Figure 8-15: Landscape Study Area

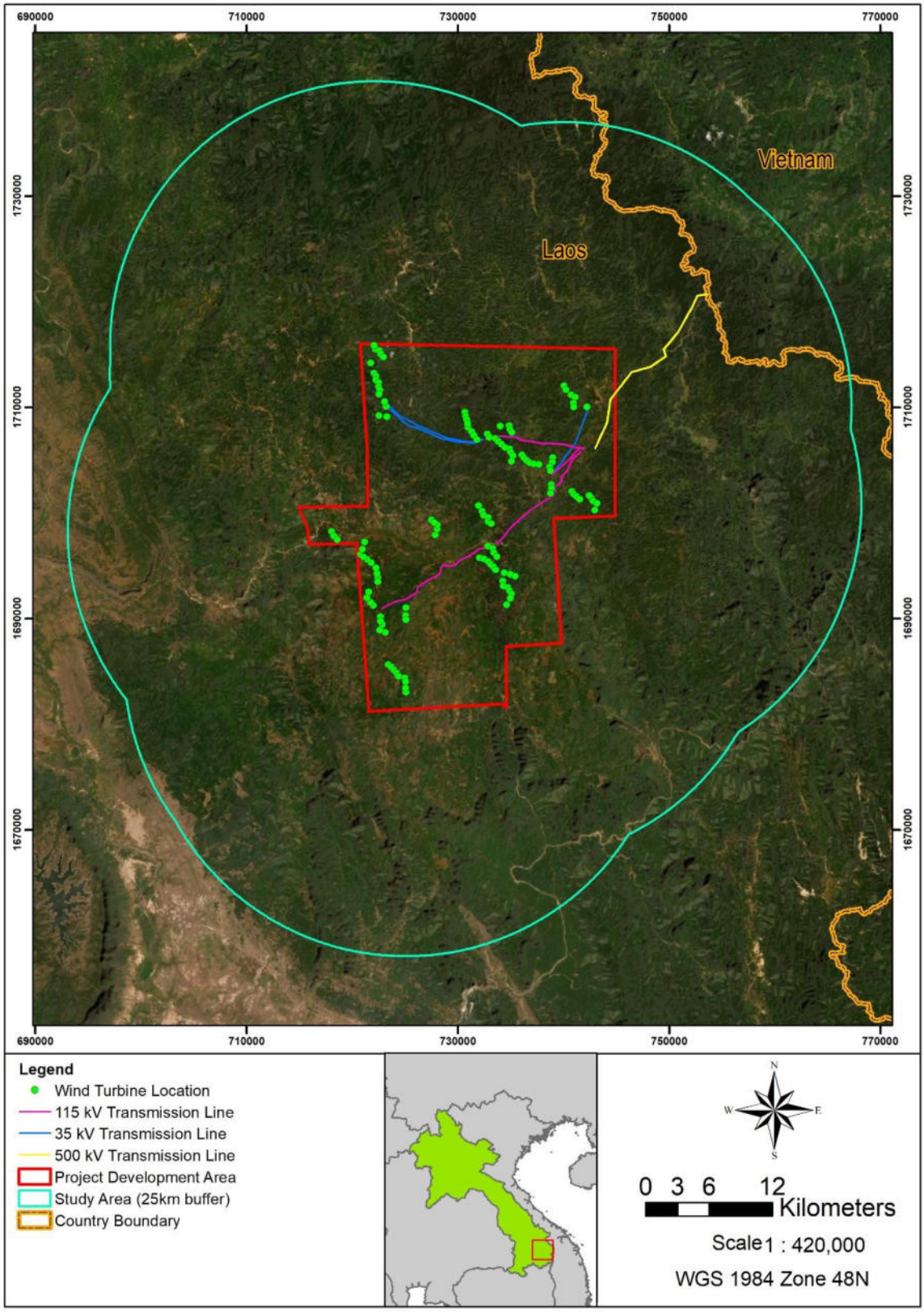
