Integrated Spatial Planning and Analysis to Prioritize Biodiversity Conservation in Sri Lanka

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INTEGRATED SPATIAL PLANNING AND ANALYSIS TO PRIORITIZE BIODIVERSITY CONSERVATION IN SRI LANKA

PREPARED BY:

ERIC WIKRAMANAYAKE & VINDHYA BUTHPITIYA

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The “Integrated Spatial Planning and Analysis to Prioritize Biodiversity Conservation in Sri Lanka” project was conducted by EFL in partnership with the National Biodiversity Secretariat of Sri Lanka and was supported by the Convention on Biological Diversity and the Japan Biodiversity Fund. In the project, spatial analysis is used as a tool to identify conservation priorities in Sri Lanka, producing several socio-economic and infrastructural spatial overlays to identify areas of conflict in order to prioritize where conservation should take precedence over infrastructure and other development, and where mitigation could help minimize environmental impacts.

Sri Lanka is recognized as possessing globally important biodiversity. However, extensive conversion, fragmentation and pollution of natural ecosystems have placed this natural heritage under severe threat. Despite being an early signatory to the Convention on Biological Diversity (MoFE, 1999), Sri Lanka has only achieved 19% of the priority recommendations from the first National Biodiversity Strategic Action Plan (NBSAP) (Bandaratillake, 2014), attributed to the poor integration of targets and recommendations into plans, policies and programmes of the development sector agencies. The objective of this project was to identify conservation priorities at the national scale within the vis-à-vis NBSAP targets, that can be integrated into the National Physical Plan.

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- Sri Lanka Land Reclamation & Development Corporation
- Biodiversity Secretariat, Sri Lanka
- Forest Department

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EXECUTIVE SUMMARY

Sri Lanka is recognized as possessing globally important biodiversity by several yardsticks of measurement (Biodiversity A-Z, 2014). However, extensive conversion and pollution of natural ecosystems has placed this natural heritage under severe threat. Despite being an early signatory to the Convention on Biological Diversity (MoFE, 1999), only 19% of the priority recommendations from the first National Biodiversity Strategic Action Plan (NBSAP) were achieved (Bandaratillake, 2014). This lack of progress was attributed to poor integration of biodiversity conservation targets and recommendations into the plans, policies and programmes of the development sector agencies.

The Government of Sri Lanka is now revising the National Physical Plan and Policy (NPP). There is an urgent need to identify and spatially map the biodiversity conservation priorities so they can be integrated into development plans. The objective of this project was to conduct a spatial analysis to identify biodiversity priorities at the national scale, vis-à-vis the NBSAP's targets, that can be integrated into the NPP.

We collected available biodiversity, socio-economic, and development data. Using this data, 16 maps were produced depicting various features of the landscape, and conservation and developmental priorities. These maps include existing protected areas, proposed gaps in protected areas, forest areas important for erosion and flood control, habitat suitability and corridor models, as well as areas identified for commodity agriculture and large-scale infrastructure.

Outputs indicate that more conservation attention is needed in the wet zone. However, ecological connectivity in both the dry and wet zones should be maintained and expanded. Large gaps in the dry zone offer opportunities to create ecological corridors between protected areas (Jayasuria, et al., 2006). In the wet zone, habitats around the forests were found to be suitable to support smaller endemic species, and should be included within the conservation strategy.

Overlays of the large infrastructure and agricultural zones indicates the potential for severe land use conflicts. Planned infrastructure will overlap with several protected areas, severing habitat connectivity and causing loss of wildlife habitat. Further conversion of forest for large scale commodity plantations should be disallowed. With the decline in both rubber and tea as a commodity in global markets, abandoned plantations offer opportunities to reforest the land.

The spatial database is meant to complement the recommendations put forth in the National Biodiversity and Strategic Action Plan 2016-2022 (NBSAP). These outputs are timely, especially since The National Physical Planning Department is in the process of revising the existing plan. This database and analysis will be integrated into this process via stakeholder meetings. The plan will also provide an opportunity and entry point for the Biodiversity Secretariat (BDS) and other stakeholders in biodiversity conservation to engage with the process. The spatial database will be deposited within the BDS, and also be made available to other stakeholders so it can be updated, accessed, and used for planning and implementation of the NBSAP.

1. BACKGROUND

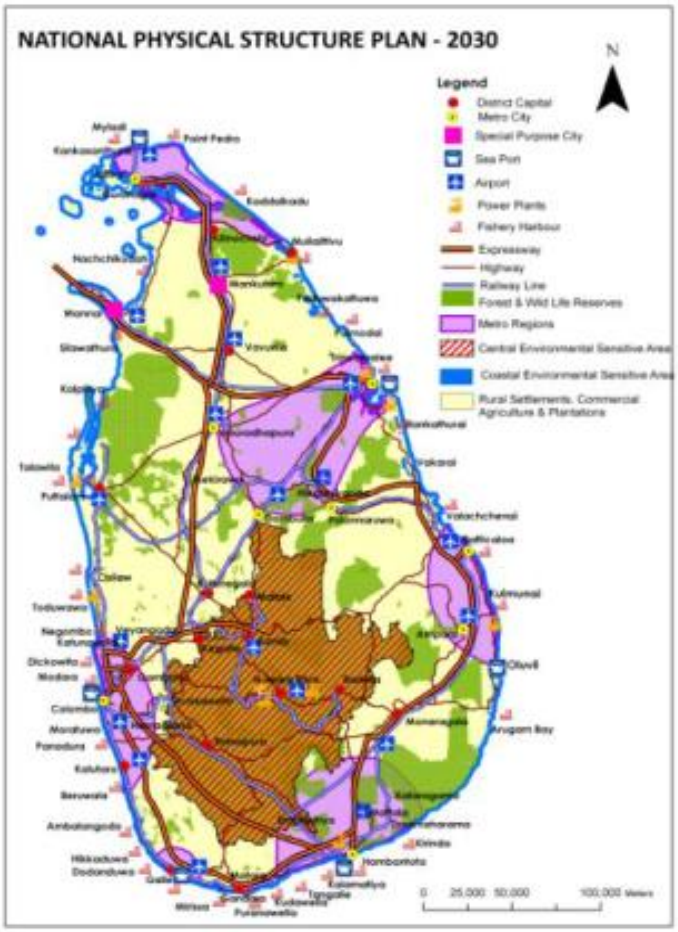
Sri Lanka is recognized as possessing globally important biodiversity by several yardsticks of measurement. As an island biogeographically isolated from mainland India since the early Pleistocene (Deraniyagala, 1958), Sri Lanka is rich in irreplaceable endemic species, especially in the southwestern and central tropical moist forests (Gunathilleke, et al., 2005) (Wickramanayake, et al., 2001). However, extensive conversion and pollution of natural ecosystems has placed this natural heritage under severe threat; many species are isolated in small forest fragments, aquatic biodiversity is stressed from pollutants and habitat loss, and ecosystem processes and services are being degraded.

Sri Lanka is an early signatory to the Convention on Biological Diversity, and prepared a national 'Biodiversity Framework for Action Plan' (BCAP) in 1999 (MoFE, 1999), with a subsequent addendum of strategies and actions. The plan identified conservation priorities to stop the erosion of biodiversity. The major recommendations from the BCAP were: identify critically important hotspots and include them within the protected areas (PA) system, especially since the existing protected areas system was not representative of the island's ecosystems; assess the need for ecological linkages among the core areas (i.e., protected areas) and conserve them; and prepare and implement species recovery plans.

The second NBSAP plan has now been prepared for the period 2016-2022 (MoMDE, 2016), and will adopt an ecosystem-based approach that is more consistent with current approaches to biodiversity conservation, and integrating biodiversity into national development priorities. The second plan is also linked to contributing to the Aichi Biodiversity Targets and Sustainable Development Goals (SDGs).

Since the BCAP was prepared, Sri Lanka has embarked on a rapid socio-economic development program, which includes expansion of major urban and commercial areas, building expressways and rail transportation system to link these areas, expansion of commercial agriculture, and rural development through small to medium enterprises (SME) and other livelihood opportunities (Figure 1) (NPPD, 2010). These socio-economic development plans will inevitably lead to land and resource conflicts with biodiversity conservation priorities.

Figure 1. Proposed economic development infrastructure and conservation areas. From the National Physical Planning Policy and Plan (2010) (NPPD, 2010)



However, this assertive push towards development in post-war Sri Lanka, despite its intentions of drawing in foreign direct investment and creating localized opportunities for employment and livelihood development has not yielded the desired outcome in terms of benefits to rural communities. In many instances, these top-down approaches have instead contributed to the perpetuation of exclusion and marginalization due to the lack of participatory mechanisms and community-centred development.

Within the scope of the numerous infrastructure, commercial and tourism-oriented development projects undertaken in the last decade, local communities were relocated and actively driven away from their traditional livelihood activities including agriculture, farming and fisheries with no practicable interim options or alternatives being provided, thus exacerbating their immediate vulnerability to poverty (Kuruppu & Ganepola, 2005; Fonseka

& Raheem, 2010; Gunasinghe, 2012; Liyanaarachchi, 2013). What is also noteworthy is that those communities whose traditional livelihoods have been dependent upon natural resources, be it foraging, farming or fisheries, have been most affected by these development projects and interlinked displacement.

In the war-affected North, North-West and North-East of Sri Lanka, where the weight of decades of war and displacement are still persistent, contentions related to land use, ownership and resettlement, alongside enduring strains between host and displaced communities, and land-grabbing related to economic development continue to marginalise communities. Access to land, resources and livelihoods have been gravely affected, notably within the fisheries and agricultural sectors. This has also increased the strain on natural resources and community contentions over these. Furthermore, where communities have been relocated to make room for development projects, the socio-economic and environmental impacts of relocation have been overlooked, thus aggravating land and resource conflicts with conservation priorities.

Moreover, Sri Lanka's increasing vulnerability to natural disaster have also compounded these concerns, with whole villages awaiting resettlement as a consequence of their susceptibility to landslides and floods in particular. These realities give rise to various environmental concerns such as deforestation, encroachment, strain on/ poor management of natural resources and energy generation, pollution, and poor waste management which hinder conservation priorities, aside from amplifying prevalent challenges such as the human-elephant conflict and the poor management of land, water bodies and other natural resources. This highlights the need to not only mainstreaming environmental priorities within economic development policy and planning, but also within the scope of relocation and resettlement towards effectively reconciling the conservation of biodiversity and socio-economic development. Thereby, it is imperative that national development goals are aligned with the needs of communities and in consideration of their relationships to the environment, with a view of strengthening both local development and conservation.

Development projects that do not recognize and integrate ecological and conservation priorities into their own will result in loss of critically important forest and freshwater ecosystems. Climate change is also expected to impact both biodiversity and people, as well as economic development plans, with complex feedback loops. The landscape approach to ecosystem management of the second NBSAP (2016 – 2022) is better suited to address these emerging issues.

The updated NBSAP (2016 – 2022) will also be a guiding framework for provincial authorities of Sri Lanka to use as a touchstone when planning and implementing development and conservation initiatives at sub-national scales. Planning and implementing conservation initiatives at sub-national scales require a national scale perspective, especially when transitioning to a landscape or basin scale approach to ensure that ecosystem processes and services that transcend administrative boundaries are continuous and undisrupted.

According to the Fifth National Report to the CBD (Bandaratillake, 2014), only 19% of the priority recommendations from the first plan were achieved (Bandaratillake, 2014). The lack of progress was attributed to the lack of adequate integration of biodiversity conservation targets and recommendations into the plans, policies, and programmes of the development sector line agencies (Bandaratillake, 2014). Integration of biodiversity conservation targets into development sector plans through better coordination with the development sector authorities is a strong recommendation of the NBSAP (2016- 2022) (MoMDE, 2016).

The Government of Sri Lanka is now revising the National Physical Plan and Policy and there is an urgent need to identify and spatially map the biodiversity conservation priorities so they can be integrated into development plans. Doing so will minimize land allocation conflicts and minimize and mitigate the impacts from socio-economic development.

The objective of this project was to conduct a spatial analysis to identify biodiversity priorities at the national scale, vis-à-vis the NBSAP's targets, that can be integrated into the national physical plan now being prepared as a base to implement the NBSAP's in-situ conservation recommendations.

1.1 Overview of Sri Lanka's Biogeography and Biodiversity

Sri Lanka is a continental island in the Indian Ocean, located off the southeast coast of the Indian subcontinent, at 5˚ 55'-9˚ 51' N and 79˚ 41'-81˚ 54' E. The island is 64,740 km^2, with a central massif that rises to about 2,524 m, at the highest point of the island. The topography consists of three peneplains, with the first rising from sea level to 300 m, the second to 1,500 m, and the third to the highest peaks over 2,200 m (Survey Department, 2007).

The central mountains intercept two monsoons—the southwest and the northeast—influencing the island's climate and the distribution of biodiversity. While six bioclimatic zones have been recognized by Wijesinghe et al. (1993), two broader climatic zones are generally recognized; the wet zone in the southwest and the dry zone through the rest of the island. The former is characterized by mean annual rainfall of 2,500mm and a mean temperature of about 27˚ C in the lowlands to around 16˚ C in the montane areas. The dry zone receives 1,250 mm to 1,900 mm of annual rainfall, but spread unevenly with a dry period lasting about 5 months. The mean daily temperature is about 30˚ C. Two small coastal areas in the northwest and southeast form an arid zone, with a mean annual rainfall less than 1,250 mm (Survey Department, 2007).

The combination of variable rainfall, geological isolation from the continent, and dissected terrain in the three mountain ranges of the central massif has resulted in speciation, giving rise to a high number of endemic species in the wet zone and central regions. Several zonal classifications have been made based on the distributions of different taxonomic groups, including endemic species. Eisenberg and McKay (1970) classified the distribution of mammals into seven zones; Kotagama (1993) recognized six avifaunal zones; Senanayake and Moyle (1982) four ichthyological zones; and Ashton and Gunatilleke (1987) identified fifteen floristic regions. All of these zonations recognize that the moist forests of the southwestern region and the central montane region harbor the highest endemicity, and thus, Sri Lanka's irreplaceable biodiversity. Overall, more than 75% of the known endemic species are restricted to the wet zone. A few endemic animals and plants are also known from the isolated rock outcrops (inselbergs) scattered throughout the dry zone (MoMDE, 2016).

The dry zone, however, supports a rich megafauna, including one of Asia's largest Asian elephant (*Elephas maximus*) populations, an endemic subspecies of the common leopard (*Panthera pardus kotiya*) (Miththapala, et al., 1991), and sloth bear (*Melurusus ursinus*). Compared to the subcontinent, the large mammalian fauna of Sri Lanka is depauperate; however, the regionally distributed large mammal populations can contribute to global conservation priorities. They are also national priorities because of their flagship status, and importance in a wildlife tourism strategy.

Sri Lanka has the 'unfortunate distinction' of being recognized as one of the 35 global 'Biodiversity Hotspots' (Myers, et al., 2000); distinction because of the recognition of the rich endemism that makes it comparable with other high biodiversity regions in the world, but 'unfortunate' in that this biodiversity is threatened by >70% loss of forest cover. Over the last 150 years forest cover has undergone a marked decline due to extensive clearing for commodity crop plantations, agriculture, and expansion of human settlements. As a result, a high proportion of species in most taxonomic groups, and especially the endemic species, are now threatened with extinction. Less than 10% of the forests in the wet zone now remain, and these occur as small patches in a highly fragmented landscape.

Forest loss and fragmentation, especially in the wet zone and central mountains also pose severe threats to human populations, their livelihoods, and to the government plans for economic development. Almost all perennial rivers originate in the central mountains and radiate out, forming a wagon wheel of watersheds. An ancient agrarian-based civilization in the Dry Zone was sustained by storing water from the major rivers in a complex system of over 10,000 irrigation reservoirs. Many of these reservoirs have now become 'naturalized' and provide perennial and seasonal water for both wildlife and humans. Other than these reservoirs (or 'tanks'), Sri Lanka has no large natural lakes.

The rivers are an important source of ecosystem services, and represent strong links between nature and the economic development aspirations of people and the country (Millennium Ecosystem Assessment , 2005) (TEEB, 2009). The recent increase in severe floods and prolonged droughts in the dry zone, will also have consequences and costs to people and economic development plans, unless the ecological parameters that can increase resilience and reduce vulnerabilities can be protected and conserved.

Furthermore, subsequent to the severe floods and landslides faced by a number of districts in Sri Lanka in 2016, the resettlement of vulnerable communities residing in areas determined as risky by the National Building Research Organisation (NBRO) has posed new challenges of securing suitable alternatives for relocation that accounts for not only residential requirements, but largely cultivation-centric livelihoods. While private lands for acquisition, and unoccupied state lands are in the process of being evaluated for this purpose, the social and environmental impacts of relocating communities in whole or part will inevitably entail considerable social, economic and environmental consequence. Even within this interim period, which may extend to over a year depending on the speed with which land for resettlement is acquired, communities in temporary shelters have been compelled to rely on natural sources for water, with little or no provision for sanitation and waste disposal. Given the inevitable impacts of climate change, notably in terms of extreme weather, existing policy and implementation provisions for dealing with post-disaster situations must be re-examined as a matter of priority.

Few economic valuation studies of ecosystem services have been conducted Sri Lanka so the economic value of the wet zone forests are poorly understood. A few examples provided in the NBSAP show that: 35% contribution of hydropower to electricity generation was valued at SLRs 4.6 billion in 2011; between 2002 and 2010 the conventional value of forestry was about 0.6% of the GDP, although green accounting increased the estimates to between 2.7 and 4.9%.

1.2 Conservation Stewardship and Responsibilities

The stewardship of most remaining natural ecosystems and habitats that support biodiversity is vested within the Department of Wildlife Conservation (DWC) and the Forest Department (FD); the two major government custodians of protected areas in Sri Lanka. The current protected areas system, declared under the Fauna and Flora Protection Ordinance and the Forest Conservation Ordinance covers about 23,000 km^2 or 35% of Sri Lanka's land area (MoMDE, 2016). However, the protected areas are disproportionately distributed, with most DWC protected areas—national parks, nature reserves, strict natural reserves, jungle corridors, and sanctuaries—being in the dry zone.

There are several FD protected areas in the Wet Zone that were initially gazetted for silviculture, and not for biodiversity conservation. However, an amendment to the Forest Ordinance in 1995 (No. 23 of 1995) established a new category, designated 'Conservation Forests' that afforded protection to wet zone forests and reduced large-scale forest conversion. While the Conservation Forests have a high level of protection, other categories of forests under the FD are also now free from logging, and contribute to biodiversity conservation. These include the Reserved Forests where some extraction of certain forest resources is allowed under a permit, and the Village Forests that are used communities under sustainable management practices.

