin is given in the following table.

Table 8: List of threatened frogs

	Scientific Name	English Name	Sinhala Name	SpS	CoS
1	<i>Adenomus kelaartii</i>	Kelaart's dwarf toad	Kelartge kuru gamba	Endemic	VU
3	<i>Duttaphrynus kotagamai</i>	Kotagama's dwarf toad	Kotagamage kuru gamba	Endemic	EN
2	<i>Lankanectes corrugatus</i>	Corrugated water frog	Vakarali madiya	Endemic	VU
3	<i>Nannophrys ceylonensis</i>	Sri Lanka rock frog	Lanka galpara madiya	Endemic	EN
4	<i>Pseudophilautus abundus</i>	Labugagama shrub frog	Labugama paduru madiya	Endemic	EN
5	<i>Pseudophilautus cavirostris</i>	Hollow snouted shrub frog	Hirigadu panduru madiya	Endemic	EN
6	<i>Pseudophilautus fergusonianus</i>	Ferguson's shrub frog	Fergasonge panduru madiya	Endemic	VU
7	<i>Pseudophilautus singu</i>	Horned shrub frog	Ang paduru madiya	Endemic	EN
8	<i>Pseudophilautus sordidus</i>	Grubby shrub frog	Anduru lapavan panduru madiya	Endemic	VU
9	<i>Pseudophilautus tanu</i>	Slender shrub frog	Sihin panduru madiya	Endemic	EN

Source: IUCN database

Reptiles – Total of 11 nationally threatened species are recorded within the Kelani valley basin. This includes one critically endangered (CR) six endangered (EN) and five vulnerable (VU) species. The list of threatened Reptiles recorded in the Kelani River Basin is given in the following table.

Table 9: List of threatened Reptiles

	Scientific Name	English Name	Sinhala Name	SpS	CoS
1	<i>Cyrtodactylus triedra</i>	Spotted bowfinger gecko	Pulli vakaniyahuna	Endemic	VU
2	<i>Lankascincus taprobanensis</i>	Smooth Lanka skink	Sumudu lakhiraluva	Endemic	EN
3	<i>Lyriocephalus scutatus</i>	Lyre head lizard / Hump snout lizard	Gatahombu katussa / Karamal bodiliya	Endemic	VU
3	<i>Nessia layardi</i>	Layard's snakeskink	Leyardge sarpahiraluva	Endemic	EN
4	<i>Calotes liocephalus</i>	Crestless lizard	Kondu datirahita katussa	Endemic	CR
5	<i>Ceratophora aspera</i>	Rough horn lizard	Raluang katussa / Kuru angkatussa	Endemic	EN
6	<i>Ceratophora stoddartii</i>	Rhinohorn lizard	Kagamuva angkatussa	Endemic	EN
7	<i>Acrochordus granulatus</i>	Wart snake	Diya goya/Redi naya	Indigenous	VU
8	<i>Cercaspis carinata</i>	The Sri Lanka wolf snake	Dhara radanakaya	Endemic	EN
9	<i>Chrysopelea ornata</i>	Ornate flying snake	Malsara	Indigenous	VU
10	<i>Dendrelaphis caudolineolatus</i>	Gunther's bronze back	Viri haldanda	Indigenous	VU
11	<i>Oligodon calamarius</i>	Templeton's kukri snake	Kabara dath ketiya	Endemic	EN

Source: IUCN data base

Birds- Total of 25 nationally threatened species are recorded within the Kelani valley basin. This includes 10 endangered (EN) and 15 vulnerable (VU) species. The list of threatened bird species recorded in the Kelani river basin is given in the following table.

Table 10: List of threatened Bird species

	Scientific Name	English Name	Sinhala Name	SpS	CoS
1	<i>Eurystomus orientalis</i>	Dollarbird	Dumkawa	Indigenous	EN
2	<i>Cuculus varius</i>	Common Hawk Cuckoo	Ukusukoha	Indigenous	EN
3	<i>Phaenicophaeus pyrrhocephalus</i>	Sri Lanka Red-faced Malkoha	Sri Lanka Watha-rathu Malkoha	Endemic	VU
4	<i>Centropus chlororhynchus</i>	Sri Lanka Green-billed Coucal	Sri Lanka Bata Ati-kukula	Endemic	EN
5	<i>Tachymarptis melba</i>	Alpine Swift	Alpine-thurithaya	Indigenous	EN

	Scientific Name	English Name	Sinhala Name	SpS	CoS
6	<i>Phodilus badius</i>	Oriental Bay Owl	Peradigu Gurubassa	Indigenous	EN
7	<i>Otus thilohoffmanni</i>	Serendib Scops Owl	Panduwan Kanbassa	Endemic	EN
8	<i>Glaucidium castanonotum</i>	Sri Lanka Chestnut-backed Owlet	Sri Lanka Pitathambala Upabassa	Endemic	VU
9	<i>Columba torringtoniae</i>	Sri Lanka Wood Pigeon	Sri Lanka Mayila Paraviya	Endemic	VU
10	<i>Porzana fusca</i>	Ruddy-breasted Crake	Laya-rathu Wil-keraliya	Indigenous	VU
11	<i>Rostratula benghalensis</i>	Greater Painted-snipe	Raja Ulu-kaswatuwa	Indigenous	VU
12	<i>Falco peregrinus</i>	Peregrine/Shaheen Falcon	Para Kurul Ukusugoya	Indigenous	VU
13	<i>Dicrurus lophorinus</i>	Crested Drongo	Maha silu Kavda	Pro:endemic	VU
14	<i>Urocissa ornata</i>	Sri Lanka Blue Magpie	Sri Lanka Kahibella	Endemic	VU
15	<i>Myophonus blighi</i>	Sri Lanka Whistling Thrush	Sri Lanka Uruwan-thirasikaya	Endemic	EN
16	<i>Zoothera spiloptera</i>	Sri Lanka Spot-winged Thrush	Sri Lanka Thithpiya Thirasikaya	Endemic	VU
17	<i>Zoothera imbricata</i>	Sri Lanka Scaly Thrush	Kayuru Thirasikaya	Endemic	EN
18	<i>Eumyias sordida</i>	Sri Lanka Dull Blue Flycatcher	Sri Lanka Neelan-masimara	Endemic	VU
19	<i>Sturnus albofrontatus</i>	Sri Lanka White-faced Starling	Sri Lanka Wathasudu Sharikawa	Endemic	EN
20	<i>Gracula ptilogenys</i>	Sri Lanka Myna	Sri Lanka Salalihiniya	Endemic	VU
21	<i>Hirundo domicola</i>	Hill swallow	Sethkara Wahilihiniya	Indigenous	VU
22	<i>Garrulax cinereifrons</i>	Sri Lanka Ashy-headed Laughing-thrush	Sri Lanka Alu-demalichcha	Endemic	EN
23	<i>Turdoides rufescens</i>	Sri Lanka Orange-billed Babbler	Sri Lanka Rathu Demalichcha	Endemic	VU