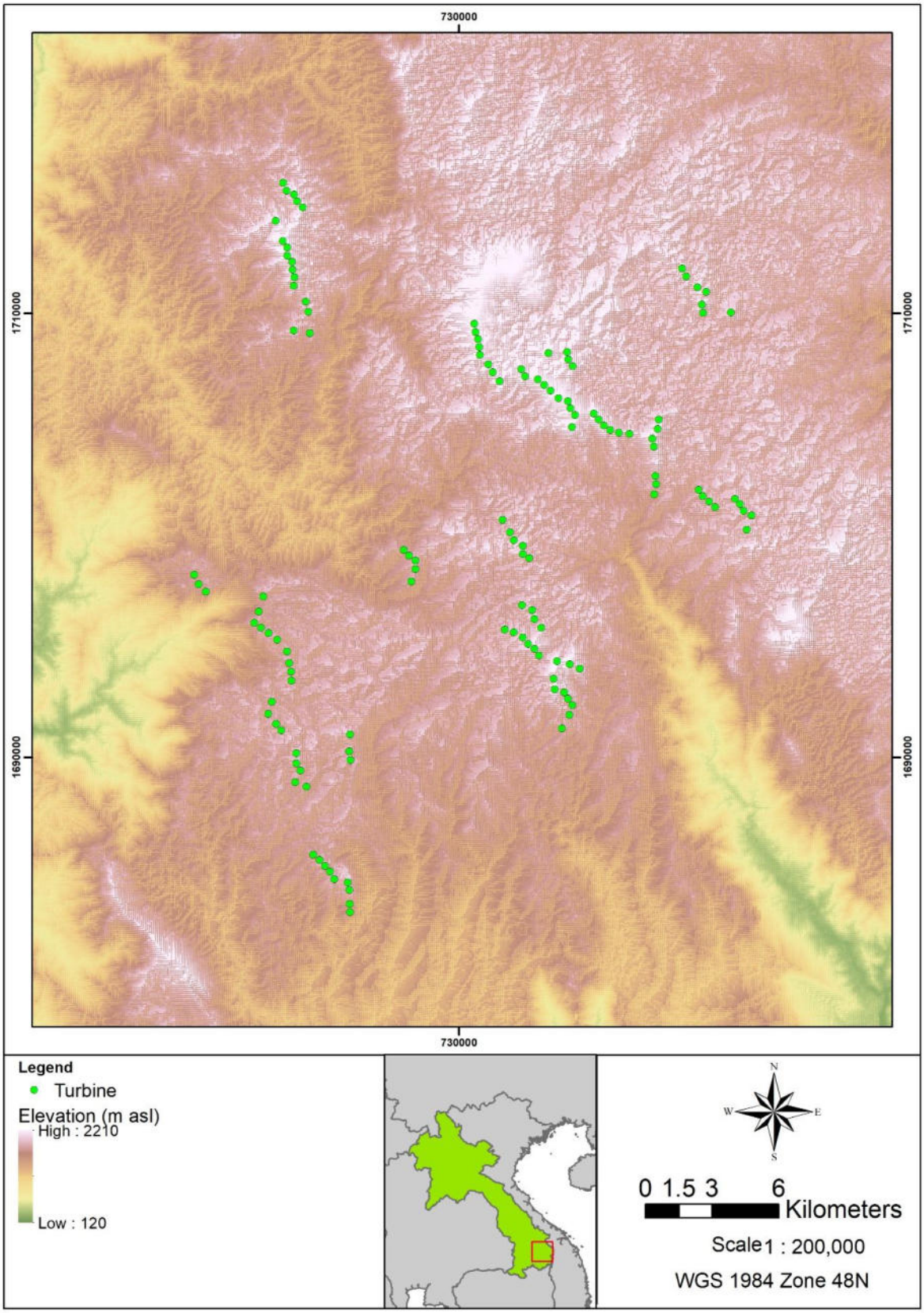