1.3 Spatial Scope and Priority Areas of the Analysis

The spatial scope of the analysis is the entire country and the ecosystems selected reflect this broad scale. Various analyses have classified Sri Lanka's ecosystems and habitats into a number of categories, depending on species biases and analytical objectives (MoMDE, 2016). The NBSAP also introduces a new set of ecosystems and habitats such as above ground rock caves and below ground rock caves, and Palmyrah woodlands. However, a broad scale analysis cannot consider these microhabitats; moreover, the necessary data is unavailable. Thus, this analysis uses the WWF terrestrial eco-region assessment (Olson, et al., 2001) as the basis for ecosystem delineation.

Since the outputs from the analysis are meant to provide a base for national-scale conservation priorities that can then also be used as a touchstone for sub-national scale priorities, these smaller scale ecosystems and habitats will be included at the appropriate scales. These data will also be included in a database that can be used for conservation planning and monitoring, as recommended in the NBSAP. The analysis will contribute to several targets and activities in the NBCAP (Table 1)

Table 1. Targets and activities from the National Biodiversity Strategic Action Plan (NBSAP), 2016-2022 (MoMDE, 2016) **to which the spatial planning project will contribute. The targets, activities and numbers correspond to those indicated in the NBSAP document.**

No	Conservation actions proposed in the NBSAP	Project contribution or engagement
	Target 1: Inventory of ecosystems (structure, composition and distribution), species (taxonomy conservation status), and their services and values to inform conservation planning and decision making	
1	Establish a national list of ecosystem types and species with regular updating	Work with the National Biodiversity Secretariat (BDS) to identify the ecosystem types and standard classification, and use it to conduct a conservation gap analysis
2	Establish a national biodiversity database to document biodiversity in all-natural sites and species with regular updating	Provide outputs to include in database
9	Develop and implement a communication strategy to disseminate the information collected	Socialize project outputs through print and digital media
	Target 2: Reduction in habitat loss, degradation and fragmentation	
2	Develop a national ecosystem/habitat conservation plan identifying the best possible strategy for afforestation, restoration (including coastal and marine systems) and maintaining connectivity	Project outputs will identify conservation priorities, including areas for reforestation and restoration based on ecological connectivity The wet zone forests are highly fragmented but supports >90% of endemic species of Sri Lanka. The montane regions are also important for trapping monsoon rains and watershed integrity is important for regulated and sustained water flows. These regions will receive special attention in the analysis
3	Implement the national ecosystem/ habitat conservation plan by integrating with the development activities as well as private sector investment	The project will conduct finer-scale analyses of biodiversity-rich areas that overlap with planned development projects, including large infrastructure, and identify areas of conflict with land conversion for development and conservation priorities. The recommendations can be integrated into development plans
	Target 3: Ensure that the PA network is representative of all critical ecosystems and species	
1	Update the protected area gap analysis based on recommendations of the provincial Sustainable Energy Authority (SEA) and identify critical habitats that needs to be protected and bring them under protection	The project will review existing gap analyses that have been undertaken (e.g., PoWPA), and ensure that all representative ecosystems, distribution of biodiversity (especially endemic species, umbrella species etc.), available habitats and natural ecosystems, and potential for ecological connectivity are included in the protected areas system and are spatially mapped. Recommendations to protect and conserve these areas will be made
	Target 4: Reduction in loss of species	

2	Establish an interactive web portal on threatened species to create awareness on threatened species of Sri Lanka	The project will contribute towards this activity by providing the collected information and the outputs. EFL will continue to be engaged with this activity by providing data and playing a role in maintaining the database
8	Develop and implement species level management plans for mitigation of conflicts caused by threatened species	The project will address the Human-elephant conflict, which has become a priority social and political issue for the government. The government has allocated 4 billion Sri Lankan Rupees (approximately USD 28,000,000) to address human elephant conflict, and a special committee has been established to develop an island-wide strategy. However, this will require better land use planning and zoning in priority elephant conservation and management landscapes, for which this study will provide data and recommendations
	Target 5: Mainstream valuation of biodiversity and its sustainable use	
6	Develop guidelines to incorporate Biodiversity and Ecosystem Services values into regional/national biodiversity financing mechanisms	The project will contribute towards these activities through a socio-economic analysis and recommendations for PES-related conservation initiatives, where communities could be engaged in stewardship of strategic forests and water sources and resources.
7	Initiate voluntary payment and rewarding mechanisms for Biodiversity and Ecosystem services (BES)	

1.4 Methodology

We collected available biodiversity, socio-economic, and development data and plans for the spatial analysis at a national scale. The data layers used are:

- WWF terrestrial eco-regions
- Land cover/Land use: The most recent data available (2010) was used.
- Ecosystems: Forest ecosystems, aquatic systems, grasslands, etc. This dataset was extracted from the LULC database (above).
- Species distributions ('umbrella' species, centres of endemism). The assemblage of amphibians available from IUCN Red List was used as a proxy for endemism, and the elephant was used as a proxy for larger, 'landscape species'.
- Protected areas: The database was downloaded from the WDPA website. The 2015 database was used, instead of the 2016 database because the Proposed Forest Reserves have been removed from the latter. These Proposed Forest Reserves still have protection status and represent important habitat for biodiversity conservation.

- Sources of ecosystem services and major use areas: The forests prioritized by the National Conservation Review for headwater protection, erosion mitigation, and flood control were used as proxies to assess ecosystem services.
- Infrastructure data: Layers were acquired from the Survey Department of Sri Lanka, and derived from the National Physical Plan.
- Digital Elevation Model
- Human population distributions and demographics: These datasets are only available at district levels.
- Poverty distribution and equity indices: These datasets, available at district level, were derived from the Central Bank reports.
- Human vulnerabilities and insecurities to food, water, energy, health: These data are not available at a meaningful scale.
- Human-elephant conflict: Areas including forests and unprotected forest patches were derived from expert consultations.

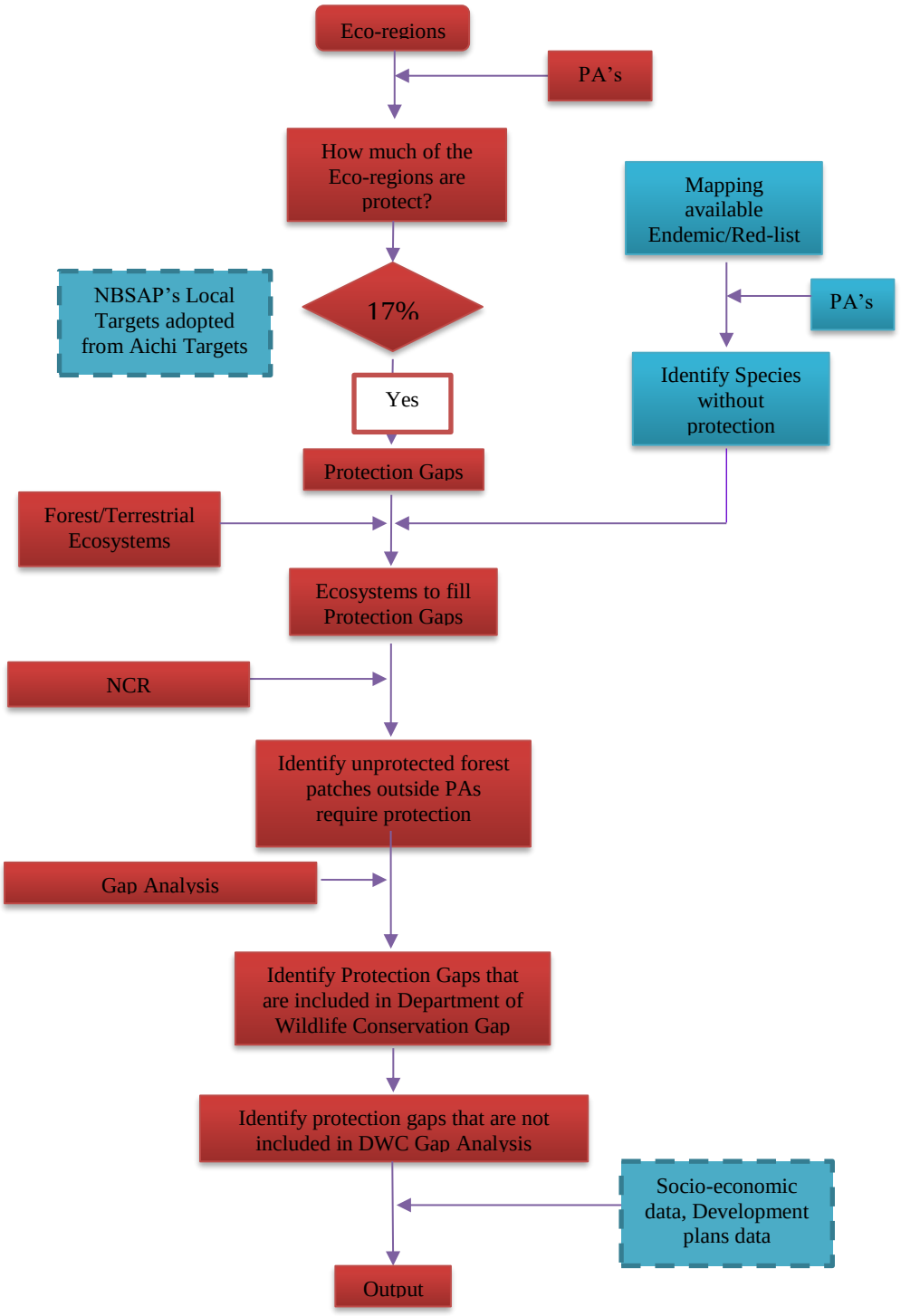
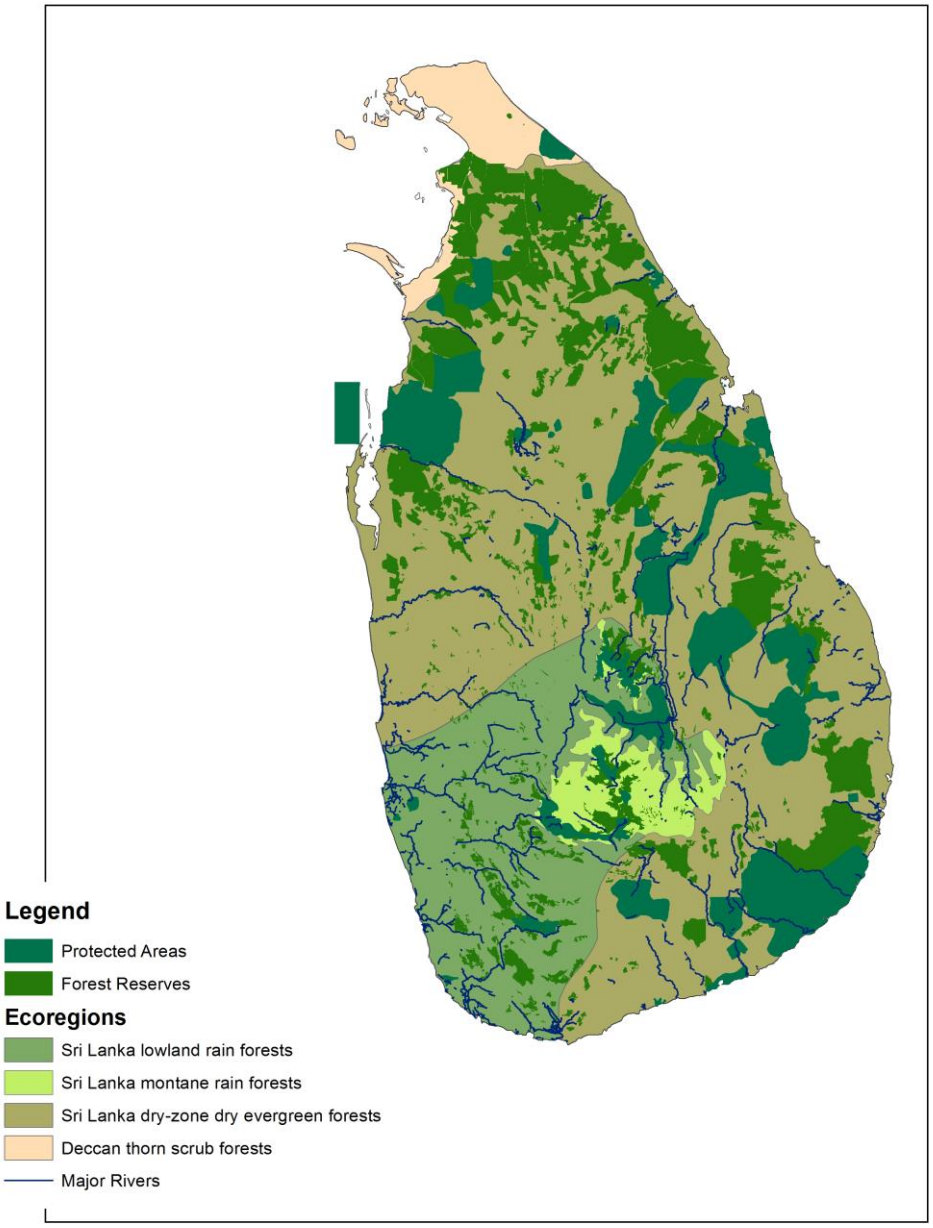


Figure 2: Flowchart of the Analytical Process

The analysis followed the process outlined in the flow chart (Figure 2). The terrestrial eco-regions were used as a base layer to define the major climate and biogeographic regions. The four eco-regions represented in Sri Lanka are: Sri Lanka dry zone dry evergreen forests; Sri Lanka lowland rainforests; Sri Lanka montane rainforests; and the Deccan thorn scrub forests[1] (Figure 3). The last eco-region is represented in the Jaffna peninsula, but is also widespread across the Indian subcontinent. The first three eco-regions are represented only in Sri Lanka. The protected areas were overlayed on the eco-regions to identify the extent of protection within each eco-region.



- **Figure 3. WWF eco-regions and protected areas of Sri Lanka. The protected areas include all lands under the jurisdiction of the Department of Wildlife Conservation (DWC) and the Forest Department (FD). The protected areas database was downloaded from** (Protected Planet, n.d.)

The Aichi target 11 seeks to conserve at least 17% of terrestrial systems. The NBSAP seeks to assess if Sri Lanka's protected areas system is representative in achieving this target. The overlay provides an indication of how much of each eco-region is represented within the current protected areas system, and can identify strategies of where additional actions are necessary to reflect the 17% target in the representative biogeographic regions. Noting, however, that a 17% target need not be a universal target for all biogeographic areas; some regions may need more, and some less to achieve representation.

The land cover layer was used to identify where additional natural ecosystems and habitats are available outside the current protected areas system. Most of Sri Lanka's protected areas were designated several decades ago, when protected areas planning was not a well-established science. In the intervening years, land conversion has increasingly isolated these protected areas in human dominated landscape matrices. Large species, especially Sri Lanka's flagship mammals are being isolated within the protected areas that are too small to contain viable populations. Most of Sri Lanka's irreplaceable biodiversity is in the wet zone moist forests, and recent surveys have added increasing numbers of new species discoveries to the lists of endemic species from these forests. Thus, the layer of remaining forests was used to identify potential landscape connectivity, and to assess where additional habitat can be brought under the conservation network. A database of amphibians, reptiles, birds, and fishes, was used as a proxy for overall endemicity.

A protected areas gap analysis was conducted for the DWC over a decade ago (Jayasuriya, et al., 2006). The additional areas proposed in this analysis were digitized, and overlayed. A habitat suitability map layer was created from the landuse-landcover data for the dry and wet zones. A corridor analysis was done, separately for the dry and wet zones, to assess landscape permeability for species. The suitability scores were assigned based on the overall faunal assemblages in the wet and dry forests. Most of the irreplaceable fauna in the wet zone are smaller species, many of which are endemic and habitat specialists. Because they are sensitive to environmental changes and habitat degradation, they cannot survive in highly degraded forests or streams. In the dry zone, habitat suitability scores were assigned on the basis of the ecology and human-wildlife conflict potential of the larger landscape species. Most are generalists, and use various forest types, but come into conflict with people in home gardens,

which were thus given appropriate unsuitable scores. The scores given to each habitat is provided in Annex 2. These outputs provide spatial representations of: a) the current extent of the areas that are protected, including the proposed gaps; and b) the potential connectivity between the protected areas.

We then used spatial overlays of current population densities and infrastructure to assess pressures on ecosystems from anthropogenic drivers. We then overlayed the large infrastructure projected planned by the National Physical Planning Department (NPPD, 2010). These layers help to assess the major impacts to the existing protected areas, and to landscape-scale connectivity, and also provide guidelines on how to integrate development with biodiversity conservation in areas of overlap through appropriate strategies such as 'Green Infrastructure', robust EIAs, and better land use planning (Quintero, 2007) (Quintero, et al., 2010).

Thus the final outputs provide a spatial guide to where the conservation gaps and opportunities are, as well as where the important conservation areas are threatened by development plans. The spatial database can be used with the NBSAP to roll out activities in Targets 1-5 to achieve viable, representative biodiversity conservation (Table 1).

The spatial database and all layers will be deposited within the Biodiversity Secretariat (BDS), and also be made available to other stakeholders so it can be updated, accessed, and used for planning and implementation of the NBSAP.

2.0 RESULTS AND DISCUSSION

2.1 Analysis of Biological Overlays

Most of the protected areas in Sri Lanka are in the dry zone (Figure 3). The initial overlay of the protected areas with the eco-regions indicated that both the Sri Lanka dry-zone dry evergreen forests and the Sri Lanka montane rain forest eco-regions far exceeded the 17% threshold (Table 2). The Sri Lanka lowland moist forest eco-region has 13% within protected areas, whereas the Deccan thorn scrub forest eco-region has 15% within protected areas; however, the latter eco-region has additional protection in the subcontinent.

Table 2. Extent of eco-regions included within the protected areas, including DWC and FD.		
Eco-region	Extent of Protected Areas (km^2)	Percent protected areas in eco-region
Sri Lanka dry-zone dry evergreen forests	18171	38
Sri Lanka lowland rain forests	1677	13
Sri Lanka montane rain forests	944	31
Deccan thorn scrub forests	400	15

2.2 The Dry Zone

The dry zone protected areas are larger, and cover a greater spatial area of the eco-region. Many of the Forest Department (FD) protected areas are contiguous with the Department of Wildlife Conservation (DWC) forest reserves and form large protected areas complexes (Figure 3). Unfortunately, poor coordination between the DWC and the FD to work towards a common conservation goal constrains synergistic management of these large complexes.

Considerable forests exist outside the current dry zone protected areas system, and the protection gaps that were identified have attempted to create corridors between protected areas (Figure 4), and to capture some of the unique floral assemblages of the dry zone, especially in inselbergs (Annex 1) (Jayasuria, et al., 2006). However, much of the land in these corridors have been converted into human use areas (Annex 3).