	Scientific Name	English Name	Sinhala Name	SpS	CoS
24	<i>Dicaeum vincens</i>	Sri Lanka Legge's Flowerpecker	Sri Lanka Pililichcha	Endemic	VU
25	<i>Lonchura kelaarti</i>	Black-throated Munia	Gelakalu Weekurulla	Indigenous	VU

Source: IUCN data base

Mammals- A total of 28 nationally threatened species are recorded including one critically endangered (CR) 14 endangered (EN) and 13 vulnerable (VU) species.

Table 11: List of threatened Mammals

	Scientific Name	English Name	Sinhala Name	SpS	CoS
1	<i>Taphozous longimanus</i>	Long-armed sheath-tailed bat	Dikba Kepulum- vavula	Indigenous	EN
2	<i>Taphozous melanopogon</i>	Black-bearded sheath-tailed bat	Ravulkalu Kepulum- vavula	Indigenous	VU
3	<i>Hipposideros fulvus</i>	Fulvous-leaf nosed bat	Malekaha Pathnehe-vavula	Indigenous	EN
4	<i>Hipposideros galeritus</i>	Dekhan leaf-nosed bat	Kesdiga Pathnehe-vavula	Indigenous	VU
5	<i>Hipposideros lankadiva</i>	Great leaf-nosed bat	Maha Pathnehe-vavula	Indigenous	VU
6	<i>Megaderma lyra</i>	False vampire bat	Boru Ley-vavula	Indigenous	VU
7	<i>Megaderma spasma</i>	Long-eared vampire bat	Kandiga Boru Ley-vavula	Indigenous	VU
8	<i>Cynopterus brachyotis</i>	Lesser Short-nosed fruit bat	Heen Thala-vavula	Indigenous	EN
9	<i>Rhinolophus beddomei</i>	Great horse-shoe bat	Maha Ashladan-vavula	Indigenous	VU
10	<i>Kerivoula hardwickii</i>	Malpas's bat	Rathbora Kehel-vavula	Indigenous	CR
11	<i>Miniopterus fuliginosus</i>	Long-winged bat	Dickpiya-vavula	Indigenous	EN
12	<i>Scotophilus heathii</i>	Great yellow bat	Maha Kaha-vavula	Indigenous	VU
13	<i>Semnopithecus vetulus</i>	Purple-faced leaf monkey	Sri Lanka Kalu-wandura	Endemic	EN
14	<i>Loris tardigradus</i>	Sri Lanka red slender loris	Sri Lanka Rath Unahapuluwa	Endemic	VU
15	<i>Panthera pardus</i>	Leopard	Kotiya/ Diviya	Indigenous	EN
16	<i>Prionailurus rubiginosus</i>	Rusty-spotted cat	Kola Diviya / Balal Diviya	Indigenous	EN

	Scientific Name	English Name	Sinhala Name	SpS	CoS
17	<i>Prionailurus viverrinus</i>	Fishing cat	Handun Diviya	Indigenous	EN
18	<i>Lutra lutra</i>	Otter	Diya-balla	Indigenous	VU
19	<i>Paradoxurus aureus</i>	Golden Wet-zone palm civet	Sri Lanka Pani uguduva	Endemic	EN
20	<i>Moschiola kathygre</i>	Sri Lanka pigmy mouse-deer	Sri Lanka Kuru Meminna	Endemic	VU
21	<i>Golunda ellioti</i>	Bush rat	Panduru-miya	Indigenous	EN
22	<i>Mus mayori</i>	Sri Lanka spiny rat	Sri Lanka Depahe Katu Heen-miya	Endemic	EN
23	<i>Srilankamys ohiensis</i>	Sri Lanka bicolored rat	Sri Lanka Depehe-miya	Endemic	EN
24	<i>Vandeleuria oleracea</i>	Long-tailed tree mouse	Gas-miya	Indigenous	VU
25	<i>Petaurista philippensis</i>	Giant flying squirrel	Ma-hambawa	Indigenous	EN
26	<i>Petinomys fuscocapillus</i>	Small flying squirrel	Heen-hambawa	Indigenous	EN
27	<i>Funambulus layardi</i>	Sri Lanka flame-striped jungle squirrel	Sri Lanka Mukalan Leena	Endemic	VU
28	<i>Funambulus obscurus</i>	Sri Lanka jungle squirrel	Punchi Leena	Endemic	VU

Source: IUCN data base

2.11. Heritage

Prehistoric evidences: One of the most significant archaeological sites in the Kelani River Basin is the Pre-historic Belilena cave, found in Kitulgala. Here, P.E.P. Deraniyagala found skeletons of the Balangoda Man, which was described as *Homo sapiens balangodensis*, who is believed to have inhabited the cave approximately 30,000 years ago. Some of the oldest geometric microlith stone tools dating back to more than 27,000 BP were discovered here. These findings, along with others, indicated that these Mesolithic people entered this technological phase faster than those in Europe. Evidence of numerous animals that may have been consumed for food, such as reptiles, rats and other mammals, snails and fish were also unearthed here. Belilena also holds evidence of salt transport and exchange from the coast in excess of 27,000 BP (Deraniyagala, 1996).

Recent history: The basin lies mainly within the two ancient kingdoms, Kotte (Sri Jayawardanapura) and Sithawaka (15AD). The upper basin belongs to the Kandyan Kingdom (18AD). There are a number of archaeological sites belonging to early Anuradapura period (1BC). Most of these sites are Buddhist monasteries eg. Sri Jaywardanapura kotte, Kelaniya, Koratota, Nawagamuwa, Sithawaka Barandikovila, Sithawaka palace, Kaikavala, Ambagamuwa, and Hatton (Peak wilderness part). Other than that number of Forts which was built during the colonial periods have also been identified within the basin (eg; Colombo fort, Gurubavila fort- Hanwella). These heritage sites can be conserved and

2.13. Natural Disaster Potential

According to the Landslide Studies Division of the National Building Research Organization (NBRO) the agency in charge of landslides, about 400 sq. km. in the Kelani River Basin is under high landslide prone areas where landslides can be expected anytime. Another 140 sq. km. are under most likely landslide potential areas and about 650 sq. km. area is considered as having a moderate likelihood of having a landslide.