Figure 8-16: Topography of Project Area



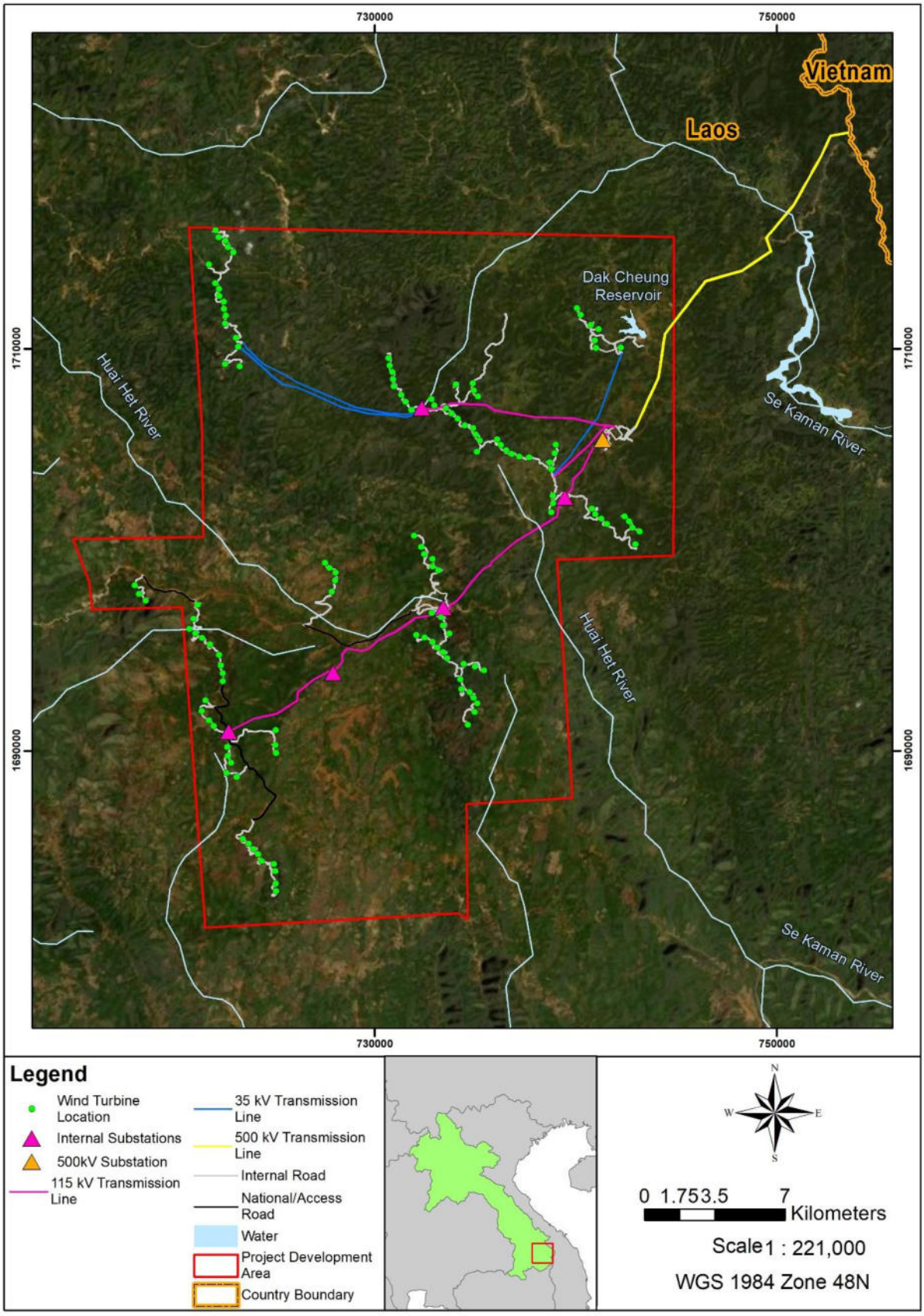
8.3.7.1.3 Hydrology of Area

The water streams in the project area are considered the main sources of water that the locals depend on for consumption. The areas in which there are important water sources include: Houay Nuan, Huoay Lo, Houay Bouat, Nouay Ang, Houay Hok, Houay Air, Huoay Preed, Houay Joon, Houay Nam Ngon, and Nouay Nheun. Surface water within the project area is shown in ***Figure 8-17***. The streams are located near the villages, which have made people use the water for agricultural production, domestic use, and livelihood. The streams in the project area and in Dakcheung District are small and have a high slope, making it unable to be used for navigation. As for the transmission line route of the project, the route passes through Xekaman River, as well as the streams. Since the pre-construction phase only consist of the survey, planning, and design of the transmission line, no hydrological impact will be caused to the water sources in the project area.

In terms of the potential impacts, the Project will have no impact on the water sources or on the hydrological flow of the water sources, as the operational process and activities of the project are not related to the water resources. The proposed project will be installed on the mountain range, making it not relate to and have no impact on the hydrologic flow of the water in the area. As for the transmission line route, if the tower is to be place along the stream or on the slope of the stream, the tower location must be above the highest level of past flood water to avoid obstruction of water flow and ensure stability.

Despite the wind farm not having any impact on the water sources in the area, the construction project components should proceed with caution, especially during the rainy season. Soil that is dug out and removed from the construction site should be used for earthfilling, rather than piled along the sides of the canal or in places which would obstruct the flow of water. On a rainy day, earthwork must not be active. For the transmission line, since it passes through the Xekaman River at one point and through the streams, the project must not build the transmission line tower on the river. There will be no hydrological impact to the water sources in the project area if the tower locations stretch the wires over the river/stream without obstructing it.