The habitat suitability surface indicates that there is relatively good habitat along the eastern region of the island, through the north and northwest (Figure 5). These are the areas that have been identified as a priority for elephant conservation (Figure 6). The elephant has been

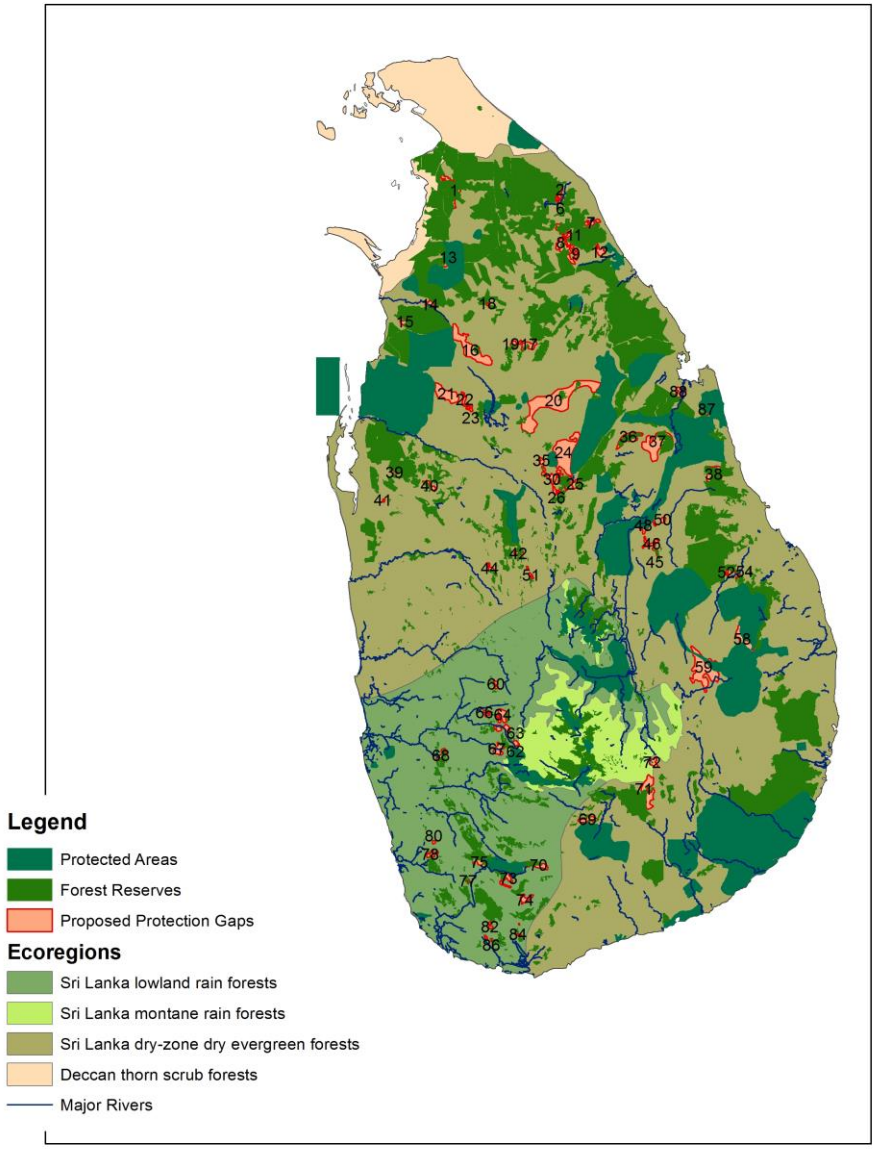


Figure 4. Proposed gaps in the protected areas system identified by Jayasuriya et al (2006).

used as a proxy for other landscape species (e.g., leopard [*Panthera pardus kotiya*], sloth bear [*Melursus ursinus*]), as well as the smaller species of mammals and birds that require relatively smaller spatial areas, or can move through a less permeable landscape, with less conflict with people. The west-central and north-central region has less suitable habitat, since a lot of the natural habitat has been extensively cleared for paddy cultivation and other agriculture. The

corridor analysis indicates that landscape permeability is good for vagile species (Figure 7), except in the west-central region.

The analysis indicates that the dry zone protected areas are large and cover a greater spatial area of the ecoregion. However, most of the larger protected area gaps were also identified in the dry zone, and that these gaps have been converted to human use. In relation to this assessment, it is imperative to note that the Northern, North-Western, North-Eastern and Eastern coastal areas have also been earmarked for extensive tourism-centric and other infrastructure as suggested by the examples such as the proposed Kalpitiya Integrated Tourism Development Project (including the development of 14 islands in the Kalpitiya Bay) and the Sampur Special Economic Zone. This concern also extends to the involuntary displacement and resettlement of local communities, especially those whose traditional livelihoods have been bound to natural resources such as forests, inland water bodies or the ocean. Fishing villages in particular have been especially vulnerable in this respect, having their access to the ocean from certain locations restricted or cut-off due to proposed tourism developments. Both the social and environmental implications of the resettlement of these communities must be evaluated with a view of ensuring that not only interim measures or alternative livelihood opportunities are being made available to them, but also account for the ecological impact of such relocations.

The analysis also indicates that these areas have relatively good habitat, and a priority for elephant conservation, which also in this instance has been utilised as a proxy for other landscape species. While these features may bode well for tourism-oriented developments, they must be examined through the lens of potential for human-wildlife conflicts (see Box 1), especially where local communities have been relocated into less-frequented areas that serve as wildlife habitats. The settlement of people in areas surrounded by forests has escalated human elephant conflict, especially as the settlements cause forest fragmentation and creates a mosaic of forests and agricultural lands. The elephant populations that take refuge in the forest patches then begin to raid agricultural fields that represent more nutritious food sources. In addition to the conservation problem, the escalation of the human-elephant conflict has also created a social and political conundrum for the government, since the

elephant has high cultural and religious significance to the people of Sri Lanka who usually have a relatively benevolent attitude towards elephants.

In 2016, the Government of Sri Lanka's budget allocated Rs 4,000 million to address the human elephant conflict. What is also essential to note is in relation to this is the politicization of agriculture and interlinked focus on agricultural communities as a voter base. These communities, who are often most prone to human-elephant conflict situations, are considered a key voting demographic, aside from the historical and cultural values attributed to agriculture. This in turn might be observed to influence policy decisions pertaining to environmental issues such as the human-elephant conflict. Also, relevant in this respect is encroachment into habitats, exacerbated by slash and burn agriculture in particular. This is a problematic area of concern to address given the dependence of rural livelihoods and wellbeing on small-scale agriculture. The erosion of habitats minimizes the distance between human and elephant populations, increasing the likelihood of tensions and risk, and sometimes even fatal encounters for both humans and elephants. This not only worsens the threat to the lives of farmers and the related possibility of elephants being pre-emptively attacked, but also destruction to crops, which in turn could have a detrimental socio-economic impact on rural communities at large due to their reliance on economic returns and subsistence needs. Thereby, efforts to mitigate this require careful, long-term, immersive in-situ research, coupled with a comprehensive consultation process to derive insights from local communities as a means of devising a plan for management given the issue's inevitable intensification.

A comparative study of communities that have lived with elephant presence and newly settled communities show that the former are more tolerant of elephants and occasional depredations than the latter (Fernando *et al*. 2005). Radio telemetry data also show that elephants range outside the protected areas and into the larger landscape (Fernando et al. 2008). Thus, it is essential that the larger forest complexes formed by adjacent reserves under the jurisdiction of the Forest Department and the Department of Wildlife Conservation be conserved and managed as single complexes, and the intervening natural habitats be included within these protected areas as contiguous conservation landscapes. People should not be settled in these areas, and other activities that could result in fragmentation of these large

dry zone forest complexes should be disallowed. Buffer zones should be declared around these complexes as a matter of priority to ensure that the detrimental effects of these developments and wider issues such as encroachment and environmental degradation do not intrude into the conservation areas.

The history of conflict in the North, East, North-West and North-Central provinces also serves as crucial factor in this respect, due to not only the history and present of population displacement, but the allocations for the construction of housing schemes for the internally displaced who have returned or are in the process of returning to their homelands, but also the development of various infrastructure and livelihood development programmes which are largely centered around cultivation and livestock rearing. Thereby, how the local environment may feature in both the subsistence needs of communities, but also their livelihoods and the future development and expansion of currently nascent agricultural sectors or industries reliant on natural resources must be considered in this respect. Thereby, the importance of ensuring the integration conservation priorities into local development becomes even more apparent.

Box 1. The Human Elephant Conflict

Of all the Asian Elephant range states; Sri Lanka has the highest density of elephants (Leimgruber , et al., 2003), but also poses the biggest challenge for conservation management. Historically, Lowland Rain Forests and Montane Forests regions, record the largest elephant distribution and numbers. Apart from remnant populations in Peak Wilderness National Reserve and Sinharaja Forest Reserve, elephants have since been extirpated from the wet zone following extensive settlement and land conversation to commercial agriculture (Jayawardene, 1994); (Wisumperuma, 2004). Currently, elephants are found over almost the entire dry zone, overlapping with re-development of irrigation and re-settlement resulting in a tussle for space between the human and elephant populations.

Human Elephant Conflict and Mitigation surmounts to be the largest conservation effort, cost and exercise, averaging 80% of government expenditure in conservation per annum. It is recognized as a major socio – economic impact to rural livelihoods in the dry low lands. Mitigating HEC therefore, has increasingly being politicized by an empowered rural demography resulting in many short and medium term measures undertaken both by the public and private/informal sector to offer as immediate remedies (Fernando, et al., 2008).

However these methods are flawed in application and detrimental to long term conservation of the species. The disjoint in the flow of information at the scale required to conserve elephants in the long term and shifting conventional management paradigms ingrained in the conservation system are continuing challenges to elephant conservation. Knowledge of the species and its conservation requirements need to be conveyed and incorporated to national development planning. Finding synergies through which development planning at all scales incorporates long-term elephant conservation approaches, as outlined by research, policy and legislation is critical in ensuring ecologically functioning elephant population for future generations.

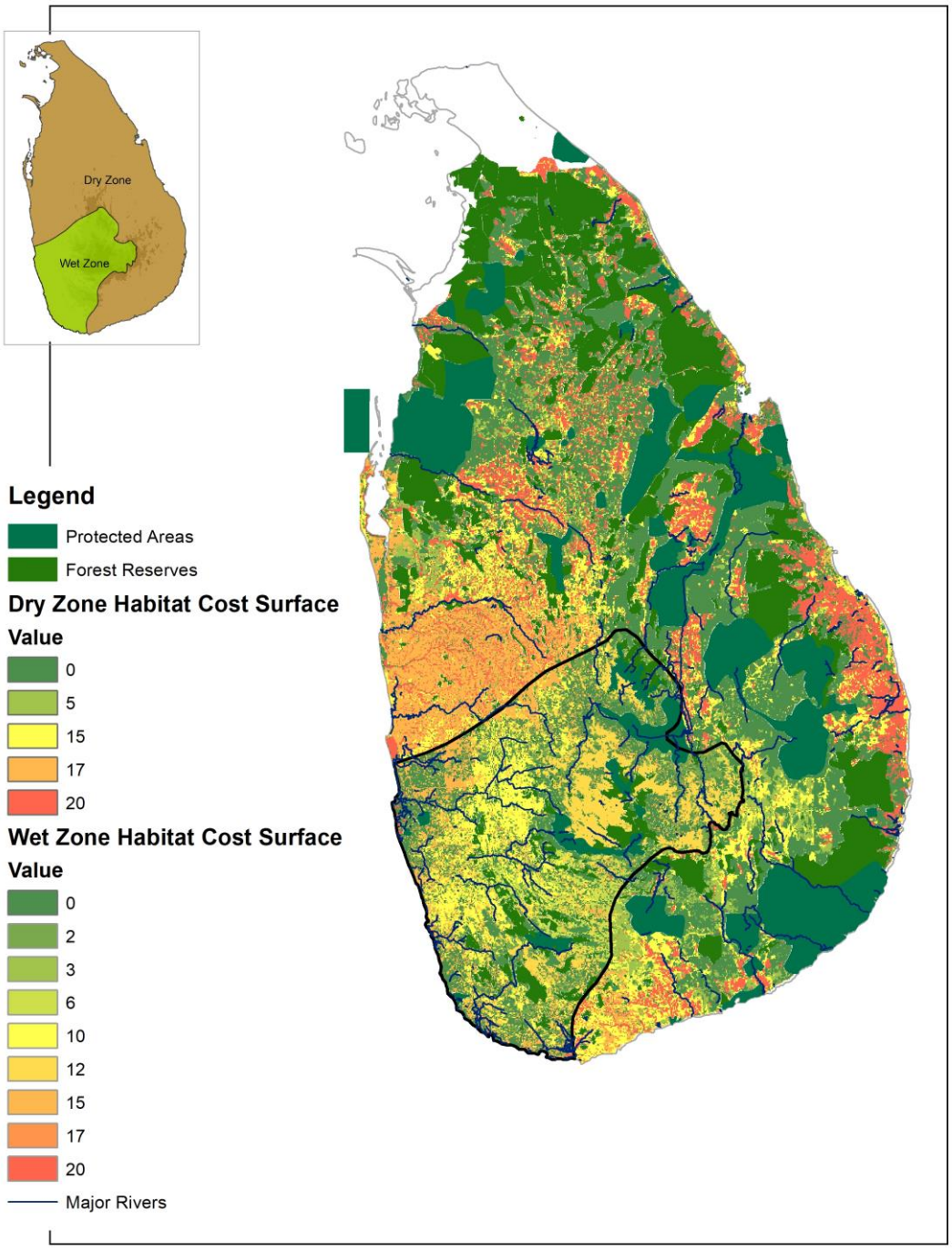


Figure 5. Habitat suitability map for the wet zone and dry zone forests of Sri Lanka (geographic extent shown in inset map) represented as an ecological cost surface. High scores indicate less suitability, since they reflect a higher ecological cost to a species to occupy and survive in the respective habitat. The suitability scores were assigned based on the overall faunal assemblages in the wet and dry forests, and were calculated separately using cost scores assigned based on the species communities and their specialization. The cost surfaces were then integrated into a single map, along with the protected areas that represent core areas. Score categories shown are based on natural breaks in distributions in each zone. Overall, the green shades (including the protected areas) represent suitable habitat for conservation of biodiversity and ecological connectivity. The scores given to each habitat is provided in Annex 2.

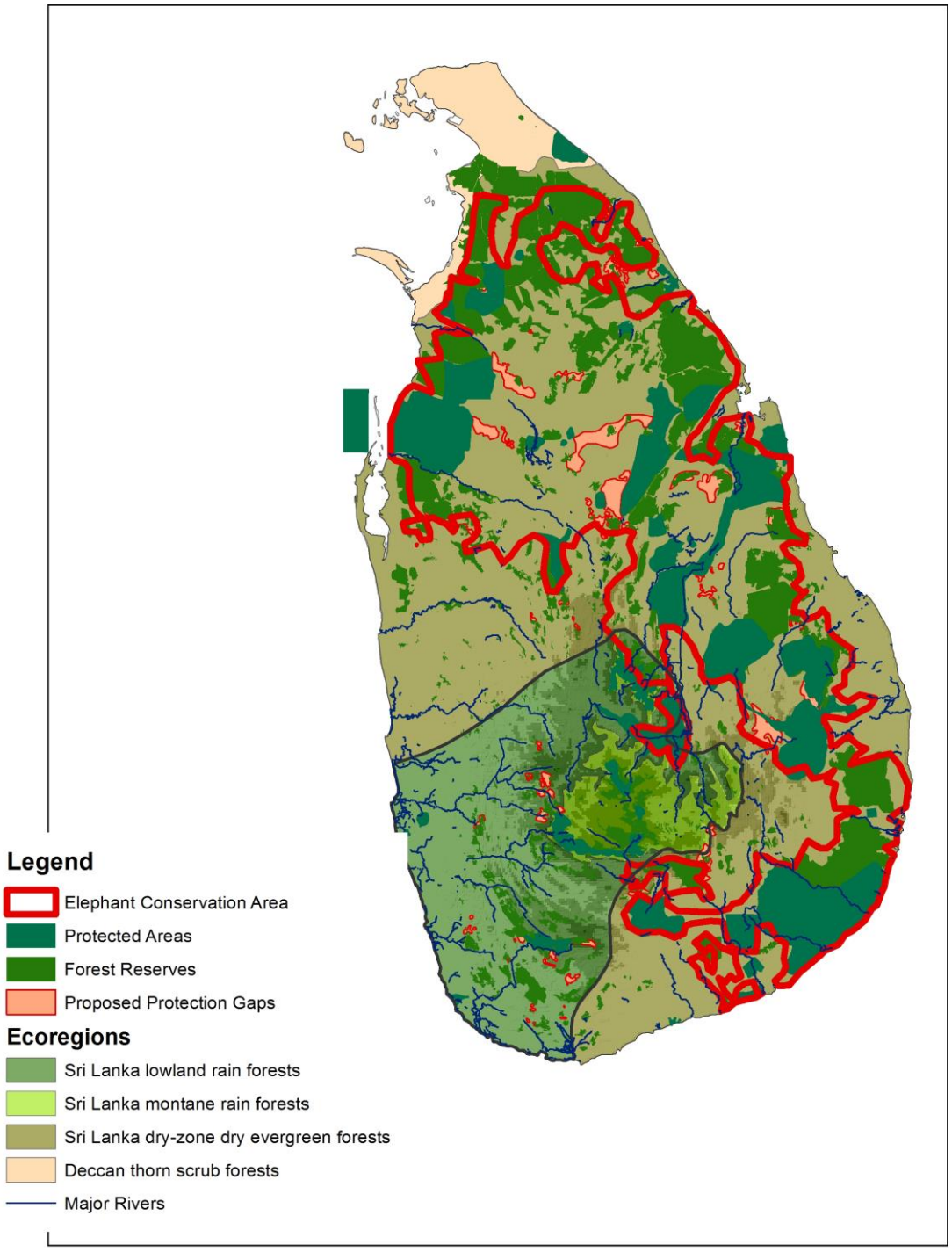


Figure 6. Elephant conservation areas identified by the Department of Wildlife Conservation, Sri Lanka for the island.