Similarly, the National Hazard Profile for Floods (DMC, 2012) highlight areas under flooding threat within the Kelani River Basin, using the floods occurred during recent past including the floods of year 2010.

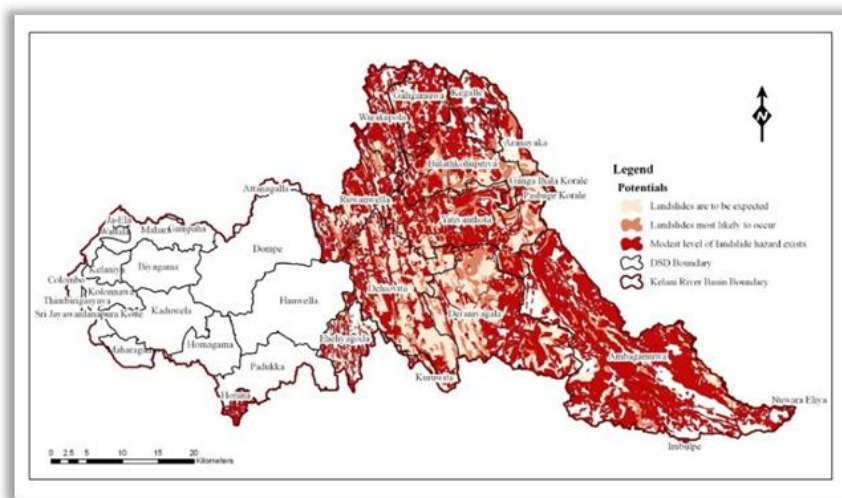


Figure 16: Areas with landslide potential

Source: R&D Unit, CEA, based on NBRO data

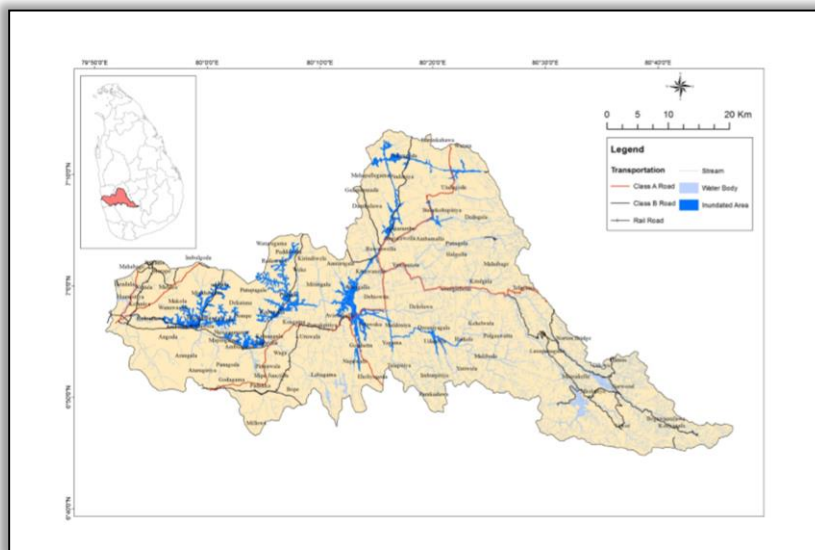


Figure 17: Flood Inundation Areas 2010

Source: Disaster Management Centre (2012)

3.0. Resource use

3.1. Types of green cover

The key categories of green cover in the Kelani River Basin are the Forests, Home Gardens, Rubber and Tea plantations. However, this land use classification is not done at a high resolution and ground truthing is not used extensively in determining the exact canopy type. Therefore, it is not advisable to use this for detailed decision making other than the general use.

There are a number of new initiatives by the Survey Department and others to update the land cover. For example, the World Bank is supporting the Survey Department to develop an accurate land use map of Kelani River Basin in collaboration with the European Space Agency using the satellite imagery for 1991, 2001 and 2012. Survey Department is also starting a LIDAR survey for the western province under JICA support. SLLRDC has a LIDAR data set for the Metro Colombo area. The Land Use Policy Planning Unit (LUPPD) is also in the process of updating the land use data.