Figure 8-17: Surface Water within the Project Area



8.3.7.1.4 Landscape Characteristic Unit (LCU)

The World Wildlife Fund (WWF) has classified areas into "*key ecoregions*" (***Figure 8-18***). Ecoregions are defined as large unit of land or water containing a geographically distinct assemblage of species, natural communities and environmental conditions[37]. Each ecoregion is characterized by distinct landscape characteristics.

The Project is located within a single ecoregion *Southern Annamites montane rain forests*. This area extends along the greater Annamite Range from central Vietnam and southwards to the Bolovans Plateau of Laos and the Central Highlands of Vietnam. It covers a region of high biodiversity. The terrain ranges from wet lowland forest to evergreen hardwood and conifer montane rain forest. Strong climatic gradients of rainfall and temperature are present within the ecoregion. There is a short dry season centred on January–February, but fog and dew are common throughout the year and support a lush forest.

It consists of a highly variable forest structure. At 600-900 m evergreen trees are present, dominated by species of Fagaceae, Myrtaceae, and Lauraceae, and above 900 m elevation montane hardwood forest are present that change their composition according to moisture and geological substrate. A number of significant endemic species are present, including *Pinus dalatensis* and *Pinus krempfii*.

Given the general homogeneity of the area where the Project will be located, a single Landscape Characteristic Unit (LCU) is proposed (***Figure 8-18***).

Factors affecting the sensitivity of change for landscapes are:

- Importance and rarity of special landscape elements;
- Ability of the landscape to accommodate change;
- Significance of the change in the local and regional context; and
- Maturity of the landscape.

Figure 8-19 provides photos from the site showing some of the main features of the landscape.

[37] https://www.worldwildlife.org/biomes

Figure 8-18: Landscape Characteristic Unit (LCU)