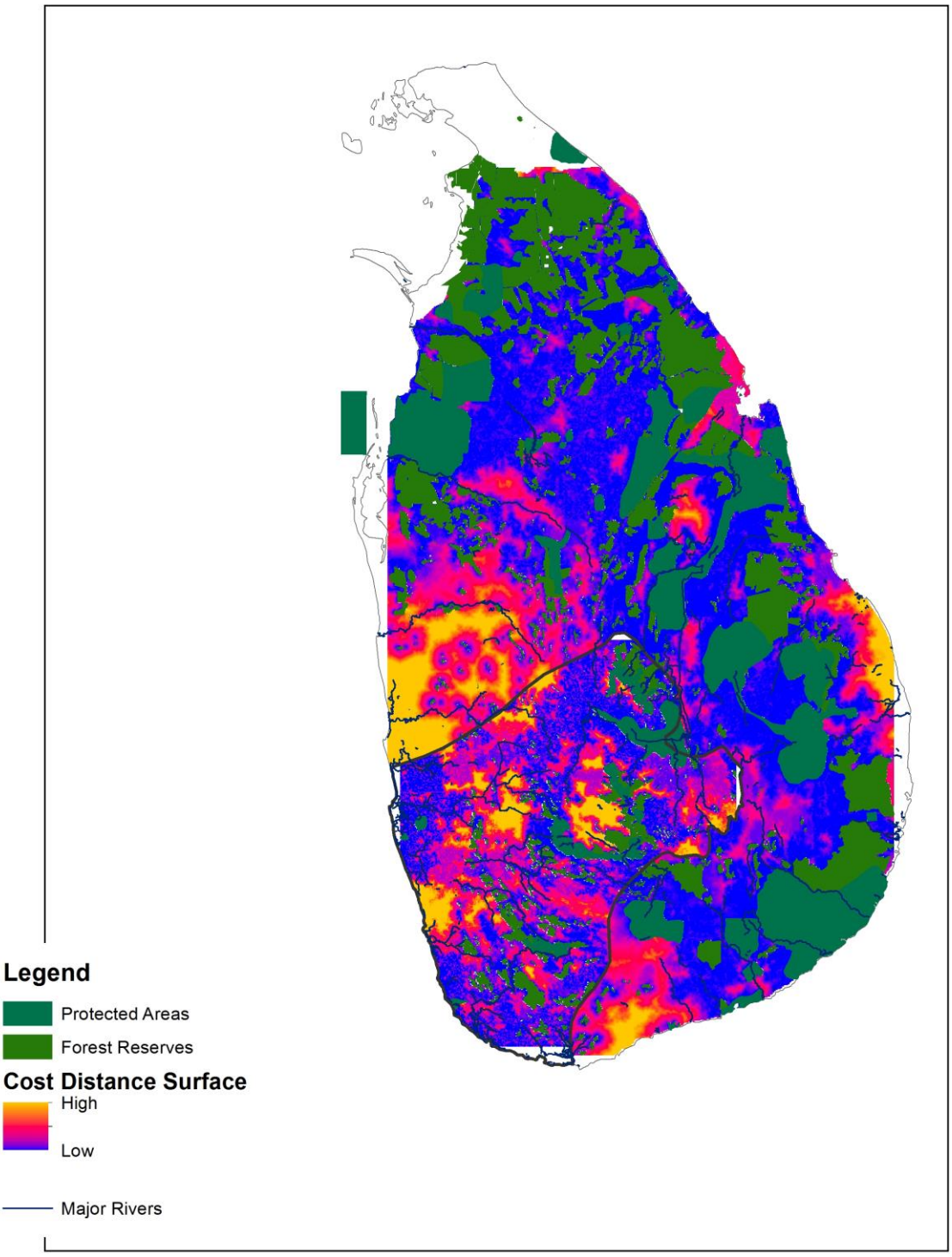


Figure 7. A corridor model for the wet zone and dry zone forests of Sri Lanka. Blue shades, grading into purple represents greater permeability, or lower ecological cost of movement through the landscape matrix outside the protected areas. Protected areas (in green) that are connected by blue or purple areas have higher ecological connectivity; thus the natural habitats in the blue areas should be conservation priorities for a landscape conservation strategy, as proposed in the NBSAP. The scores given to each habitat is provided in Annex 2.

2.3 The Wet Zone

Very few gaps were identified in the wet zone forests during the DWC gap analysis (Jayasuriya, et al., 2006) despite the lower representation of protected areas and the relatively higher rates of endemism in these eco-regions. Many of the endemic species in the wet zone are in the 'lower' taxonomic groups (Figure 8), and have small range distributions. Several species are 'point endemics', restricted to very small areas. Thus, even the smaller remaining patches of forests in the moist forest eco-regions are important repositories and habitats for Sri

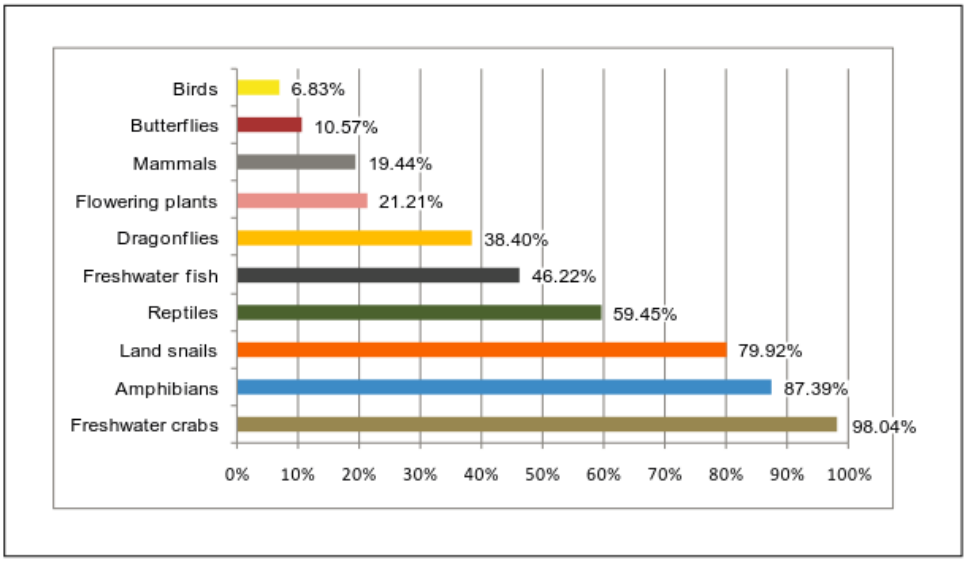


Figure 8. Patterns of endemicity among the taxonomic groups in Sri Lanka. (MoMDE, 2016)

Lanka's irreplaceable biodiversity.

The National Conservation Review (IUCN, 1999) (NCR) undertaken by the FD, in collaboration with the IUCN, has also surveyed and ranked several of the moist forest protected areas as being critically important for flood control, headwater protection, erosion reduction, and fog interception in the case of forests above 1,500 m (Figures 9,10,11). The NCR recommendations *further* state that conservation of contiguous forest patches is necessary to meet watershed protection and biodiversity conservation priorities, and with the exception of very small fragments, all forests in the wet zone should be included in a conservation system.

There are several forests in the wet zone eco-regions that are outside the protected areas system that are contiguous with the existing protected areas (Figures 9,10,11). Including these forests within the protected areas system will increase the resilience of the FD protected areas, conserve irreplaceable biodiversity, and increase the capacity of the forests to sustain ecosystem services.

While few gaps have been identified in the wet zone, it is essential to note that the highest concentration of urbanisation is recorded within this area, predominantly in the Colombo and Gampaha Districts, as made evident also in the number of housing units (Annex 04). These districts currently attract the majority of rural to urban domestic migrants, both seasonally and otherwise, and this pattern is likely to continue until peripheral developments in the other districts are able to facilitate comparable economic opportunities for those looking for temporary or permanent employment. Given the economic significance of these districts as the centre of commerce and employment in the nation for a considerable proportion of the Sri Lankan population, the population density within this area is inclining, highlighting several concerns relating to the environment linked to waste management, pollution, aside from the various impacts on ecosystems caused by human settlement and consumption needs. This is made apparent by the fact that the Gampaha district has the highest number of small farms of anywhere in the island, aside from also having one of the highest population densities. The environmental impacts of these realities and their implications for wet zone ecosystems must then be evaluated and actively utilised towards informing urban development planning and implementation.

Given Sri Lanka's development goals focused on expanding infrastructure related to tourism, the South-Western Coast, which has historically served as a tourism hotspot maybe subject to further developments that could have various environmental implications. Given also that tourism serves as a source for considerable local employment opportunity, it is necessary to explore potential for ecologically-sensitive, community tourism initiatives that enable local communities to benefit from development, but also play an active role in conservation and raising awareness on the importance of conservation among visitors. The South-Western Coast is already host to a few eco-tourism oriented attractions including various privately-owned turtle hatcheries and activities centred around the Madu Ganga. Thereby,

documenting best practices in this respect, and also encouraging private sector investment and community engagement in ecologically-sound tourism ventures must be prioritised within these developments. Such initiatives become especially important due to the presence of several point endemic species restricted to very small areas within the wet zone. Even minute disruptions to habitats or contiguous ecosystems may severely impact these species' chances of survival.

Further, as stated there are several forests in the wet zone ecoregions that are outside the protected areas system that are contiguous with the existing protected areas, and given the population strains on this particular region due to economic and farming activities, it is essential that these forests are urgently incorporated into the protected area system. The analysis also underlines that despite fragmentation, good habitat areas able to support smaller endemic species are prevalent in the wet zone and that these species can survive in traditional home gardens and village gardens around forests. Accordingly, including these gardens within conservation planning, may seek to encourage local landowners and farmers to adapt home gardens and agroecosystems towards supplementing natural ecosystem services through environmental stewardship schemes. This in turn could further benefit smallholder cultivators themselves, as these contributions possess positive implications for fruit-setting and crop yields. It is also essential that expansions related to large scale commodity plantations such as tea, rubber, palm oil are curbed, not only due to the barriers created for species movement, but also the wider detrimental effects of largescale monocultures including the deterioration of soil quality, erosion, runoff pollution. The bee population in particular is vulnerable to monoculture due to the largescale use of chemical pesticides and the demise of bees could have severe impacts on agriculture given its dependence on pollination services. The socio-economic and environmental impacts of largescale commodity plantations on small-scale farmers and their cultivation practices must also be considered, and localised environmentally-sound agroecosystem models encouraged in their place where habitats and ecosystems are vulnerable, and could explicitly benefit from supportive home garden habitats.

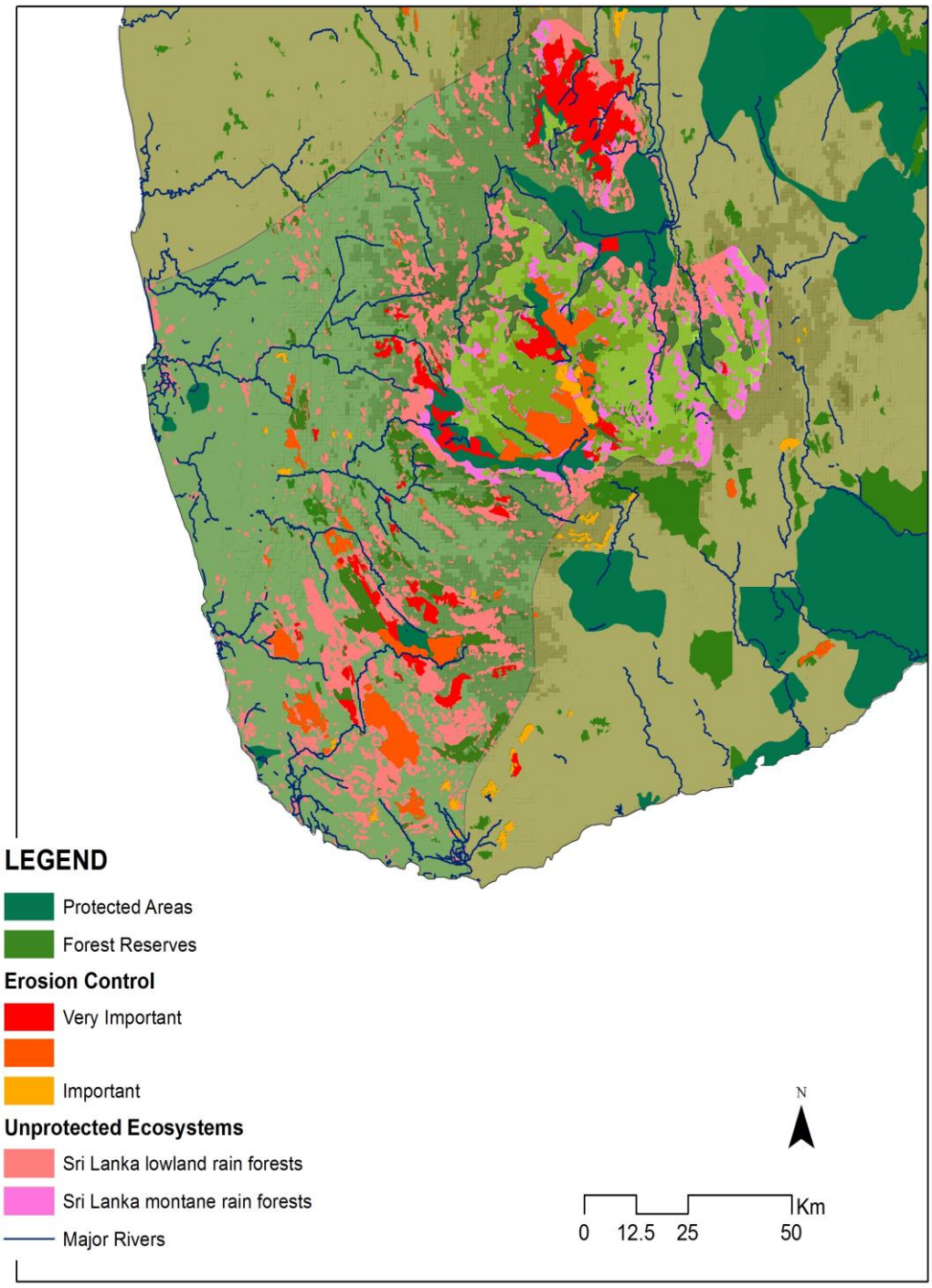


Figure 9. Forests prioritized for erosion control under the National Conservation Review (IUCN and FD, 1999). The forest reserves identified as Very Important (bright red) to Important (orange) for erosion control are mapped, along with other forest reserves and protected areas under the jurisdiction of the Department of Wildlife Conservation. Unprotected forests in the Sri Lanka lowland rain forests and Sri Lanka montane rainforests are shown in shades of pink. These areas are critical to provide ecological connectivity between the current forest reserves and protected areas, and should be secured for conservation.

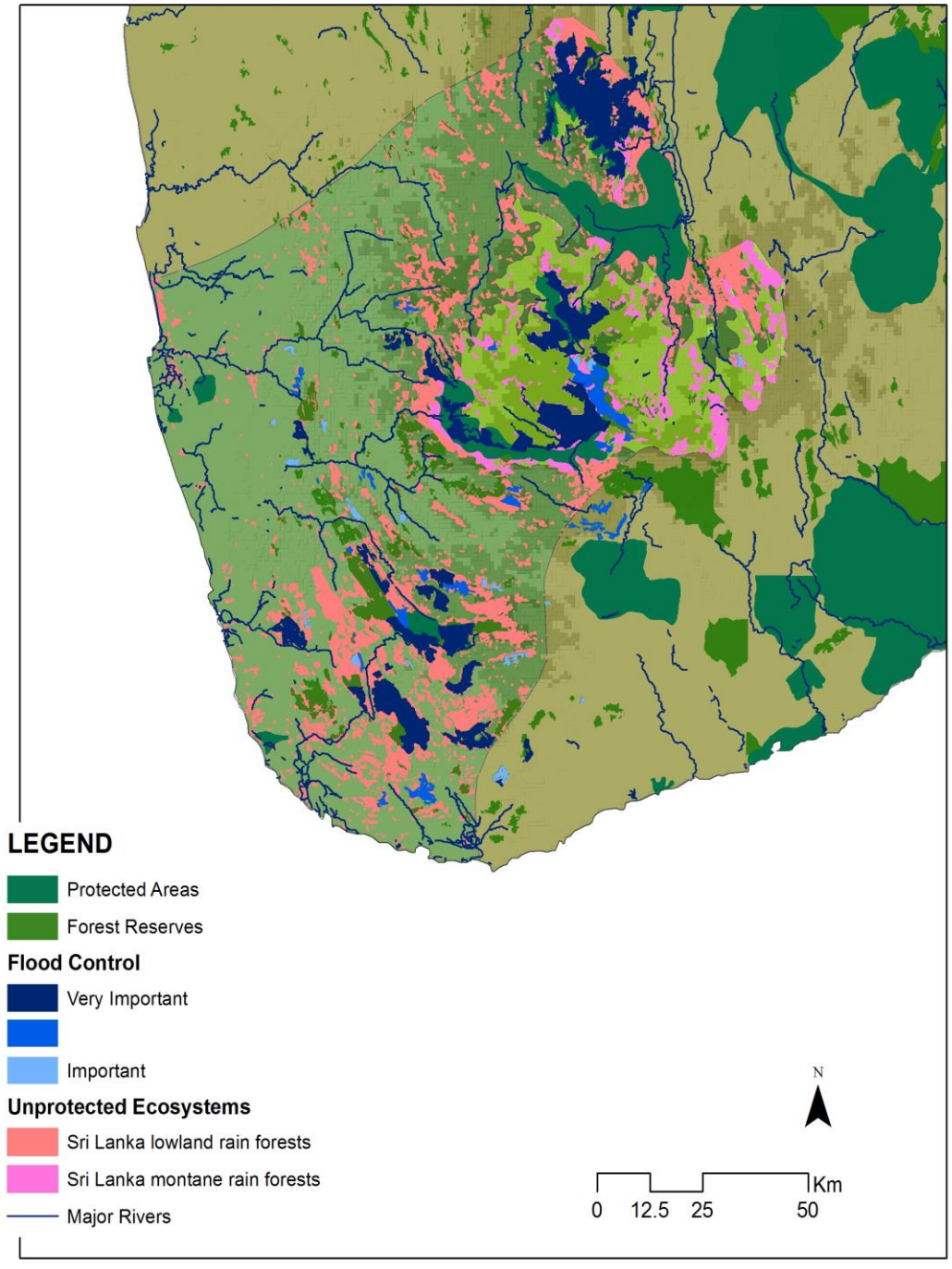


Figure 10. Forests prioritized for flood control under the National Conservation Review (IUCN and FD, 1999). The forest reserves identified as Very Important (dark blue) to Important (light blue) for flood control are mapped, along with other forest reserves and protected areas under the jurisdiction of the Department of Wildlife Conservation. Unprotected forests in the Sri Lanka lowland rain forests and Sri Lanka montane rainforests are shown in shades of pink. These areas are critical to provide ecological connectivity between the current forest reserves and protected areas, and should be secured for conservation.