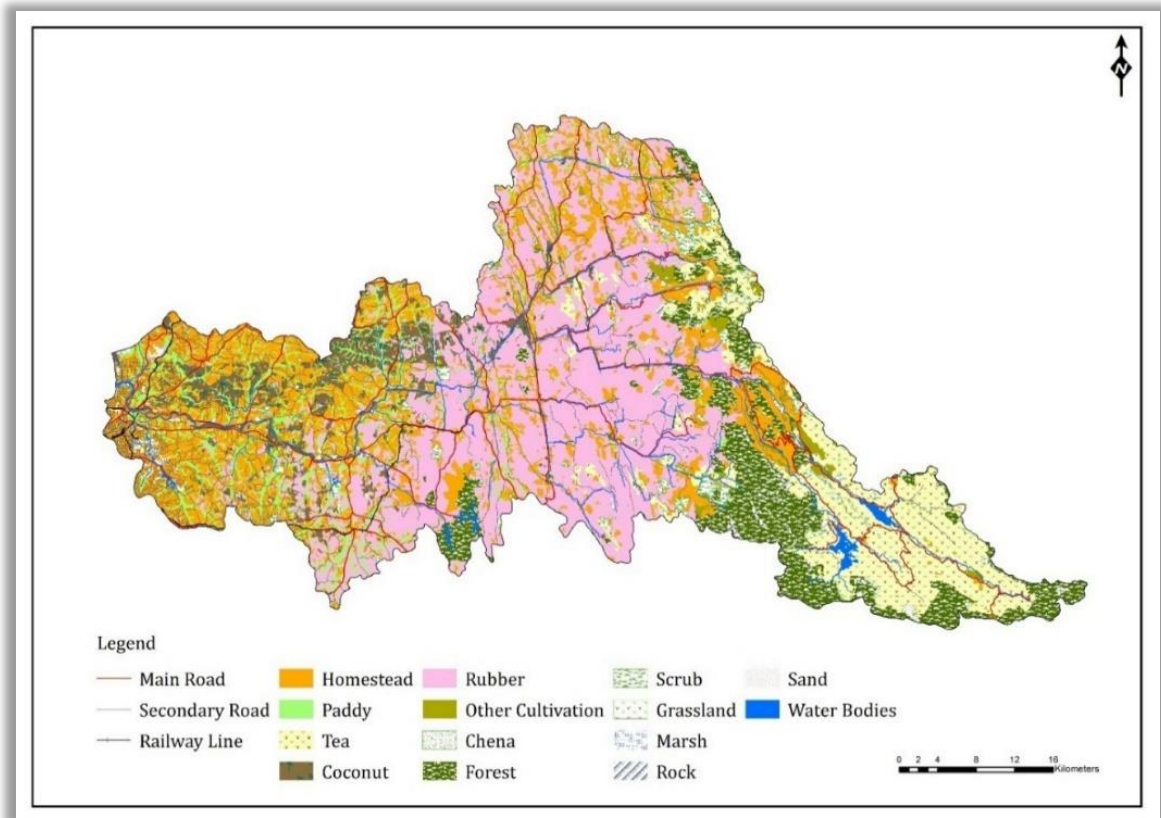


Figure 18: Land use pattern in the Kelani River Basin

Source: Survey Department

3.2. Roads and Streams

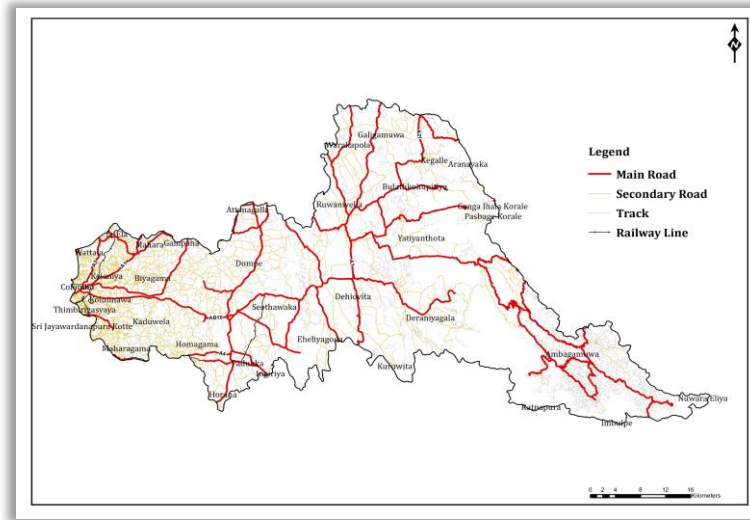


Figure 19: Road network in the Kelani River Basin

Source: Survey Department

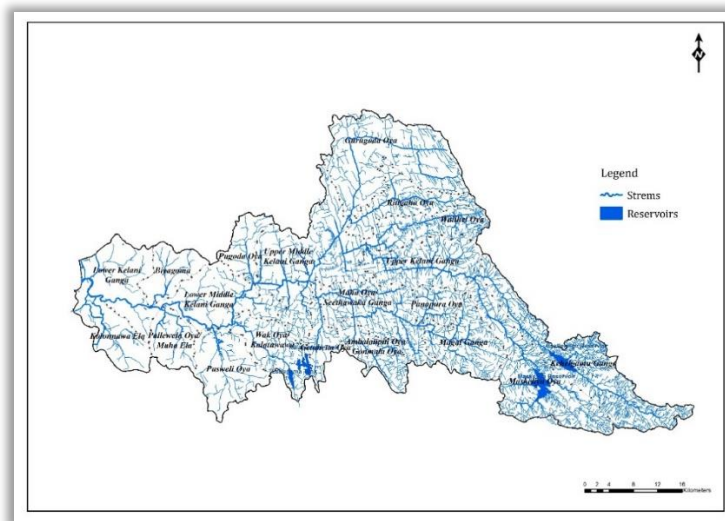


Figure 20: Stream Network with reservoirs

Source: Survey Department

Roads, related infrastructure and drainage are closely linked to water quality, quantity and development issues such as soil erosion, altered hydrology and flooding, deforestation, damage to valuable ecosystems and habitats, damage to scenic quality and tourism and human health and safety. For example, the open road cuts (new construction or old) has the potential to release sediments during intense rain events. In addition oil, grease and other petroleum based chemicals can get washed into streams along with storm water. At the same time the stream banks are also sensitive to intense rainfall and high sediments can be released to the natural system.

3.3. Industries

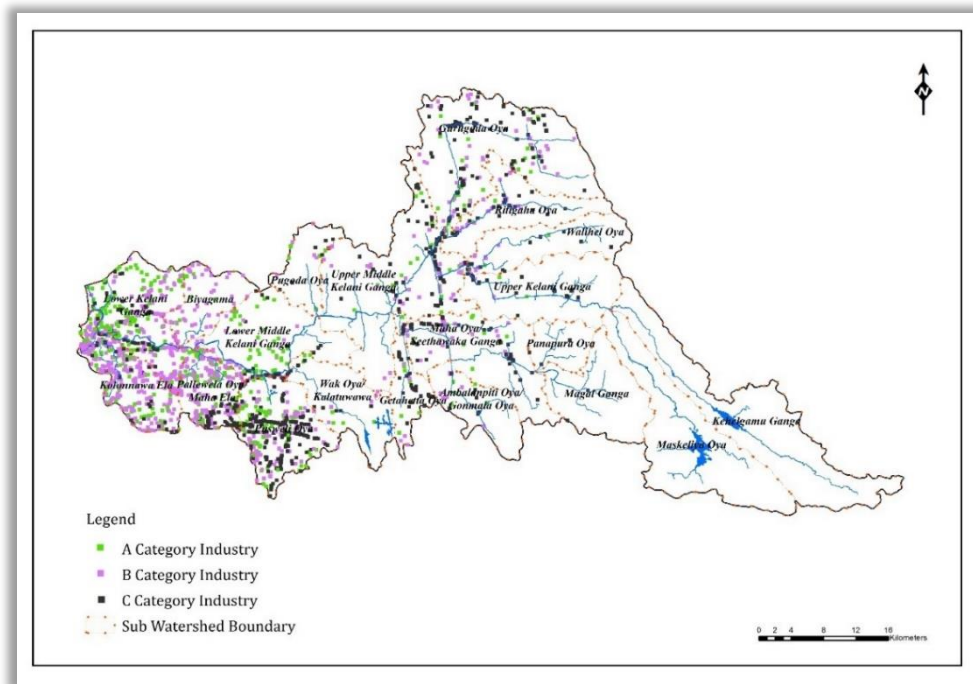


Figure 21: Industry categories and distribution

Source: R & D Unit, CEA

About 2,840 industries are recorded in the CEA database with different pollution potentials (Type A, B and C). The 2,840 industries are divided into 862 (30%); 1,220 (43%); and 760 (27%) among A, B and C type of industries, respectively. Their distribution of industries among the 20 sub-watersheds are provided in Annexure 4.