The habitat suitability layer (Figure 11) shows that despite the fragmentation there is still good habitat that can support the smaller endemic species. Many of these species can survive in the traditional home gardens and village gardens around the forests. These habitats should be included within the conservation strategy, along with the Village Forests that are managed sustainably by local communities. Further conversion for large scale commodity plantations, such as tea, rubber, oil palm, should be disallowed. The wet zone forests have less landscape permeability for species movement than the dry zone (Figure 7). Many of the smaller endemic species are habitat specialists that are sensitive to environmental and ecological change in habitats. The large-scale forest conversion in the wet zone for commodity plantations has thus created impermeable barriers for many of these species.

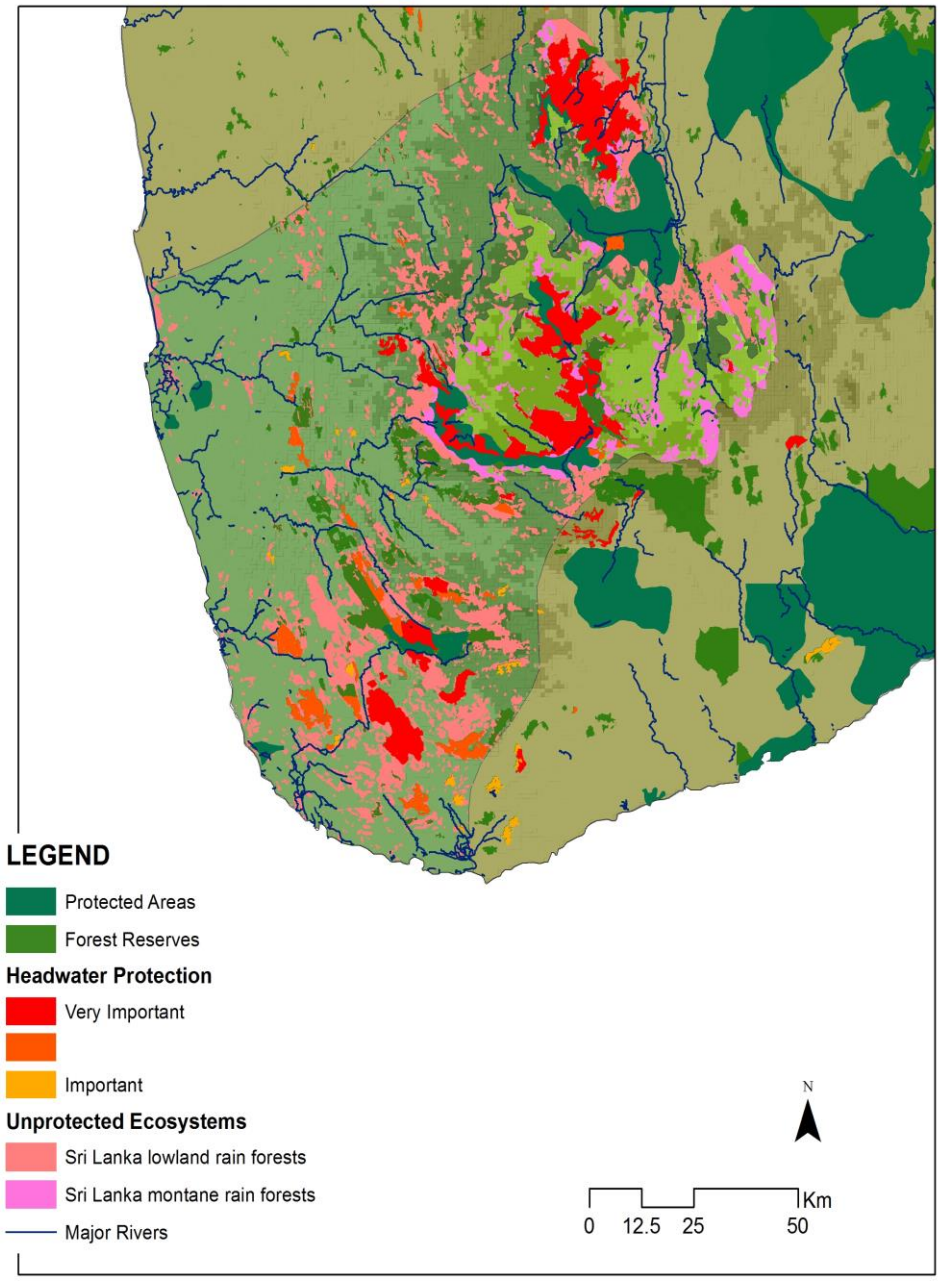


Figure 11. Forests prioritized for head water protection under the National Conservation Review (IUCN and FD, 1999). The forest reserves identified as Very Important (bright red) to Important (orange) for head water protection are mapped, along with other forest reserves and protected areas under the jurisdiction of the Department of Wildlife Conservation. Unprotected forests in the Sri Lanka lowland rain forests and Sri Lanka montane rainforests are shown in shades of pink. These areas are critical to provide ecological connectivity between the current forest reserves and protected areas, and should be secured for conservation.

2.4 Summary of Outputs

These outputs indicate that much more conservation attention is needed in the wet zone forests, both in the montane and lowland areas. Although the montane moist forests exceed the 17% conservation threshold, any remaining forests should be conserved to protect the biodiversity and the headwaters of the major rivers that radiate outwards and sustain and support both natural and human communities across the island. Any remaining lowland rainforest areas should also be brought within the conservation umbrella, and special attention should be given to the forests adjacent to, and connecting the existing protected areas (Figure 12). This area has also been recognized as a 'Sensitive Central Area' in the National Physical Plan (Figure 12). The spatial areas under conservation in the dry zone forests are currently adequate, but ecological connectivity should be maintained between and among protected areas complexes

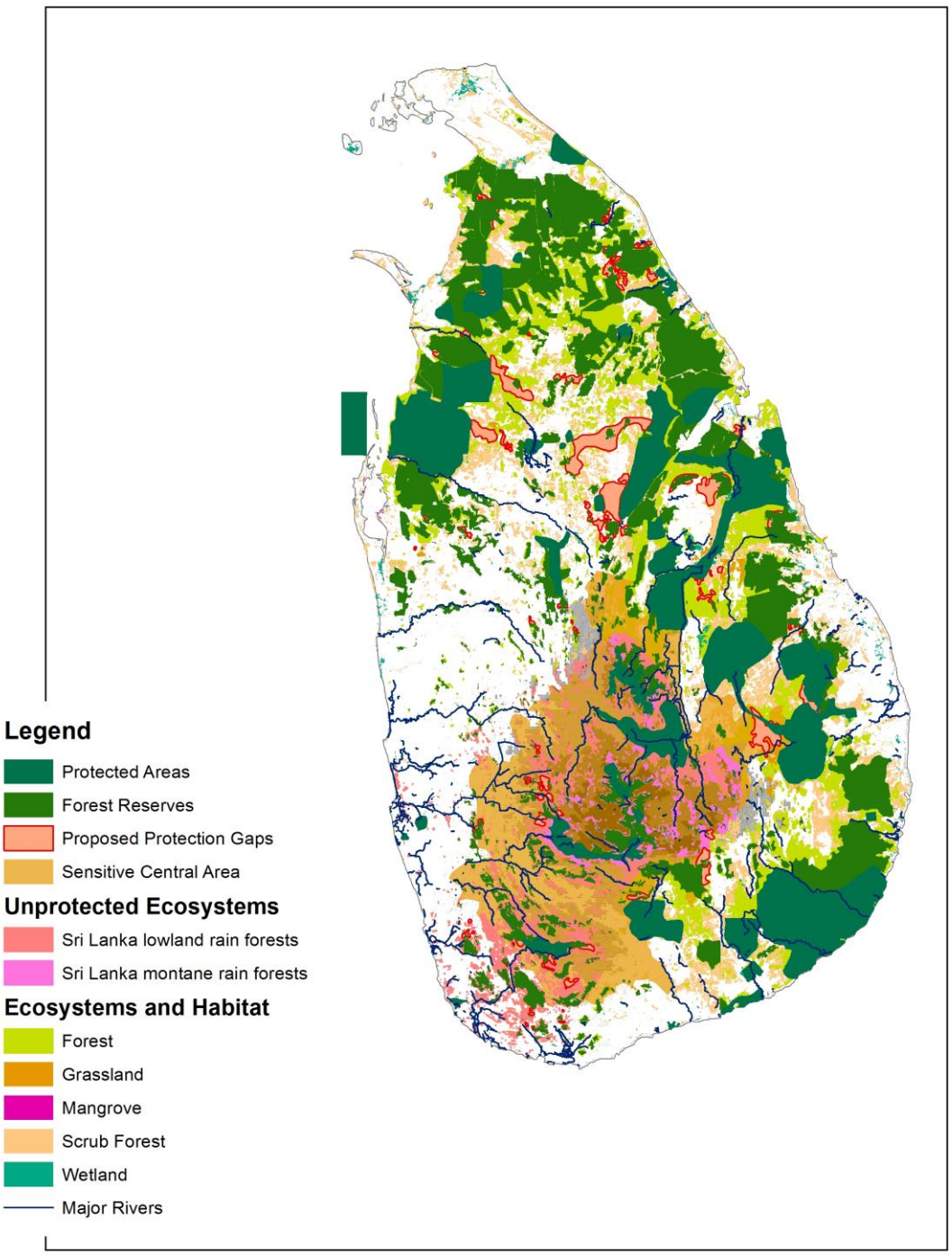


Figure 12. Unprotected wet zone forest areas, and the Sensitive Central Area identified by the National Physical Plan.

2.5 Analysis of Threat Overlays

An overlay of settlement distribution patterns indicate that most settlements are concentrated in the western part of the country and in the central hills (Figure 13).

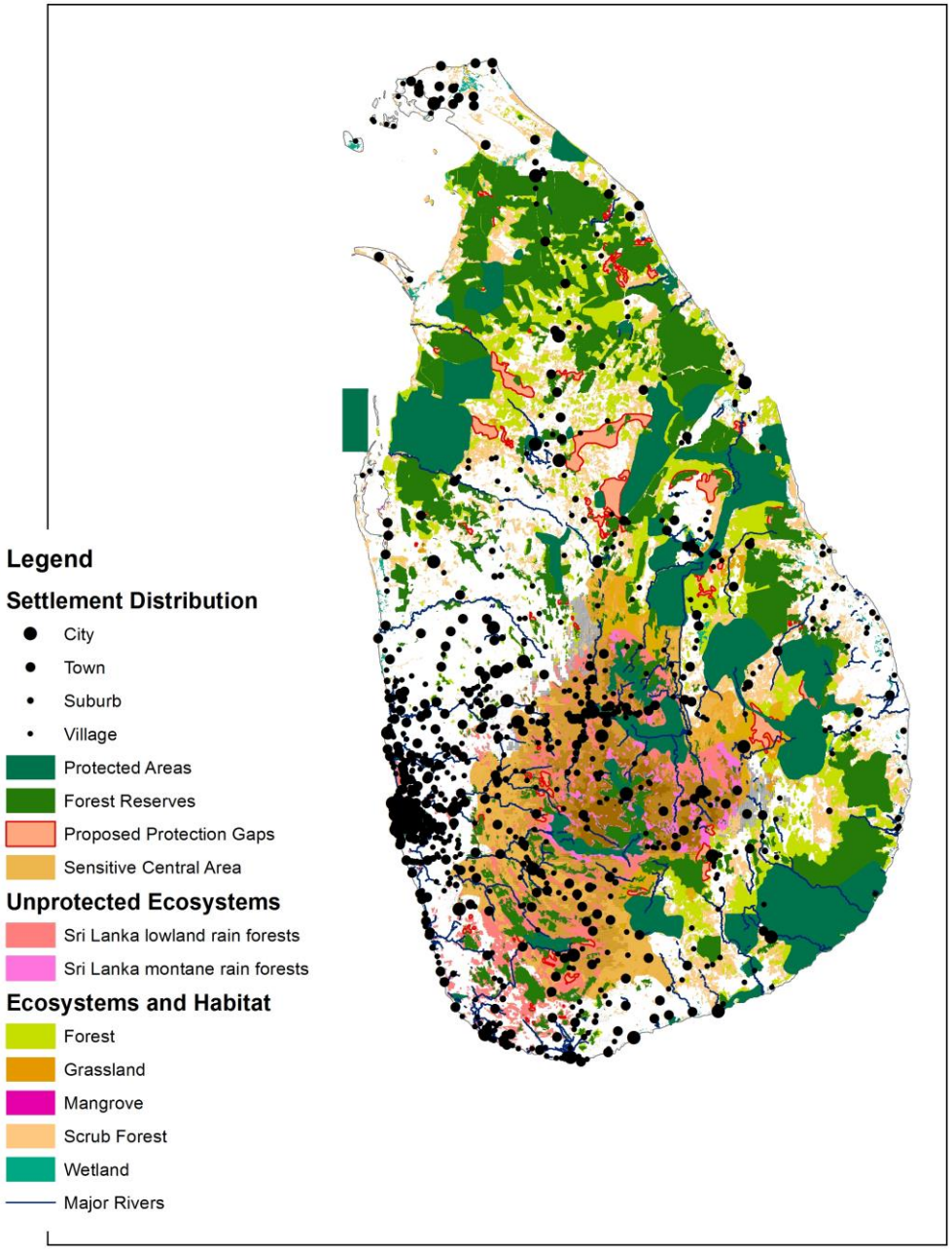


Figure 13. Major settlements and urban areas in Sri Lanka. Data from the Survey Department, Sri Lanka

These are also the districts with the highest population density (Figure 14).

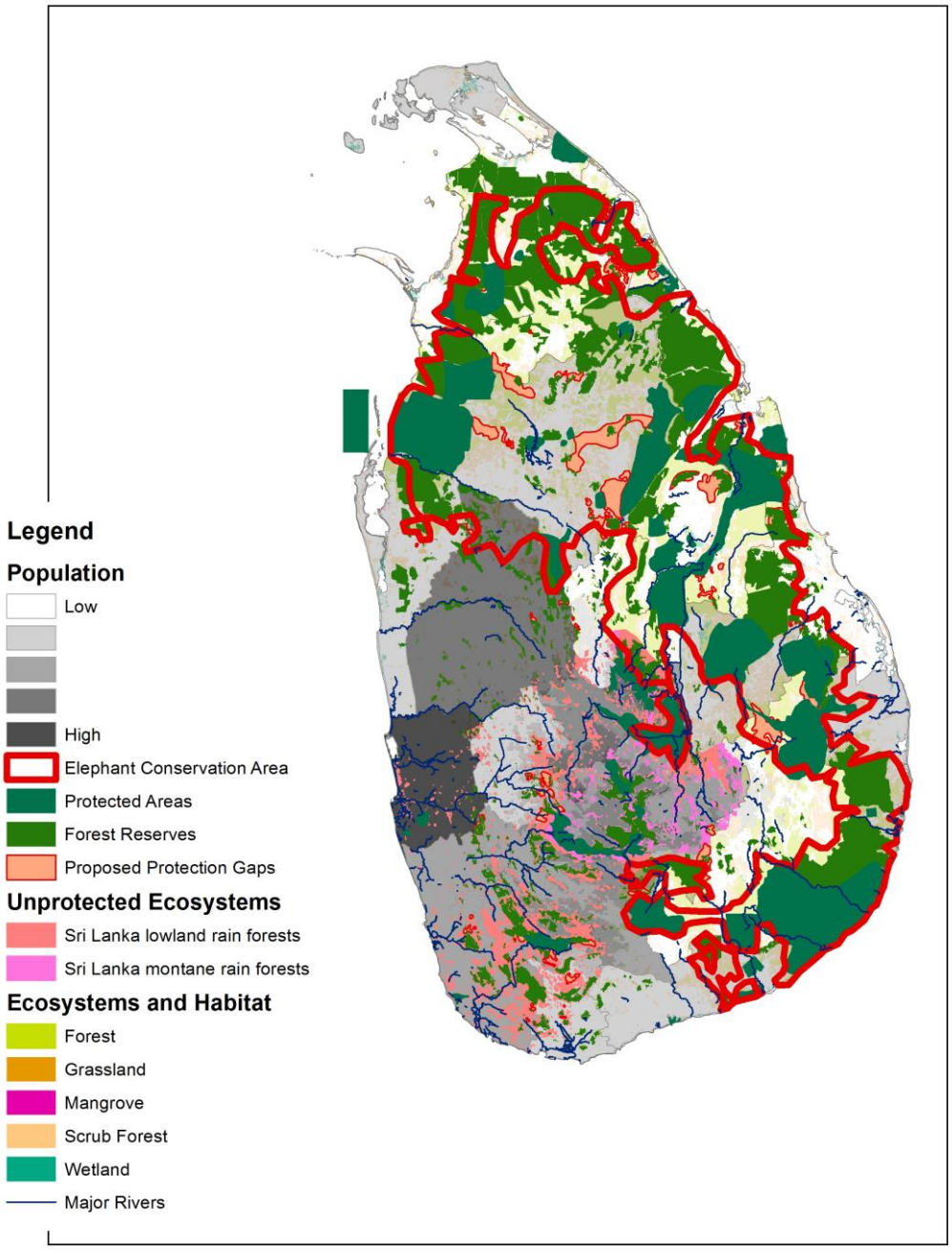


Figure 14. Population density by district. Data from the Survey Department, Sri Lanka.

Overlays of the large infrastructure and agricultural zones planned under the National Physical Plan indicate the likeliness for severe land use conflicts between conservation and development. Planned infrastructure, especially expressways, large metro regions, and an east-west economic corridor will overlap with several protected areas in the dry zone,

severing habitat connectivity and causing loss of wildlife habitat, including for the large flagship species (Figure 15).

The metro region in the south, as delineated now will overlap with several important protected areas in the south (Bundala National Park, Uda Walawe National Park, and parts of Yala National Park, (the latter being Sri Lanka's premier national park) (Figure 15). The east-west economic corridor will cut through the island, potentially severing ecological connectivity, especially for the flagship species in the eastern regions of the country. The central and western part of this corridor includes less suitable wildlife habitat. Thus, the development plans should consider the biodiversity priorities, especially in these areas of land use conflicts, and integrate conservation priorities into the development plant.

In addition to the infrastructure, the National Physical Plan has also identified areas for commodity crops, especially tea, rubber, coconut, and paddy (Figure 16). Unlike the infrastructure, these plans could have a significant impact on the wet zone forests if implemented, since large areas of the wet zone have been identified for tea and rubber. Most of the biodiversity rich forests have already been converted to tea and rubber plantations, which is the primary cause of forest conversion. However, with the decline in both rubber and tea as a commodity in global markets, many plantations are now being abandoned, or being converted to other crops. Reforestation of these plantations in strategic areas under the UNREDD/GCF can become a viable conservation strategy that should be considered. The sustainability of the metro regions that have been planned in various parts along the coast (Figure 15) will also be contingent on sustainable water from the rivers that originate from the central mountains; thus conserving these forests and reforesting where possible should become a priority and a common goal between conservationists and development agencies, especially since the intact montane watersheds will sustain vital ecosystem services that support development.

As indicated in the threat overlays, settlement distributions are most concentrated in the western portion and central hills of the country. Coupled with planned large-scale infrastructure, expansions to metro areas, and agricultural zones, not only is there significant risk to the environment, especially in terms of species movement and habitats, but past

experiences in relation to impact on local communities have not been favorable. Adequate risk and impact assessments must be uniformly undertaken in areas of and surrounding large-scale development projects including those for transport, industry, agriculture, recreation, energy generation, tourism etc. aimed at reconfiguring local landscape. This is vital towards anticipating and mitigating disruptions to local communities in terms of their social, cultural and economic participation. Focus must also be accorded to relocation plans in terms of both social, economic and environmental impact where involuntary resettlement has been proposed or enforced, accounting for sanitation, waste and pollution management in particular. As previously mentioned in relation to the dry zone, the potential for these activities to exacerbate human-wildlife conflict has also been observed in past as seen in the example of the Southern Transport Development Project and the construction of the Hambantota Special Economic Zone, and can be anticipated where major disruptions to the landscape and the lives of communities are expected. Conservation priorities must also be actively prioritised in order to reconcile as far as possible the contentions that lie at the nexus of development, communities and the environment. Establishing these priorities within policy and planning will no doubt serve as a critical framework for evaluating implementation, and must be embraced at both national and local level.

The outputs from the threat analysis highlight the areas of overlap and conflict between biodiversity conservation priorities and development plans. These outputs will thus be integrated into the development plans to ensure that actions for mitigation and conflict avoidance are considered and taken. Unless such actions are taken, the targets for maintaining ecological connectivity and representation of biodiversity, and to protect Sri Lanka's irreplaceable and flagship species will not be met.

3. RECOMMENDATIONS

One of the key aspects revealed in the analysis is the lack of synthesis between national development, local development, and conservation goals, which in turn results in top-down, infrastructure-focused, centrally-planned development being prioritised over the wellbeing and socio-economic security of local communities, and wildlife and the environment. It is imperative that these areas are aligned at national and local level through a comprehensive

set of guidelines that account for the particular Sri Lankan context which considers not only the social, cultural, economic implications for communities, but the environmental impacts of not only development, but the interlinked displacement and relocation of communities. Given not only Sri Lanka's history with conflict, but its recent experiences with a spate of natural disasters, it is important to consider that the tensions between development, communities and the environment have been aggravated. Within such a setting, it is also necessary to consider the grave impacts on forest areas and resident wildlife populations in particular that are being subject to severe harm due to human activities and encroachment. Therefore, it is important that the national and local development planning and implementation explore potential for aligning the upliftment of community livelihoods with environmental conservation, through stewardship or Payment for Ecosystem Services Schemes, be it towards enhancing watershed services, pollination services, or the restoration and preservation of forest ecosystems towards enhancing disaster risk and reduction services. This is also significant towards raising awareness on the importance of conservation at local level, and enlisting the support of local communities in activities and initiatives complementary to ecosystem service provision through home gardening and cultivation in particular.

The following recommendations outline interventions aimed at promoting stewardship and PES-related conservation related initiatives:

- Preparation of conservation-oriented national guidelines to inform development policy and planning, which seek to align conservation goals with local livelihood development.
- Actively work towards enhancing local level awareness on prevalent environmental issues.
- In areas where inclining population strains are evident, urgently seek to incorporate unprotected forests into the protected area system.
- Explore potential for valuing ecosystem services in selected areas of importance and institute public-private partnerships towards establishing PES schemes and engaging community participation where possible.
- Encourage the establishment of localised conservation priorities at divisional level in order to ensure that local needs are being addressed and being accounted for in development

activities, and improve awareness among local administrators, especially those responsible for development and land use.

- Improve awareness on local conservation priorities among existing community groups such as rural development societies and farming or livestock cooperatives, highlighting scope for community participation in and contributions to supplementing or restoring ecosystems services through home gardens and village gardens.
- Encourage conservation-oriented 'shramadana' activities at local level through community groups and societies.
- Enlist greater public consultation processes at local level to devise localised plans for conservation and mitigating existing strains vis-à-vis rural livelihoods and socio-economic needs.
- Incorporate local knowledge in the devising of plans for conservation and environmental management and ensure community involvement in implementation in order to instill a greater sense of ownership. Create and disseminate awareness materials among local small-holder cultivators and livestock farmers through the existing networks and institutions of the Ministry of Agriculture and other relevant governance bodies about the importance of conservation and ecologically-favourable interventions and how these might be incorporated into their routine practices.
- Establish a conservation and environmental protection focused legally-binding minimum standards framework applicable to all large scale farms and plantations in order to mainstream awareness on curbing environmentally-damaging practices, the importance of ecosystems services and preserving and restoring the environment, and mitigating inconsistencies in extant practices.
- Establish a conservation and environmental protection focused legally-binding minimum standards framework applicable to all largescale tourism establishments such as hotels, resorts or other pertinent infrastructure in order to mainstream awareness on curbing environmentally-damaging practices, the importance of ecosystems services and preserving and restoring the environment, and mitigating inconsistencies in extant practices.
- Within the scope of national tourism development targets, explore potential for supporting and strengthening ecologically-sensitive community tourism initiatives that

not only enable local communities to benefit from development, but also play an active stewardship role in carrying forward traditional knowledge and the conservation of the environment.

- Standardise regulations applicable to the establishment of buffer zones around forest and important watershed areas to mitigate encroachment.
- In locales where encroachment has been observed, actively seek to devise localised mitigation measures hand in hand with raising awareness among and engaging the participation of the community to pilot initiatives for management.

- Consider possibilities of reconciling local subsistence, livelihood and socio-economic needs with cultivating buffer zones in a strategic manner that address not only supplements to ecosystem services (for example, floral components that aid with pollination), but fulfilling local requirements.
- Engage private sector involvement in the cultivation of these buffer zones
- Explore potential for engaging local communities in the maintenance and restoration of buffer zones through state-sponsored stewardship or PES schemes in line with existing local livelihood or social security frameworks such as Samurdhi or Divi Neguma.
- Ensure that environmental impact and risk assessments are carried out in relation to development activities and in the resettlement of communities in new areas in order to minimise impact on local ecosystems, mitigating human-wildlife conflicts and also assuring environmentally-sound provisions for essential infrastructure related to sanitation and waste disposal in particular.
- Ensure that participatory social impact and risk assessments accounting for the community's social, cultural and economic needs are carried out in relation to development activities and in the resettlement of communities in new areas, in order to minimise impact on community's sociality and livelihoods in particular.
- Note that communities dependent on natural resources for income generation are especially vulnerable within these contexts of development-induced displacement and resettlement, and their needs and concerns must be examined through comprehensive participatory consultation processes and the introduction of viable interim or alternative livelihood measures. This is also central to mitigating detrimental impacts on ecosystems

due to potential for exploitation or the disruption of traditional stewardship or conservation practices.

- Urgently establish an ecologically-sound framework for mitigating human-animal conflicts in relevant areas with focus on the development of localised implementation plans accounting for specific local contexts and needs.
- Actively seek to create adequate ecological corridors in order to alleviate as far as possible any negative bearings on the movement of wildlife and human-wildlife conflicts.
- Raise awareness within communities susceptible to human-wildlife conflicts on the appropriate means of dealing with threats and curbing detrimental practices that further exacerbate tensions.

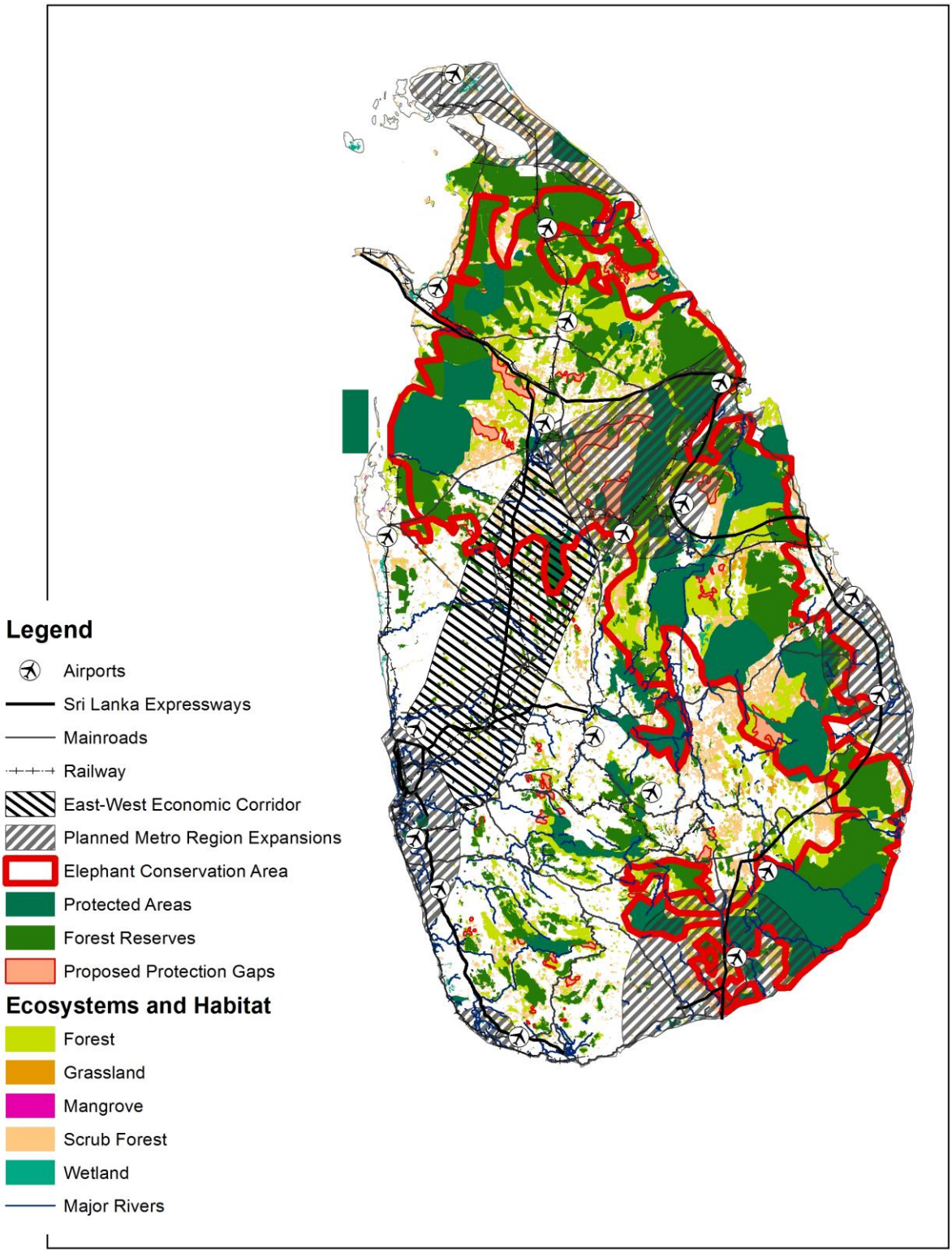


Figure 15. Large-scale infrastructure planned under the national physical plan.

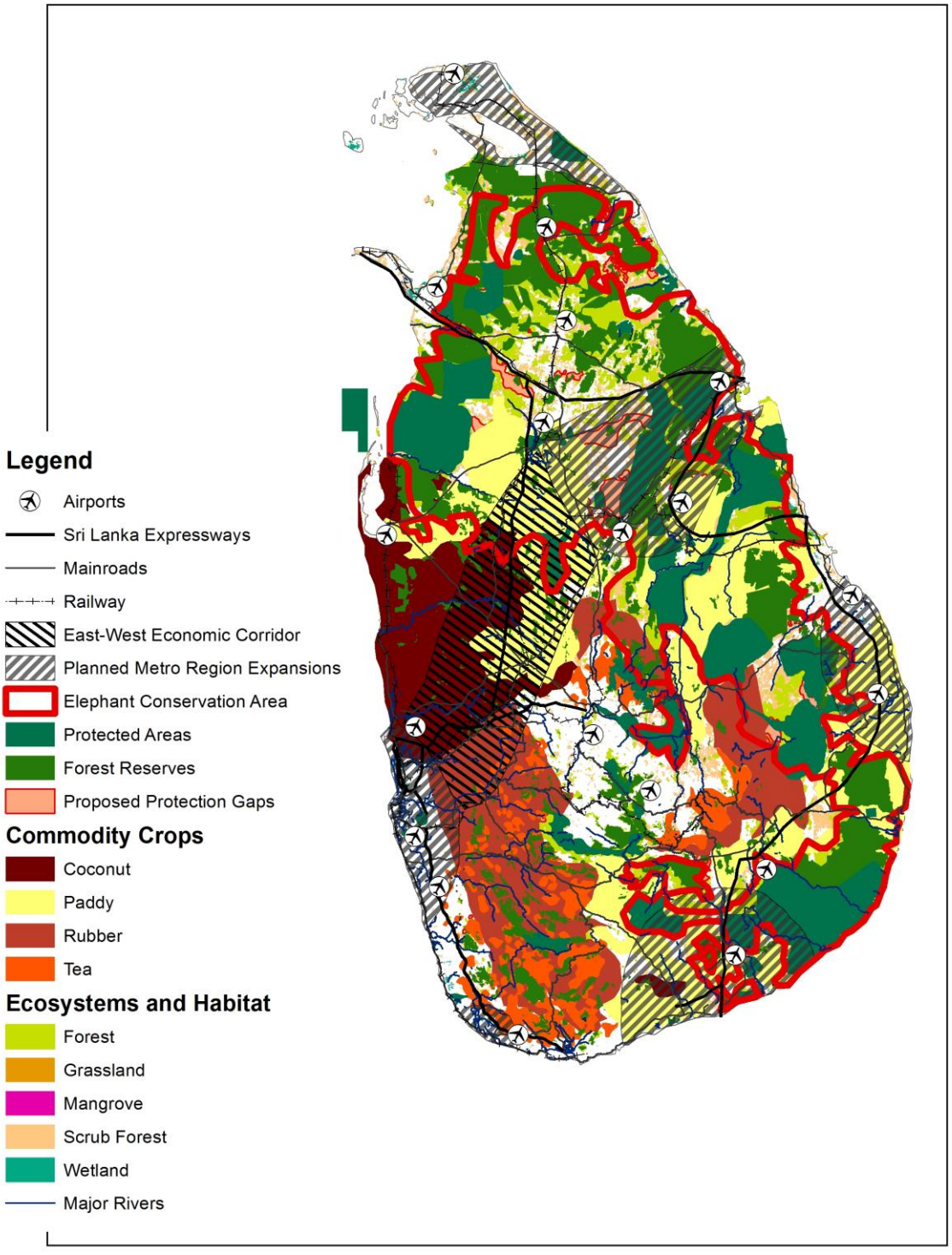


Figure 16. Areas identified for commodity agriculture under the national physical plan.

4. NEXT STEPS

The spatial database and maps are meant to complement the recommendations put forth in the NBSAP. While the NBSAP identifies what has to be done to achieve the necessary targets, the spatial database provides a roadmap of where the interventions are needed. Both outputs are timely, especially since the national planning process to revise the existing plan and identify major developments began in March 2016, and is in the process of collecting and collating information. The National Physical Planning Department will hold stakeholder meetings from December 2016. This database and analysis will be integrated into this process to address land use conflicts. The plan will also provide an opportunity and entry point for the BDS and other stakeholders in biodiversity conservation to engage with the process and contribute to it.

At sub-national levels, the UNDP/GEF funded 5-year Environmental Sensitive Areas project is working with the land use planning units of the Divisional Secretariats in the Kala Oya Basin, in the north-central/western part of Sri Lanka. The focus will be to develop a landscape-scale plan for the basin, as a pilot that can be replicated in other parts of Sri Lanka. The database created by this project will be introduced as a touchstone for national-scale priorities that should be considered and included at sub-national levels during planning of projects, such as the application of the above UNDP/GEF project to other parts of Sri Lanka.