In the Kelani River Basin (KRB) the Industrial Effluent Discharge of the industries at the Biyagama EPZ is treated by a conventional treatment facility available at site and discharged into Kelani River through Rakgahawatta canal which is located upstream of water intakes of Ambathale and Kelani Right Bank water treatment plants.

3.4. Water

Water resource is one of the main environmental inputs of the Kelani River Basin, contributing to drinking water requirement, power generation, agriculture, industry, household uses, recreation and other environmental services.

Annual yield of electricity derived from the basin was about 1,800 GWh in 2010 which accounted for about 18% of total generation (CEB, 2010). The Ceylon Electricity Board is the main hydropower harvester of the basin and owns the Laxapana complex consisting of five power stations, Old Laxapana, New Laxapana, Canyon, Samanala and Wimalasurendra. Apart from the Laxapana complex, there are more than 50 mini hydropower projects located in the Kelani Basin, which are operated by private

sector. In addition, a number of community operated micro hydro projects are also present in the Kelani River Basin that serves rural communities that do not have access to the main grid.

Majority of the urban populations in Colombo and Gampaha districts receive pipe born water extracted from Kelani River by the National Water Supply and Drainage Board (NWSDB). There are several major intakes located directly on the Kelani River (Avisawela, Kosgama, Kelani Right Bank, Chico, Pugoda and Ambatale) or its tributaries such as Seethawaka Ganga (Penrith watte) and Wak Oya (Labugama and Kalatuwawa). In addition, a number of large scale water dependent manufacturing companies such as Ceylon Cold Stores PLC, Coca Cola beverages, Pepsi and American waters use the Kelani River water which is valued at billions of rupees, annually.

3.5. Agriculture and Animal Husbandry

Several large and medium scale private owned tea and rubber estates are located in the Kelani Basin. Further, there are a large number of small and medium scale tea, rubber, coconut and cloves plantations located within the Kelani River Basin.

Rambutan and Durian are two of the major fruit crops grown in the Kelani valley that are not depicted in the national accounts. In addition, fruit varieties such as banana, pineapple and a range of vegetables are grown in the Kelani River Basin.

Subsistence fisheries, collection of aquatic plants and flowers, non-timber forest products such as “Kithul” based products are some of the minor livelihood practices found in the Kelani River Basin.

A large number of minor irrigation projects in the Colombo and Gampaha districts are based on the Kelani River or its tributaries supporting about 150 sq. kilometres of paddy lands and a range of other crops. The same schemes are being used for flood control to a greater extent.

3.6. Tourism

There are a number of Tourist Attractions located within the Kelani River Basin. Selected locations are:

- The Kelaniya Raja Maha Vihara or Kelaniya temple is located in Kelaniya on the left bank of the Kelani River. It is one of the most revered Buddhist historic temples and many visitors travel there every year (Kelaniya Rajamaha Viharaya, 2011).
- The Kelani Ganga runs through Kithulgala which is a major tourism destination in Sri Lanka. Kithulgala is best known as the location where the famous film “Bridge on The River Kwai”, a World War Two epic was filmed in 1957. The film depicts a story that took place in Japanese-held Burma, but was actually filmed on the Kelani River in Sri Lanka. The scene in the film where the bridge explodes is known as ‘one of the most iconic movie scenes of all time’ (Gordon, 2014).
- Kithulgala in the upper middle part of the Kelani River Basin is the best area in the country for white water rafting and related adventure sports. The stretch of the Kelani River, 5km upstream from Kitulgala provides seven grade two and three rapids suitable for white water rafting. The

upper section is suited for the experienced white water rafters while the lower section is suited for the beginners. In between the rapids there is a stretch of approximately 6.5 km where the flow is less rapid which is suitable for canoeing. A tributary of the Kelani River, Seetawaka river also provides opportunities for white water rafting for more skilled rafters as it has rapids classified as grade 3 to 4. There are a large number of tour operators located along the Kelani River who specialize in adventure sports serving to both local and foreign tourists.

- Kithulgala Rest House is also a popular destination amongst tourists and a resting place for people travelling between the Western and Central Provinces. The forest across the Kitulgala Rest House is a popular destination for tourists as many of the endemic birds of Sri Lanka can be seen here within a short time period.
- Located 8 km from Kitulgala, the Beli Lena caves is another tourist attraction. The caves revealed the remains (ten skeletons) of the prehistoric “Balangoda Man” (*Homo sapiens balangodensis*), Sri Lanka’s oldest inhabitant, who has occupied this cave around 32,000 years ago.
- The Kithulgala / Kelani Valley Forest Reserve, which was established to protect the Kelani River watershed is inhabited by many endemic fauna and flora. It is a popular destination for jungle treks, mountain biking and breath-taking scenery (Reddot tours, 2015).
- Various waterfalls are located in the main Kelani River and its tributaries such as Nalagana Falls on Ritigaha Oya; Aberdeen Falls; Handun Ella; Dambora Ella, Thudugala Ella, Ranmudu Ella and Olu Ella (the highest waterfall connected to Kelani river and sixth highest in the country).
- River tours using passenger boats such as the Maha Naga cruises up the Kelani River from Hamilton Canal starting from Peliyagoda through the Muthurajawela wetlands up to Negombo Lagoon (ft. lk, 2014).
- Seethawaka (Wet Zone) Botanical Garden is one of the five botanical gardens in Sri Lanka situated within the Kelani River Basin on the Puwakpitiya-Thummodara main road at Illukowita, adjacent to the Indikada Mukalana Forest Reserve at Avissawella. It has an extent of 32 ha (79 acres).