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Annex 01: Protected areas gaps identified by Jayasuriya et al 2006

Portfolio of strategic conservation sites: proposed surrogate sites for target species of threatened flora and faunna.								
Tar group - Target group/Species								
Locality - Recorded locality Geog. Coord: Lat/LongGeog (L/L). Coord: Metric								
Ext Veg - Extant vegetation type NV = no major vegetation type present								
Pro Site - Proposed surrogate sites Veg type - vegetation type								
Other - Other species benefited or conserved								
Tar Group	**Locality**	**Geog. Coordinates**	**Ext Veg**	**SU #**	**Pro Site**	**Geog. Coordinates**	**Veg type**	**Other**
Flora								
Orchidaceae								
Bullbophyllum tricarinatum	Mathurata	80˚49'/7˚03' 205,000/206,000	NV	4	Pedro PR, Mahakudalugala PR		MOEF	*Corymbokis Veratrifolia* *Habenaria barbata*
Galeola javanica	Ramboda	80˚49'/7˚03' 192,000/206,500	NV	4	Kikiliyamana PR	80˚69'/6˚99' 192,000/198,000	MEEF	*Liparis atropurpurea*
Oberonia weragamensis	Ratnapura Weragama	80˚20'/6˚40'30" 152,000/164,000	NV	1	Dambuluwana FR Muwagankanda FR	80˚32'/6˚70' 150,000/166,000 80˚37'/6˚69' 156,879/164,097	LWEF	
Pteroceras viridiflorum	Dunsinane Estate	80˚42'/7˚00' 192,000/200,000	NV	4	Kikiliyamana PR	80˚70'/7˚03' 191,502/202,680	MEEF	
Ebenaceae								
Diospyros curmenata	Ella	80˚04'/6˚52' 232,500/184,500	NV	5	Ravana Ella PR Ella PR	81˚03'/6˚86' 229,670/183,837 81˚04'/6˚89' 230,723/186,600	MEEF	
Impatiens arnottii	Heramitigala	80˚37'/6˚41' 185,500/165,000	NV	5	Massenna PR Morahela FR	80˚62'/6˚67' 183,141/163,838 80˚61'/6˚86' 183,042/164,479	LWEF	
Impatiens cornigera	Rassgala	80˚37'30"/6˚40' 182,000/163,000	NV	5	Massenna PR	80˚62'/6˚67' 183,141/163,383	LWEF	
Araceae								
Cryptocoryne nevillii	Gurukammana Tank - Near Wawinna	80˚34'30"/7˚14' 289,000/226,000	Aquatic habitat	5	Many similar tank habitats availabe in the area		Aquatic habitat	
Dry Zone Endemics								
Ceropegia parviflora *(Asclepiadaceae)*	Near Anuradhapura	80˚24'/6˚22' 160,000/350,000	NV	2	Nuwaragama FR Mihinthale FR	80˚35'/8˚35' 153,765/349,520 80˚46'/6˚38' 165,087/352,216	DMEF	
Glossocarya Scandens f. *pubescens (verbenaceae)*	Between Tissamaharama- Kataragama	81˚18'/6˚19' 259,000/125,000	DDTS (Low viability)	5	Wirawila - Tissa Sanctuary	81˚24'/6˚31' 251,943/123,284	DDTS	
Pavonia Fryxelliana *(Malvaceae)*	North of Bakiella	81˚34'/7˚30' 294,000/256,000	SPOF	5	Nuwaragala FR	81˚50'/7˚52' 280,000/257,000	MMEF	*Vatica obscura* *(Dipterocarpaceae)*
Zizyphus lucida *(Rhamnaceae)*	Hettipola	80˚04'/7˚35' 123,000/267,000	NV	2	Mawattagama FR	80˚06'/7˚71' 121,417/277,892	SPOF & DMEF	
Fauna								
Tiger Beetles								
Cicindela Labioaenea	Many localities in Kelani river basin. e.g. Aswathy Oya, Avissawella	80˚11'/6˚57' 134,000/194,000	NV	1	Four natural vegetation patches	80˚02'/6˚90' 116,799/188,802 80˚29'/7˚07' 146,382/207,145 80˚30'/6˚89' 148,820/185,939 80˚30'/6˚87' 148,608/184,455	LWEF	*Cicindela nietneri* *Cicindela henryi*
Cicindela waterhousei	Handapangoda	80˚08'/6˚47'30" 130,000/177,000	NV	1	Kurana Madakada PR Miriyagalla FR	80˚16'/6˚80 133,165/177,585' 80˚11'/6˚62' 127,729/179,136	LWEF	
Amphibia								
Philautus Hallidayi	Tanakombe Estate , Namunukula	81˚07'/6˚52' 238,000/185,000	NV	5	Namunukula FR	81˚11'/6˚64' 237,767/193,031	MEEF	

Portfolio of strategic conservation sites: Special HCV As (point localities) for threatened flora and fauna

Tax Gr.	Taxonomic Group
Sp.Low Prob	Species with extremely low probability of consevation and unrepresented within innitial portfolio
HCV As	HCV As (point localities) that are added to final portfolio. Coordinates: Lat/Lonng and Metric
Veg Type	Vegitation type characteristics of HCVA
Exam	Examples of additional threatened species conservaed conserved within HCV As
HT	Highly Threatened
TR	Threatened

Tax Gr	Sp.Low Prob.	HCV As	Coord.	Veg Type.	Exam
SU 1					
Dipterocarpaceae	*Stemonoporus moonii*	Kalutara Dist : Honaka,Walauwatte Waturana	80^0 11'601"/6^0 38'054"136,000/160,00	Riverine Forest in Wet Zone. Isolated forest patch, unmapped.	*Diospyros moonii (HT) (Ebenaceae) Mesua stylosa (HT) (Clusiaceae) Vatica paludosa (HT) (Dipterocarpaceae) Areaca concinna (HT)*
Fresh water Fish	*Sicyopus joklaasi*	Kalutara Dist: Horawala, Maha - Kalupahana	$80^0$5'4"/$6^0$16'38"131,500/ 142,500	Vegetation unmapped; probably patchy LWEF present	*Puntius titteya (HT) Puntinus nigrofasciatus (TR) Belontia signata (TR) Aplocheilus werneri (TR) Malpulutta kretseri (Freshwater fishes)*
SU 2	None				
SU 3	None				
SU 4					
Amphibia	*Philautus pleurotaenia*	Kandy Dist: Gannoruwa	$80^0$35'130"/$7^0$17'180,500 /231,500	MMEF	*Diospyros koenigii (HT) (Ebenaceae) Cnemaspis podihuna (HT) (Reptilia-Gekkonidae) Philautus zorro (HT) (Amphibia) Boiga ranawanei (recently discovered species) (Reptilia-Serpentes:Colibridae)*
Mollusca: Gastropoda	*Ravana politissima*	Numara-Eliya Talawakele	$80^0$40'/$6^0$56'188,500/192, 500	Non-forested stream reservation	
SU 5					
Balsaminceae	*Impatiens walkeri*	Badulla Dist : Way to Namunukula	$81^0$07'/$6^0$56'238,000/192, 500		*Philautus frankenbergii (HT) Philautus hallidays (HT)*
	Diospyrus rheophtica	Rathnapura Dist : Narangetahinna OSF	$80^0$27'30"/$6^0$16'26" 199,000/154,510	Vegetation unmapped SAVG	

Portfolio of strategic conservation sites: Sites included in the portfolio to represent special conservation targets.

Special conservation target	Site and approximate geographical coordinates	SU	Vegetation type and other characteristics of special area	Reasons for inclusion in portfolio
Rock outcrops in intermiediate zone	Kokagala 81˚11'/7˚25'	5	MMEF partly in Maduru Oya PRB and partly in NPRB.	Locality for several threatened species of Orchidaceae; e.g. *Ipsea specosa*
	Monaragala 80˚23'/6˚52'	5	MMEF Extention of a natural vegetation area falling within kumbukkan Oya PRB into adjecent NPRB.	Locality for several threatened species of Orchidaceae; e.g. *Rhynchostylis retusa*
	Dimbulagala (Gunners quoin) 81˚01'/7˚51'	4	MMEF within Maduru Oya PRB. Part of a cooridor.	Locality for rare endemic flora in the Dry Zone; e.g. *Croton persimilis* (Euphobiaceae) *Lindernia Sri Lankan* (Scrophulariaceae), *Pavonia fryxelliana* (Malvaceae)
	Govindahela (Westminiter abbey) 81˚33'/7˚02'	5	MMEF An extension of Sellaka Oya Sanctuary.	Only locality for extant populations of *Begonia dipetala* (Begoniaceae), a very rare and threatened species.
Coastal Habitats	Kevuliya (Foul point) 81˚19'/8˚31'	4	Beach forest; iso lated area, but in the vicinity of rich MANF sites.	Locality for some rare endemic plants, e.g. *Murraya gleniei* (Rutaceae)
	Kirinda 81˚20'/6˚12'	5	Coastal strip adjecent to a SAND site which is already in the portfolio; in NPRB	Locality for *Cicindela catena* (Tiger beetle)
Lagoons	Hambantota Lagoon 81˚08'/6˚09'	5	Isolated site; in NPRB	Locality for Cicindela fastidiosa (Tiger beetle)
Archaeological Reserve	Mihintale Archaeological Reserve 81˚31'/8˚21'	2	Low Rock outcrop and associated forest; in NPRB	Locality for *Rana gracilis* (Amphibian)
	Menikdena Archaeological Reserve	2		This archaelogical reserve has been upgraded into an Arboretum; unique vegetation on isolated hills; northern most patch of MEEF in Sri Lanka; northern most limits for some wet zone endemic flora and fauna, e.g. *Shorea dyeri* (Dipterocarpaceae) and *Lyriocephalus scutatus* (Reptilia - Agamid Lizard).
Extension to PAs as contiguous forest area	Morningside 80˚36'/6˚24'	5	MEEF in Rakwana Hills; site contiguous to Sinharaja	An eastern extension to Sinharaja forest; locality for some unique fauna species e.g. *Philautus poppiae* (Amphibia), *Microhyla Karunaratnei, Ceratophora erdleni* (Agamid Lozard). *Feroculus Feroculus* (Small mammals)
	Handapana Ella 80˚34'/6˚27'	5	…. Silimar site …	….similar reason…
	Gongala	5	…. Silimar site …	….similar reason….
	Suriyakanda	5	…. Silimar site …	An eastern extension to Handapan-ella OSF, a contiguous site to Sinharaja Forest.

Portfolio of strategic conservation sites: Special HCV As (point localities) for threatened flora and fauna					
Tax Gr.	Taxonomic Group				
Sp.Low Prob	Species with extremely low probability of consevation and unrepresented within innitial portfolio				
HCV As	HCV As (point localities) that are added to final portfolio. Coordinates: Lat/Lonng and Metric				
Veg Type	Vegitation type characteristics of HCVA				
Exam	Examples of additional threatened species conservaed		conserved within HCV As		
HT	Highly Threatened				
TR	Threatened				
Tax Gr	**Sp.Low Prob.**	**HCV As**	**Coord.**	**Veg Type.**	**Exam**
SU 1					
Dipterocarpaceae	*Stemonoporus moonii*	Kalutara Dist : Honaka,Walauwatte Waturana	80^0 11'601''/6^0 38'054"136,000/160,00	Riverine Forest in Wet Zone. Isolated forest patch, unmapped.	*Diospyros moonii (HT) (Ebenaceae) Mesua stylosa (HT) (Clusiaceae) Vatica paludosa (HT) (Dipterocarpaceae) Areaca concinna (HT)*
Fresh water Fish	*Sicyopus joklaasi*	Kalutara Dist: Horawala, Maha - Kalupahana	$80^0$5'4''/$6^0$16'38''131,500/142,500	Vegetation unmapped; probably patchy LWEF present	*Puntius titteya (HT) Puntinus nigrofasciatus (TR) Belontia signata (TR) Aplocheilus werneri (TR) Malpulutta kretseri (Freshwater fishes)*
SU 2	None				
SU 3	None				
SU 4					
Amphibia	*Philautus pleurotaenia*	Kandy Dist: Gannoruwa	$80^0$35'130''/$7^0$17'180,500/231,500	MMEF	*Diospyros koenigii (HT) (Ebenaceae) Cnemaspis podihuna (HT) (Reptilia-Gekkonidae) Philautus zorro (HT) (Amphibia) Boiga ranawanei (recently discovered species) (Reptilia-Serpentes:Colibridae)*
Mollusca: Gastropoda	*Ravana politissima*	Numara-Eliya Talawakele	$80^0$40'/$6^0$56'188,500/192,500	Non-forested stream reservation	
SU 5					
Balsaminceae	*Impatiens walkeri*	Badulla Dist : Way to Namunukula	$81^0$07'/$6^0$56'238,000/192,500		*Philautus frankenbergii (HT) Philautus hallidays (HT)*
	Diospyrus rheophtica	Rathnapura Dist : Narangetahinna OSF	$80^0$27'30''/$6^0$16'26" 199,000/154,510	Vegetation unmapped SAVG	

Portfolio of strategic conservation sites: Proposed corridors to connect Pas

Locality — Approximate Geographic Coordinates: Lat/Long, Metric X/Y
Veg Type — Constituent Vegetation types
Via. Sta — Viability Status: V= Very good, G= good, M= Moderate, P= Poor,Con - Continuity : A= +Continuous, B= Moderately patchy, C= Highly patchy

		Corridor Characteristics				
SU	**PA s connected by corridor**	**Locality**	**Area ha)**	**Veg. types**	**Via. Sta**	**Con**
1	Indikada Mukalana PR, Pallepattu FR, Getamawara PR, Kurana Madakada PR	$80^0$11'4''/$6^0$52'2'' 136,227/185,562	83.89	LWEF	V - mostly	**A**
1	Alapalwa PR, Aturupana PR, Debatgama-Bosella PR	$80^0$24'6''/$7^0$10'2'' 161,095/217,887	426.44	LWEF	G-mostly M-some	**B**
1	Peak Wilderness S, Kelani Vally FR, Kitulgala PR, Amanawala-Ampana PR	$80^0$25'2''/$6^0$58'2'' 162,141/196,964	6030.38	LWEF SPOF	V- mostly	**A**
1	Eastern Extension of Sinharaja NHWA, Hadapan Ella OSF, Gonagala OSF, Morninside, Iiumba Kanda, Suriya Kanda)	$80^0$37'2''/$6^0$23'4'' 183,714/132,761	2083.34	LWEF - mostly & MEEF SPOF - some	V & G	**A**
1	Sinharaja NHWA, Morapitiya-Runakanda PR, Kalugala PR	$80^0$19'2''/$6^0$22'8'' 150,327/132,815	344.38	LWEF	V-mostly P-some	**A**
1	Sinharaja NHWA, Dellawa PR, Diyadawa FR	$80^0$27'/ $6^0$20'4'' 166,294/127,794	2151.24	LWEF	V & G - mostly	**A**
1	Diyadawa FR, Panil Kanda FR, Ulinduwewa PR, Rammala Kanda FR,Mulatiyana FR	$80^0$33' / $6^0$15'6'' 177,291/118,026	1863.27	LWEF	V - mostly, G- some, M- few	**C**
1	Yagirala FR, Meegahatenna PR, Kabaragala PR,Badugam Full PR	$80^0$9'/$6^0$26'4'' 130,853/139,667	1052.5	LWEF	G & M mixture	**B**
1	Kombala-Kottawa PR,Beraliya (Akuressa) PR	$80^0$22'2''/$6^0$5'4'' 156,556/98,438	281.69	LWEF SPOF	G, M & P mixture	**C**
1	Haycock FR, Habarakada PR, Polgahakanda FR,Malambure FR, Kanneliya FR, Tawalama PR	$80^0$17'4''/ $6^0$18'6'' 148,018/124,165	714.43	LWEF - mostly SPOF - some	V, M, & P mixture	**C**
1	Nakiyadeniya PR, Dedigala FR	$80^0$23'4'' / $6^0$8'4'' 157,936/105,239	482.84	LWEF SPOF	M-mostly , G- few, P-few	**C**
1	KDN Extension	$80^°$21'6'' / $6^°$13'2'' 155,431/ 114, 170	460.52	LWEF	V	**A**
1	Beraliya (Akuressa) PR, Wellana FR, Kudugal Kanda FR	$80^0$27'6'' / $6^0$5' 166,015/945,797	100.53	LWEF	M	**C**
1	Welihena FR, Oliyagankele FR	$80^0$30'6''/$6^0$6' 170,819/100,147	116.63	LWEF SPOF	M-mostly	**C**
1	Welihena FR, Mulatiyana FR	$80^0$30'6" / $6^0$9'6" 170,814/106,105	403.16	LWEF-mostly SPOF-some	M	**C**
1	Kekunadura FR - Extension	$80^0$34'8" / $6^0$5'94'' 179,932/88,105	39.27	MMEF-mostly SPOF-some	G-mostly M-some	**B**
2	Chunnavil FR,Nagapaduwan FR, Akkiriyan PR, Neenthavil FR	$81^0$19'2" / $8^0$19'2" 138,322/452,151	6002.05	DMEF-mostly	G-mostly	**A**
2	Madhu PR, ParangiAru PRB	$81^0$19'2''/$8^0$19'2" 138,243/417,788	2619.41	DMEF	G	**A**
2	Mavillu FR, Veppal FR, Wilpattu NP	$81^0$19'2" / $8^0$19'2" 199,216/385,829	825.4	DMEF	G	**A**
2	Two blocks of Puvarasankulam	$81^0$19'2''/$8^0$19'2" 157,067/396,056	185.26	DMEF SPOF	M- mostly V-some	**A**
2	Wilpattu NP, Medawachchiya PR	$81^0$19'2''/$8^0$19'2" 148,033/375,580	7361.21	DMEF-mostly SPOF -some	G-mostly M-some	**A-almost**
2	Medawachchiya PR, Issebessawa PR, Hinna PR, Etakaduwa PR,Wedakanda FR	$81^0$19'2''/$8^0$19'2" 174,082/376,316	3007	SPOF-almost all	V&G-mostly M-some	**A**
2	Wilpattu NP,Nuwaragam FR, Yoda Ea FR	$81^0$19'2''/$8^0$19'2" 140,907/351,992	5847.56	SPOF-mostly DMEF-some	V,G-mixture M	**B**
2	Tabbowa S.Sellankandal PR, Wanniyagama PR Weerakulicholai-Eluwankulama PR	$81^0$19'2''/$8^0$19'2" 112,067/316,948	391.95	DMEF SPOF	M-mostly G-some	**B**
2	Wanniyagama PR, Sawarangala PR	$81^0$19'2''/$8^0$19'2" 130,984/309,637	616.67	SPOF	V,M,P mixture	**B**
2	Attavillu FR, Attavillu PR, Unaliya PR, Tonigala PR	$81^0$19'2''/$8^0$19'2" 107,994/302,971	290.29	SPOF DMEF	P-mostly M-some	**C**
2	Dunkanda PR, Dolukanda PR	$81^0$19'2''/$8^0$19'2" 158,924/271,234	216.12	DMEF SPOF	G-mostly M-some	**A**
2	Two bloks of Pallekele FR	$81^0$19'2''/$8^0$19'2" 170,467/278,921	394.15	DMEF	G-mostly M-some	**A**
2	Henegederalanda PR, Wegodopola PR, Neugalkanda PR	$81^0$19'2''/$8^0$19'2" 175,806/272,032	266.83	DMEF MMEF	G,M	**C**
2&3	Hurulu FR, Ritigala SNR, Gal Oya PR, Sigiriya S, Inamaluwa FR, Kahalla-Pallekele S, Kala Oya PRB	$81^0$19'2''/$8^0$19'2" 192,413/323,534	20,482.46	SPOF DMEF	V,G,M,P, mixture	**B**
2&3	Hurulu FR,Anaolondawa PR, Mihintale S,Alutabedawewa PR, Mahakandarawa S, Anuradhapura S	$81^0$19'2''/$8^0$19'2" 191,341/352,079	15,699.05	SOPF-mostly DMEF-some	G-mostly M-some	**B**

Portfolio of strategic conservation sites: Proposed corridors to connect Pas

Locality	Approximate Geographic Coordinates: Lat/Long, Metric X/Y
Veg Type	Constituent Vegetation types
Via. Sta	Viability Status: V= Very good, G= good, M= Moderate, P= Poor,Con - Continuity : A= +Continuous, B= Moderately patchy, C= Highly patchy

		Corridor Characteristics				
SU	**PA s connected by corridor**	**Locality**	**Area ha)**	**Veg. types**	**Via. Sta**	**Con**
3	Teravil- Oddusuddan FR, Kulamurippu'A' FR	81°19'2"/8°19'2" 191,488/448,624	971.85	SPOF-mostly DMEF-some	G,M,P-mixture	**B**
3	Kulamuripu "B" FR,Nainamadu FR, Andankulam PR,Nagancholai FR,Tanduvan FR	81°19'2"/8°19'2" 192,212/427,672	7415.79	DMEF-mostly SPOF -some	G,M,P-mixture	**A**
3	Andankulam FR, Nagancholai FR	81°19'2"/8°19'2" 205,793/434,805	1373.82	DMEF	V G	**B**
3	Andankulam FR, Maduru Oya PRB	81°19'2" /8°19'2" 210,546/421,121	1058.89	SPOF	G	**B**
4	Chundankadu FR,Mahaweli Ganga North FR,Mahaweli estuary/Trinco Harbour	81°11'4"/8°2'4" 247,196/354,363	2136.76	SPOF DMEF	V,G mixture M	**A**
4	Vappiah Venigal FR,Seruwila Allai S	81°19,2"/8°19'2" 260,920/347,839	1438.47	DMEF-mostly SPOF -some	S-some	**A**
4	Anaolondawa PR, Hurulu FR, NP Indet, Galoya PR, Minneriya PR	80°58'2"/8°12'6" 222,615/333,866	14734.16	DMEF-mostly SPOF -some	G-mostly M-some P-few	**B**
4	NP Indet, Maduru Oya PRB	81°6'/7°46'2" 236,434/285,537	3421.85	MMEF-mostly VILG-some SPOF-few	M-mostly G-some	**C**
5	NR Indet, Koralai FR	81°20'4"/8°3'6" 263,392/316,982	3963.83	DFEF-mostly SPOF-some	G-mostly	**A**
5	Nuwaragala FR,Rugam PR	81°25'2"/7°38'4" 272,028/271,032	647.94	MMEF SPOF	M,P-mixture,G	**B**
5	Nuwaragala FR,Gal Oya NP,Ampara S	81°28'2"/7°22'2" 276,897/240,960	4595.86	MMEF	V G	**A**
5	Galoya NP, Sellaka Oya S, Maduru Oya PRB	81°28'2"/7°15' 258,656/227,388	11862.35	SPOF-mostly MMEF-some SAVG-few	V&G-mostly M-some	**B**
5	Bogahapitiya S, Bibilehela PR, Rawana Ella PR,Meegallegama PR	81°3'6"/6°45' 233,566/172,790	5054.75	MMEF-mostly SPOF-some DPTG-some	G, M mixture	**B**
5	Bogahapitiya S, Wetahira kanda NR, Udawalawe NP	80°48'6"/6°35'4" 205,146/154,362	1127.05	DMEF,MMEF SPOF-mixture	G-mostly M-some P-few	**B**

Annex 2: Land Use Categories of the Corridors identified on figure 4

Corridor No	Area km^2															
	Chena	Forest	Home Garden	Paddy	Scrub Forest	Stream	Tank	Water Body	Wetland	Lagoon	Rock	Coconut	Rubber	Grassland	Tea	Bare land
1	0.000000	51.697355	0.065014	2.768491	9.052002	0	1.718581	0.114968	0.64485	0	0	0	0	0	0	0
2	0.058754	1.65888	0	0.306498	2.042653	0	0.041156	0.012569	0	0	0	0	0	0	0	0
3	0.221245	0.153675	0	0.141799	0.262036	0	0.00639	0	0	0	0	0	0	0	0	0
4	0.065064	0.089267	0.000009	0.462451	0.176752	0	0	0	0	0	0	0	0	0	0	0
5	0.186416	0	0	0.233021	0.429974	0	0.163919	0	0	0	0	0	0	0	0	0
6	0.973325	0.043141	0	0.990602	0.72497	0.244206	0.000443	0	0	0	0	0	0	0	0	0
7	0.000000	6.129438	0	0.816469	1.935744	0.335312	0.028503	0.015586	1.563912	0.31142	0	0	0	0	0	0
8	0.906589	36.630537	2.689722	3.770003	11.927397	0.101515	2.125772	0	0.111049	0	0	0	0	0	0	0
9	0.000000	7.648062	0.332337	0.616428	1.363754	0	0.748994	0	0	0	0	0	0	0	0	0
10	0.000000	4.101071	0	0.081585	0.195131	0.021326	0.180921	0	0	0	0	0	0	0	0	0
11	0.085338	1.621433	0	0.728863	0.836687	0.082483	1.266732	0	0	0	0	0	0	0	0	0
12	0.000000	3.989471	0	1.340429	5.946814	0.086943	0.030939	0	0.265152	0	0	0	0	0	0	0
13	0.000000	26.180381	0	0	1.339965	0	0.08714	0.402596	0.015744	0	0	0	0	0	0	0
14	0.318621	8.645311	0.328527	0.390292	0.002585	0.641664	0.442655	0.071073	0.158747	0	0	0	0	0	0	0
15	0.000000	4.901877	3.914449	0	0	0	0	0	0.544341	0	0	0	0	0	0	0
16	17.447578	65.779127	3.172843	6.836327	5.68611	1.681221	2.74025	0.811806	0	0	0.274445	0	0	0	0	0
17	1.054309	6.306259	1.276882	3.400256	8.200257	0	1.361109	0	0	0	0	0	0	0	0	0
18	0.000000	1.359367	0	0.137107	0.526904	0	0.044126	0.011909	0	0	0	0	0	0	0	0
19	1.247077	1.938728	0.819558	1.516033	2.642115	0	1.046623	0	0	0	0	0	0	0	0	0
20	21.399239	61.714422	17.661382	41.556558	69.412787	0.516432	21.525115	0.017067	0	0	1.036453	0	0	0	0	0
21	21.139869	13.970009	1.933418	2.194381	9.981674	0.276461	5.374697	0.007016	0	0	0	0	0	0	0	0
22	3.177484	0.386942	0.443131	1.043726	2.388985	0.08525	0.924073	0.00691	0	0	0	0	0	0	0	0
23	0.000000	0	0.405758	0.710642	3.132981	0	0.062815	0	0	0	0	0	0	0	0	0
24	17.077050	26.532833	7.585676	9.723051	49.245845	1.015629	11.693184	0	0	0	0.493857	0	0	0	0	0
25	2.158373	0.103685	0.437993	0.165615	8.025688	0	0.289698	0	0	0	0.008711	0	0	0	0	0
26	4.188078	0.54697	0.506683	0.131009	8.027966	0	0.349904	0	0	0	0	0	0	0	0	0
27	0.076817	1.485887	0.194434	0.100174	0.623929	0	0.224187	0	0	0	0	0	0	0	0	0
28	0.802442	1.211522	0.257894	0.588697	0.513739	0	1.697225	0	0	0	0	0	0	0	0	0
29	0.200372	0	0.612834	0.24285	0.926894	0	0.281583	0	0	0	0	0	0	0	0	0
30	0.954266	2.217012	0.235589	1.633236	6.503287	0.034248	0.541512	0	0	0	0	0	0	0	0	0
31	0.363518	0.297471	0.650347	0.213656	2.963453	0	0.007904	0	0	0	0	0	0	0	0	0
32	0.344594	0.000212	0.327047	0.170456	1.325673	0	0.032525	0	0	0	0	0	0	0	0	0
33	0.763321	0.830124	0.248145	0.266078	0.976317	0	0.206692	0	0	0	0	0	0	0	0	0
34	0.487920	0.44362	0.450898	0	1.034287	0	0.163767	0	0	0	0.027813	0	0	0	0	0
35	0.601542	1.117911	0	0.674654	2.352788	0	0.267185	0	0	0	0	0	0	0	0	0
36	0.000000	30.990228	0.236581	0.144925	5.149954	0	0.469955	0.018148	0	0	0.338805	0	0	0	0	0
37	0.000000	87.210849	1.842187	3.534941	13.086494	0.104299	2.705919	0.052684	0.419413	0	0.03569	0	0	0	0	0
38	0.000000	41.361707	1.801794	0	5.10753	0	0.56887	0	0	0	1.368113	0	0	0	0	0
39	0.105523	1.174509	2.234044	0	0.156458	0	0.049075	0	0	0	0	0	0	0	0	0
40	0.000000	0	2.456823	2.190448	3.771457	0.028135	0.18298	0	0	0	0	0	0	0	0	0
41	0.345692	0	0.317013	0.417506	0	0	0	0	0	0	0	0.112914	0	0	0	0
42	0.000000	0	3.399932	0.072129	1.273496	0	0.051056	0	0	0	0	1.053714	0	0	0	0
43	0.000000	0	0	0	0.850204	0	0	0	0	0	0	0.114934	0.850204	0	0	0
44	0.000000	0.357454	0.958286	0.352963	0.402011	0	0.004338	0	0	0	0.308468	1.9047	0	0	0	0
45	0.000000	2.563891	0	0	0	0	0	0	0	0	1.025771	0	0	0	0	0

Corridor No	Area km^2															
	Chena	Forest	Home Garden	Paddy	Scrub Forest	Stream	Tank	Water Body	Wetland	Lagoon	Rock	Coconut	Rubber	Grassland	Tea	Bare land
46	0.000000	8.879826	0.119705	0	0.113638	0	0.099551	0	0	0	0	0	0	0	0	0
47	0.000000	3.102074	0	0	0	0	0.654771	0	0	0	0.220262	0	0	0	0	0
48	0.000000	1.084208	0	0	0.978332	0	0	0	2.191708	0	0	0	0	0	0	0
49	0.000000	0	0.012074	0.333586	0.153917	0	0.003207	0	1.507593	0	0	0	0	0	0	0
50	0.000000	0	0.004331	0.024004	0.869562	0	0.292519	0	0	0	3.395805	0	0	0.035922	0	0
51	0.000000	0.664316	0.629749	0.299412	1.02204	0	0	0	0	0	0	0.362217	0	0	0	0
52	0.051734	0	0.060401	0	2.914054	0	0	0	0	0	0	0	0	0	0	0
53	0.000000	0	0	0	0	0	0	0	0	0	0.022173	0	0	0	0	0
54	0.000000	0	0	0	0.327991		0.224502		0.000094	0	0.55426	0	0	0	0	0
55	0.000000	0	0	0.00047	0.189875	0	0	0	0	0	0.046163	0	0	0	0	0
56	0.000000	0.367686	0	0.036501	0.355123	0.507761	0.013687	0	0	0	0	0	0	0	0	0
57	0.000000	0	0	0.00977	0.512982	0	0	0		0	0	0	0	0	0	0
58	0.008679	40.824855	0.048464	0	0.531195	0.323254	0.070363	0.001637	0	0	7.724636	0	0	0	0	0
59	4.123831	106.416806	4.449796	0.558156	8.360321	1.614382	0.105949	0	0	0	4.246887	0	0	0.841751	0	0
60	0.000000	0.524814	1.947573	0.487135	1.16835	0	0	0	0	0	0.029983	0	0.370908	0	0	0
61	0.000000	4.132587	1.733389	0.085648	0.090549	0.421518	0	0	0	0	0.182437	0	1.930017	0	0	0
62	0.000000	2.402163	2.717976	0.043947	0.363943	0.021516	0.131754	0	0	0	0	0	0	0	0.061529	0
63	0.000000	2.761271	2.460407	0.082726	0	0.258709	0	0	0	0	0.027373	0	0.896301	0	0.22109	0
64	0.000000	9.634135	1.216014	0.013048	0.333473	0.006617	0	0	0	0	0.178033	0	0.037225	0	4.753177	0
65	0.000000	0	1.346613	0.038962	0.053356	0.03858	0	0	0	0	0.067321	0	1.446523	0	0.372936	0
66	0.000000	0.779545	0	0.139293	0	0				0	0.608285	0	2.276264	0	1.044784	0
67	0.000000	5.58654	2.380672	0.056515	5.19671	0.454587				0	0.084798	0	1.397322	0	0.454587	0
68	0.000000	4.01624	1.378158	0.036059	0.144071	0.039288	0.190323			0	0	0	2.987625	0	0	0
69	6.859158	7.041683	0.965369	0.788536	0.223728	0.567462	0			0	0.018611	0	0	0	0	0
70	0.808705	17.665388	0	0	0.643932	0	0	0.151674	0	0	0	0	0	0	0.380774	0
71	11.265583	15.556953	7.756995	0.240783	13.063286	0.20356	0.176264	0	0	0	0.67091	0	0	3.613546	0.924712	0
72	0.000000	5.881593	0.824001	0.516383	2.295648	0.256923	0	0		0	0	0	0	0	0.962409	0
73	2.175720	11.25663	0.482483	0.357519	0.646873	0.161743	0	0.032366		0	0	0.005327	0	0.078066	1.598109	0
74	0.540253	7.292621	1.111752	0.817488	1.445389	0.08627	0	0	0	0	0	0.035447	0.001582	0	1.639391	0
75	0.000000	5.588658	0.465975	0.114953	0	0.083671	0	0.004836	0	0	0.544157	0	0.162674	0	0.0309	0
76	0.000000	0.033416	0	0	0.469304	0	0	0	0	0	0	0	0.260419	0	0	0
77	0.000000	0.753743	0.311028	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0.000000	2.297944	0.406279	0.418326	0.865242	0	0	0	0	0	0	0	2.552256	0	0	0
79	0.000000	0	0.052438	0.079877	0.636662	0	0		0	0	0	0	0.323931	0	0	0
80	0.000000	0	0	0	0.158396	0	0	0	0	0	0	0	0.979875	0	0.647109	0
81	0.000000	0.155806	0.456689	0.128407	0.216445	0.031992	0	0	0	0	0	0	0.255327	0	0.001242	0
82	0.000000	0.157574	0	0.342031	1.677659	0	0	0	0	0	0	0.086711	0	0	0	0
83	0.000000	0.409426	0	0	0.801204	0	0	0	0	0	0	0	0	0	0	0
84	0.000000	0.027346	0.38001	0.397629	0.029422	0	0.023382	0	0	0	0	0.01329	0.555798	0	0.141743	0
85	0.000000	0	0	0.089823	0.102176	0	0	0	0	0	0	0	0	0	0.030091	0
86	0.000000	0	0	0	0.121632	0	0	0	0	0	0	0	1.182204	0	0	0
87	0.000000	6.877397	1.461528	1.541815	1.665313	0	0.033328	0	0	0	0.031248	0	0	0	0	0
88	0.000000	6.46864	0	0.740308	4.090216	0.402118	0	0.094245	0.141724	0	0	0	0	0	0	0.046666
89	0.000000	2.266941	0	0.03029	1.314616	0	0.0265	0	0	0	0	0	0	0	0	0

Annex 3

Ecological cost scores assigned to the land use and land cover categories to create a habitat suitability layer and applied to the cost-distance model. Cost scores were assigned differently to the dry zone and wet zone land use and habitat types, considering the species assemblages and proxy species. Good habitats are assigned lower cost scores, and unsuitable habitats are assigned higher cost scores, on a scale of 0-20. Output maps are in Figures 5 and 7.

Land Use/Land Cover (habitat)	Dry Zone Score	Wet Zone Score
Forest	0	0
Grassland	0	0
Mangrove	0	0
Scrub Forest	0	2
Chena	5	6
Wetland	0	0
Stream/River	0	0
Tank/Lake/Water Body	0	0
Home Garden	15	5
Rubber	17	10
Coconut	17	15
Tea	20	12
Paddy	20	15
Rock	5	3
Bare Area	17	17
Built up Area	20	20

Annex 4:

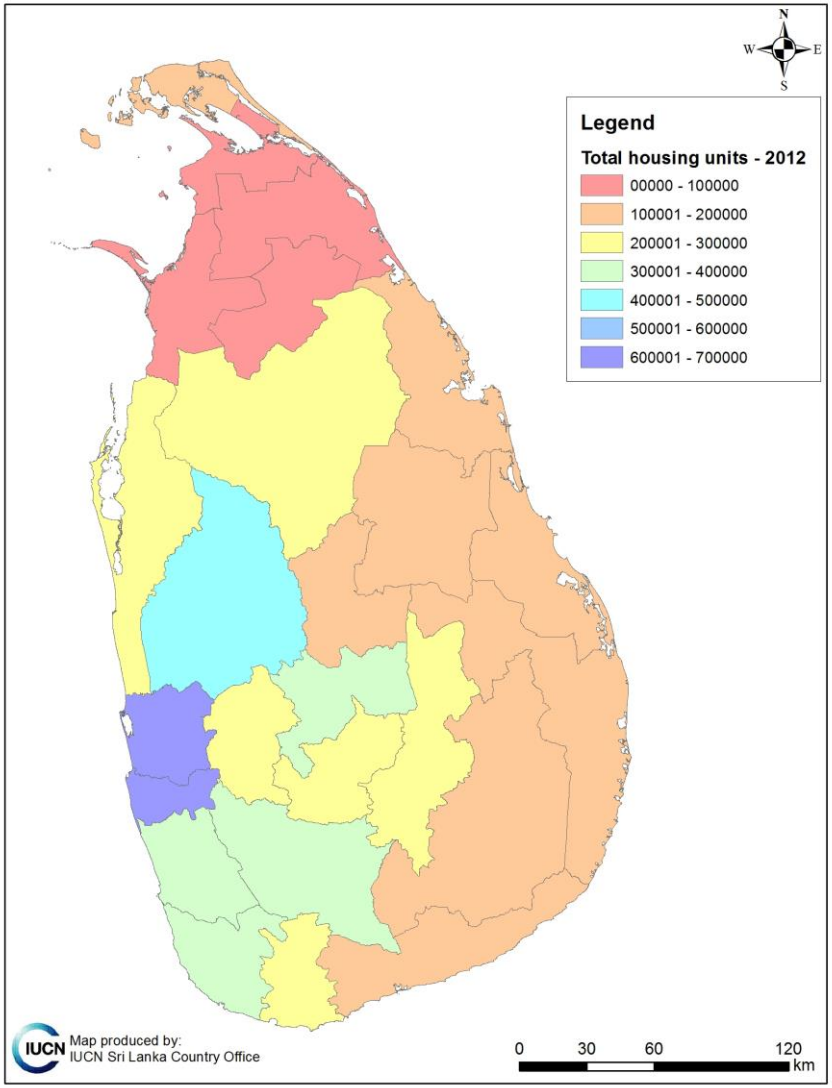

Figure 17 : Total Number of Housing Units - 2012

Environmental Foundation Limited

The Environmental Foundation Limited (EFL) established in 1981, is one of Sri Lanka's oldest public interest organizations working in environmental conservation and protection. It is a nonprofit making institution that has gained a reputation for a balanced approach transparency and neutrality and is well known for its legal actions over the years. Successful Judicial interventions by EFL include the *Eppawela phosphate mining case* and the *Galle Face Green privatization case*, both which were resolved in the Supreme Court. EFL carries out scientific investigations of issues, provides technical support including scientific reports, expert evidence and periodically updates court on matters of environmental degradation.

EFL has carried out several projects with government and private organizations on the matters of conservation of habitats and endangered species, and mitigating pollution of water sources from industrial and home-based effluents and waste discharge. EFL publications include, Sri Lanka's only handbook on environment, '*Your Environmental Rights and Responsibilities: A Handbook for Sri Lanka*' and number of issue-based policy papers and briefing papers aimed at knowledge sharing and influencing policy. The activities of the organization are supported by a number of donors, who currently include Ford Foundation, WWF, IUCN, UNEP.

Convention on
Biological Diversity