3.7. Mineral Resources

Gem, sand and clay are extensively extracted from the Kelani Valley. Gem mining is one of the main economic activities in the middle part of Kelani River while sand mining takes place in most parts of the basin and ranges from small to medium scale extractions. Raw clay extraction takes place in the middle and lower part of the basin for the brick and pottery industries.

4.0 Key Issues

4.1. Lack of detailed inventories in Natural Habitats

Based on the preliminary data gathering it was clearly identified that more than 75% of the natural habitats in the Kelani River Basin have not been studied in detail. Much of the data available on biodiversity of the Kelani Basin comes from isolated studies done to fulfil different objectives and many of them have focussed on sites outside the natural habitats. Hence, the spatial distribution of natural habitat data cover is incomplete.

Nevertheless, based on the data sources used it can be concluded that the Kelani Basin supports a rich faunal and floral assemblage with many endemic and threatened species. It is proposed that the KRMP approach invests on identifying data gaps and completing the natural habitat profiles and ecosystem information so that richness of the biodiversity of the Kelani River Basin is well understood and also provide entry points to strengthen the management and conservation of these valuable resources, including the employment creation opportunities.

4.2. Encroachment and land degradation

The expansion of the population and agricultural activities such as Tea and Rubber Small Holdings has resulted in encroachment of the few remaining natural habitats. Further, encroachment of wetland habitats due to expansion of human settlements has resulted in a gradual reduction of the natural wetland habitats in the basin.

On the upper reaches of the basin extensive agriculture in steep lands with crop types not suitable for the landscape features has been identified as a major issue resulting in land degradation and loss of natural habitats.

4.3. Industrial Pollution

Two large industrial zones with central waste treatment facilities are located at Seethawaka and Biyagama. In addition, a large number of industries are located outside the industrial zones along the river. The river drains the most populated province in the country thus, there are many industries releasing treated and untreated industrial effluents in to the river.

According to CEA (2015), the water quality parameters that exceeded standards at Thulduwa and Seethawaka ferry monitoring sites included COD (37% times), BOD (13% times), Dissolved Oxygen (43% times) and Heavy metals (7% times). The quality of water at the two locations rapidly deteriorated during the past three years with the Seethawaka ferry site receiving industrial waste water from the Seethawaka industrial zone. Sampling sites in the middle of the river basin such as Pugoda Ferry, Hanwella Bridge, and Kaduwela Bridge had a superior water quality compared to their upstream Seethawaka location, primarily due to the dilution effects as the river receives water from tributaries towards the middle of the basin.

The sampling site at Raggahawatte receives contaminated industrial waste water from Biyagama Industrial Zone. The parameters frequently exceeded during the last three years are COD (36% times), BOD (7% times), Dissolved Oxygen (27% times) and Heavy metals (7% times). In addition, the Ma

Oya tributary reports discharges of organic waste resulting exceeding levels of COD (13% times), BOD (60% times), Dissolved Oxygen (80% times) and heavy metals (7% times), during the last three years.

Organic dye waste discharged in to the river by textile factories located in the Hanwella area may produce carcinogenic chloroaromatic compounds during chlorination during water treatment. Long term accumulation of such chloroaromatic compounds is known to cause gastric cancers and possibly kidney disease (Ileperuma, 2000).

4.4. Non-point source pollution

Non-point sources of pollution or diffuse pollution in the Kelani River Basin may have origins in agricultural, poor land use related erosion and degradation, runoff from urban areas etc.

A five year (2010-2015) estimate of the mass of sediments indicate that, on the average, about 2,300 metric tons of sediments and 65 tons of nitrate nitrogen passed by the Hanwella Bridge, annually (Mallawatantri and Samarathunga, 2016 unpublished). It also indicates a seasonal variation with high amounts of sediments and nitrates in the river during rainy seasons. For example, the monthly load of sediments passing by Hanwella Bridge vary from is about 40 tons per month in February to about 725 tons per month in October, on the average.

Faecal coliform in river water is an issue at lower reaches and parts of upper reaches of the Kelani Basin where population density is high. Poor sanitation practices, disposal of untreated or partially treated sewage (example, from household latrines and restaurants/hotels located on the banks) and inadequate urban infrastructure (central pumping etc.).

4.5. Ground water pollution

Arewgoda (1988) states that well waters in the vicinity of a number of operating brass foundries are contaminated with lead (0.095 ppm), cadmium (0.065 ppm) and zinc (10.91 ppm). Zinc contamination occurs mainly through the manufacture of brass in open crucibles where sand used for moulds is generally dumped on open ground. The soil becomes heavily contaminated with zinc, copper, lead and cadmium which eventually runoff to the river during the rainy season. No vegetation or flowering plants grow on such contaminated soils. For families engaged in gold recovery, the mean urinary mercury level was found to be around 0.5141 ppm which is significantly higher (Ratnayake and Arewgoda, 1987) than in the control group, where the mean level was 0.0734 ppm. Potential and need exists to expand the knowledge on the ground and surface water related environmental processes and pollution pathways among all stakeholder entities in the Kelani River Basin, significantly (De Silva and Mallawatantri, 2016).

4.6. Impact of water diversion and impounding

A large number of weirs and dams have been constructed across the Kelani River or its tributaries for the purpose of diverting water for agriculture, energy generation and drinking water. Such diversions or impoundments may block the free movement of aquatic species such as migratory fish in the river. The resulting reduction in water availability below the diversion/ impounding point and reduced speed (velocity) of water changes the water quality (pH, EC, Temperature etc.), dynamics in river mixing, causes changes in vector population and increases predation of aquatic species. These changes in the

river structure also contributes to a host of social issues such as loss of livelihoods based on river resources, loss of bathing places, lack of drinking water etc.

Therefore, it is extremely necessary to evaluate the current status of diversions and impoundments in terms of environmental flows and ecological impacts. It may be necessary to incur a number of changes to the present condition to ensure the sustainability of the natural resource base in the Kelani River Basin.

4.7. Poor service delivery

Urban service delivery and natural resources are connected through a number of ways. Poor collection and process of municipal waste is considered as the number one. Seepage from dumping grounds causes pollution impacting habitats. In addition, the service delivery issues harming the natural environment may also include wastewater, electronic waste and sewerage disposal.

4.8. Impact of climate change

Climate change could affect natural habitats and resources through the changes in rainfall pattern, temperature increase, sea level rise etc. In the Kelani River Basin the general climate prediction is that the basin may get more rain. Already the sea level rise and sea water intrusion is visible during the low flow periods with sea water travelling up to Ambathale water treatment plant area. Increased temperature may change the habitat types and also brings additional issues such changes to the growth and spread of invasive alien species, among others.

4.9. Chemical accidents and response capacity

With a large number of industries and high population centres located within the Kelani River Basin, any chemical accident (industrial, transport, fire, storage etc.) can be disastrous not only to the humans but also to the natural environment. Some accidents can be instant accidents or others may be slow such as leaking petrol station storage or storage of agro-chemicals or radio-active material.

Therefore, it is necessary to prepare contingency plans for different type of chemicals and potential scenarios and train and prepare both public and private sector stakeholders as well as public to take necessary steps.

5.0. In conclusion

During the compilation it was evident that the Kelani River Basin natural resources including its biodiversity and heritage can be better characterized and the management and conservation of the same resources can be improved, significantly with adequate investment.

As the urban expansion progresses the Kelani River Basin natural resource base is expected to face a number of challenges in terms of ecological changes including impacts on wetlands and other habitats. However, it is encouraging to note that positive steps are being taken by the Government to ensure the development and urban expansions follow environmental management principles (UDA, 2016).

One of the potential approaches to reverse the conclusion of Kelani River being the most polluted river is to better understand and appreciate the natural resource base of the basin and take action to conserve and use the natural resources to provide alternative employment in place of polluting industries.

Improved understanding and management of the natural resource base may also add to the knowledge of present and future generations, thereby, encouraging the preservation and sustainable use of the same resources. Nature trails, hands on learning and concepts such as “healthy parks and healthy people (Victoria Parks, 2016)” are some of the innovative approaches to be considered in this context to improve the use of natural resources in a sustainable manner, benefiting the humans as well as nature.

The natural resources listed in this document cover only a fraction of the natural resources within the Kelani River Basin as much more resources are waiting to be discovered and described. It is also necessary to develop detailed descriptions of the items including the heritage sites so that the information can be used by multiple audiences, including, researchers, travellers, students and general public. Improved access to this information also need to be facilitated.

More knowledge of natural resources, historical treasures and potential ecosystem services within the Kelani River Basin could justify and support policy decisions required to conserve the natural resources of the basin and promote nature based solutions in the development processes, in a meaningful manner.

6.0. References

- Arewgoda, C.M. (1986). Pollution due to heavy metals in Kelaniya area. In: Some aspects of the chemistry of the environment of Sri Lanka, *Sri Lanka Association for the Advancement of Science, Special Publication*, 161 –165.
- CEB (2010) CEB Annual Report of 2010, Ceylon Electricity Board, Colombo.
- Central Environmental Authority. (2014). *Water Quality in Kelani River Introduction*. Available: <http://www.cea.lk/web/index.php/en/water?id=160> Last accessed 24/06/2015.
- Cooray, P.G. (1984) *The geology of Sri Lanka*. Second Revised Edition. National Museums of Sri Lanka Publication. 340 p.
- Department of Agriculture. (2006). *Climate of rice growing regions in Sri Lanka*. Available: <http://www.agridept.gov.lk/index.php/en/crop-recommendations/903>. Last accessed 17.06.2015.
- Department of Agriculture. (2006). *Rice Soils of Sri Lanka and their Productivity*. Available: <http://www.agridept.gov.lk/index.php/en/crop-recommendations/901>. Last accessed 17.06.2015.
- Deraniyagala, S.U. (1996, September). Pre-and protohistoric settlement in Sri Lanka. In *XIII UISPP Congress Proceedings* (Vol. 5, pp. 277-285).
- ft.lk. (2004). *River cruises, a new milestone in Sri Lanka's eco-tourism industry*. Available: <http://www.ft.lk/2014/04/10/river-cruises-a-new-milestone-in-sri-lankas-eco-tourism-industry/>. Last accessed 25/06/2015.
- Gordon, S. (2014). *Sri Lanka to rebuild iconic Bridge On the River Kwai that starred in Oscar-winning film*. Available: http://www.dailymail.co.uk/travel/travel_news/article-2738001/Sri-Lanka-rebuild-iconic-Bridge-On-The-River-Kwai-starred-Oscar-winning-time-won-t-blown-up.html#comments Last accessed 25/06/2015.
- Ileperuma, O.A. (2000). Environmental pollution in Sri Lanka: a review. *Journal of the National Science Foundation of Sri Lanka*, 28(4), 301-325.
- IUCN Sri Lanka (2013). *Enhancing the Ecological Integrity and Ecological Services of Halgolla Estate*. IUCN Sri Lanka Country Office. 121pp.
- Perera, W.P.N., Goonatilake, S. de A., Wadugodapitiya, A, De Silva G. and Weerakoon D. (2014) *A Descriptive guide to Galapitamada-home of the Critically Endangered Bandula Barb*. IUCN Sri Lanka Country Office. 28pp.
- Jayasuriya, A. H. M., Kitchener D. and C. M. Biradar (2006) portfolio of strategic conservation sites / protected area gap analysis in Sri Lanka. EML consultants & ministry of environment & natural resources.

Mallawatantri, A., A. Rodrigo and K. De Silva. 2016. Medium to Long-term Multi-Stakeholder Strategy and Action Plan for management and conservation of the Kelani River Basin. Central Environmental Authority and International Union for Conservation of Nature in Sri Lanka, 2016. 156 pp.

De Silva, K. and A. Mallawatantri. 2016. Preliminary Perception Survey on Water Safety of the Kelani River Basin. International Union for the Conservation of Nature Sri Lanka Country Office and Central Environment Authority. Colombo. 30 pp.

Panabokke, C. R. (1996). Soils and agro-ecological environments of Sri Lanka. Colombo, Sri Lanka: NARESA. xvi, 220pp. (Natural resources series no.2)

Punyawardena, B. V. R. (2004). Technical report on the characterization of the agro-ecological context in which Farm Animal Genetic Resources (FAnGR) are found: Sri Lanka. *Farm Animal Genetic Resources Project*.

Ratnayake, A.H. and Arewgoda, C.M. (1987). Mercury levels in urine of families engaged in gold recovery. *Proceedings of the Sri Lanka Association for the Advancement of Science* pp. 220.

Red Dot Tours. (2015). *Kitulgala-Kelani Forest Reserve*. Available: <http://www.reddottours.com/133/kitulgala-kelani-forest-reserve-activity-profile.htm>. Last accessed 26/06/2015.

Silva, E. I. L. (1996). Water Quality of Sri Lanka. *A Review of Twelve Water Bodies, Institute of Fundamental Studies, Kandy, Sri Lanka*.

Survey Department of Sri Lanka (2007). The National Atlas of Sri Lanka (Second Edition), pages 62-65.

Survey Department of Sri Lanka (2014). *Topo Map Information*. Available: <http://www.survey.gov.lk/surveyweb/Home%20English/Map%20Index.php>. Last accessed 17.06.2015.

Urban Development Authority (2016). Environmental Assessment and Management Framework for Strategic Cities Development Project (SCDP).

Urban Development Authority (2016). Resettlement Policy Framework for Strategic Cities and Development Project (SCDP).

Victoria Parks. 2016. Healthy Parks-Healthy People, Victoria, Australia (<http://parkweb.vic.gov.au/>) last accessed January 10, 2016.

Wellaboda, K.T.A. (2011). *Kelani Raja Maha Viharaya*. Available: <http://www.kelaniyatemple.org/>. Last accessed 25/06/2015.

Wijesinghe, T.M.K. (1979). Agro-Ecological Regions of Sri Lanka. 1:100,000, Peradeniya: Department of Agriculture.

Annexure 1: Areas under 20 sub-basins

NO	Sub Watershed/Basin	Area(ha)	%
1	Kolonnawa Ela	8,597	3.68
2	Pallewela Oya/Maha Ela	6,146	2.63
3	Pusweli Oya	11,367	4.87
4	Wak Oya/Kalatuwawa	9,372	4.02
5	Getahetta Oya	4,327	1.85
6	Ambalanpiti Oya/Gonmala Oya	6,965	2.98
7	Maha Oya/ Seethawaka Ganga	14,500	6.21
8	Panapura Oya	4,289	1.84
9	Magal Ganga	11,123	4.77
10	Maskeliya Oya	19,537	8.37
11	Kehelgamu Ganga	21,226	9.10
12	Upper Kelani Ganga	13,359	5.73
13	Walihel Oya	8,922	3.82
14	Ritigaha Oya	9,395	4.03
15	Gurugoda Oya	23,887	10.24
16	Upper Middle Kelani Ganga	23,977	10.28
17	Pugoda Oya	5,214	2.23
18	Lower Middle Kelani Ganga	12,780	5.48
19	Biyagama	6,174	2.65
20	Lower Kelani Ganga	12,178	5.22

Annexure 2: Distribution of soil types in major sub basins

Soil Extent (ha) - See the map in 2.6 for soil type description)											
Sub Catchment/soil type	1	2	3	4	5	6	7	8	9	10	11
Ambalanpiti Oya/Gonmala Oya							90	6,875			
Biyagama	192					5,982	1,103				
Getahetta Oya							3,184	3,008			
Gurugoda Oya				1,880				14,150	4,674		
Kehelgamu Ganga				4,841	305			15,946			133
Kolonnawa Ela	434	2,334				5,814				15	
Lower Kelani Ganga	2,797	350	419			8,374				238	
Lower Middle Kelani Ganga	2,048					10,043		688			
Magal Ganga				5,552				4,605			966
Maha Oya/Seethawaka Ganga							1,515	12,985			
Maskeliya Oya				11,237				6,045			2,255
Pallewela Oya/Maha Ela	208	166				4,964		807			
Panapura Oya								4,289			
Pugoda Oya	35					5,104		75			
Pusweli Oya	28	493				6,059		4,787			228
Ritigaha Oya				2,422			932	5,813			157
Upper Kelani Ganga				3,548			76	9,577			
Upper Middle Kelani Ganga	234					3,957	4,455	15,332			
Wak Oya/Kalatuwawa	143	216				1,973		6,649			
Walihel Oya				5,012			224	3,339			347

Annexure 3: Slope steepness classes within sub-basins

Sub Catchment	Slope Extent (ha)			
	Low	Moderate	High	Very High
	(0-5)	(5 - 15)	(15-25)	(25-35)
Ambalanpiti Oya/Gonmala Oya	3,471	3,427	67	
Biyagama	6,173	1		
Getahetta Oya	2,710	1,589	29	
Gurugoda Oya	13,158	9,428	1,212	80
Kehelgamu Ganga	5,436	12,680	3,028	67
Kolonnawa Ela	8,581			
Lower Kelani Ganga	11,765			
Lower Middle Kelani Ganga	12,631	148		
Magal Ganga	1,283	6,260	3,203	377
Maha Oya/Seethawaka Ganga	7,102	7,250	148	
Maskeliya Oya	4,220	10,732	3,857	728
Pallewela Oya/Maha Ela	6,146			
Panapura Oya	1,027	2,918	344	
Pugoda Oya	5,214			
Pusweli Oya	11,102	265		
Ritigaha Oya	2,805	5,160	1,369	60
Upper Kelani Ganga	2,527	7,865	2,684	283
Upper Middle Kelani Ganga	15,985	7,908	84	
Wak Oya/Kalatuwawa	6,463	2,898	11	
Walihel Oya	1,964	4,727	1,929	303
Total	129,762	83,256	17,965	1,898
%	55.7	35.8	7.7	0.8

Annexure 4: Distribution of A, B and C type industries in 20 sub basins

Sub Catchment	A	B	C	Total	%
Ambalanpiti	6	9	9	24	
Biyagama	14	58	1	73	
Getahetta Oya	10	14	31	55	
Gurugoda Oya	34	62	118	214	
Kolonnawa Ela	180	296	47	523	
Lower Kelani Ganga	190	183	66	439	
Lower Middle Kelani	50	43	30	123	
Magal Ganga	0	0	2	2	
Maha Oya/Seethawaka	18	34	50	102	
Pallewela Oya/Maha	161	230	67	458	
Panapura Oya	0	0	3	3	
Pugoda Oya	7	7	5	19	
Pusweli Oya	148	173	184	505	
Ritigaha Oya	5	27	24	56	
Upper Kelani Ganga	2	8	21	31	
Upper Middle Kelani	28	61	78	167	
Wak Oya/Kalatuwawa	7	4	12	23	
Walihel Oya	2	11	12	25	
Total					
%	30.3	42.9	26.7	100.0	

ISBN 9789550205417



9 789550 205417