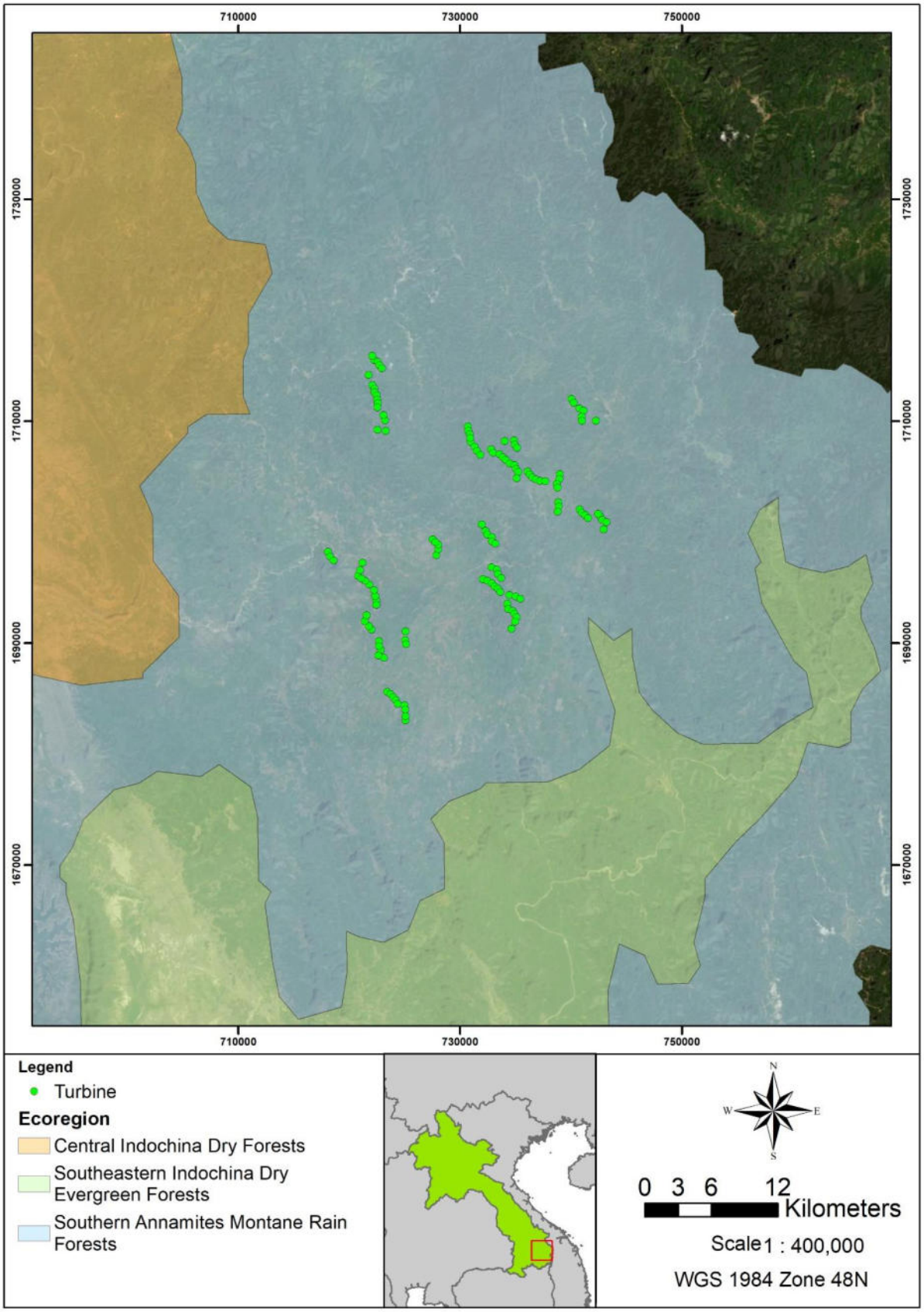


Figure 8-19: Photo of Nearby Landscape




8.3.7.1.5 Protected landscape

During the desktop baseline review, the following national and international protected areas have been considered:

- National parks, reserve forests and other locally protected areas;
- BirdLife International Important Bird Areas (IBA) and Endemic Bird Areas;
- International Union for Conservation of Nature (IUCN) Protected Areas;
- RAMSAR[38] Wetlands of International Importance;
- United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere (MAB) Reserves;
- World Heritage Sites; and
- World Commission on Protected Areas.

Based on the outcomes of the desktop review, the 25 km buffer of the Project Area intersects with two relevant protected areas, Dong Ampham (Laos) a National Protected Area, and Song Thanh (Vietnam) a nature reserve. These are shown in ***Figure 8-20***.

Dong Ampham

Dong Ampham National Biodiversity Conservation Area is a national protected area which covers the northeastern part of Attapeu Province and southeastern part of Sekong Province in the southeast corner of Laos on the border with Vietnam.[39] The Dong Ampham IBA is also located within Dong Ampham Protected Area. The area is located 15 km from the wind turbine boundary and 25 km from the transmission line of the Project.

It consists of around 200,000 ha covered by a heavily forested area and it forms one of the National Protected Areas of Laos. National PAs established since 1993 are afforded the highest level of protection and are the only managed, national-level areas devoted to conservation in Laos PDR, with Provincial and District PAs having no national legal framework and variable provincial legislative framework and there has been almost no assistance or development of provincial and district PAs [40].

[38] The Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat

[39] BirdLife International, http://datazone.birdlife.org/site/factsheet/dong-ampham-iba-laos

40 Lao PDR has a hierarchy of three types of protected areas classified, including (1) National Protected Areas (NPAs), (2) Provincial PAs and (3) District PAs. National PAs (legal establishment since 1993) are the only managed, national-level areas devoted to conservation and are founded based on 2 key principles (ICEM, 2003):

Protection needs to be provided to the full range of ecosystems and species communities occurring within the country; and

The total area under protective management needs to be adequate to prevent or minimise species extinctions.

Although National Parks are enabled in the NPA Regulations (2001), none have been nominated. There are no separate national parks, national wildlife sanctuaries, or similar areas (ICEM, 2003). National-level Conservation Forests (forest land set aside for the purposes of conservation of fauna, flora, nature, and various things of historical, cultural, touristic and environmental value and for scientific study and research) are included in the NPAs under the Forestry Law (1996).

There are a variety of Provincial and District Protected Areas. Some 276 areas have been designated as conservation or protection forests at provincial and district level. Provincial protected areas (including Provincial Conservation Forests) have no national legal framework and variable provincial

The area was established on 29 October 1993 and contains areas of lowland and tropical forests. Rivers flowing through the park include Xe Kaman River and Xe Xou River. The wetlands are home to populations of Siamese crocodiles and elephants, and large cats are known to inhabit the park.

Dong Ampham is also classified as an IUCN 'Category VI' National PA, a category of PA which include protection and sustainable use of natural resources as mutually beneficial actions as a *means* to achieve nature conservation,together and in synergy with other actions more common to the other categories (Dudley, 2008[41]).

Song Thanh

Song Thanh Nature Reserve is located in Southwest Quang Nam province with a total area of 76,964 ha and it was designated in October 2000. Song Thanh Nature Reserve is recognized as a Key Biodiversity Area (KBA) because of the importance of its mammal fauna, and is also a globally important conservation corridor. The area is located 11 km from the wind turbine boundary and right next to the transmission line of the Project.

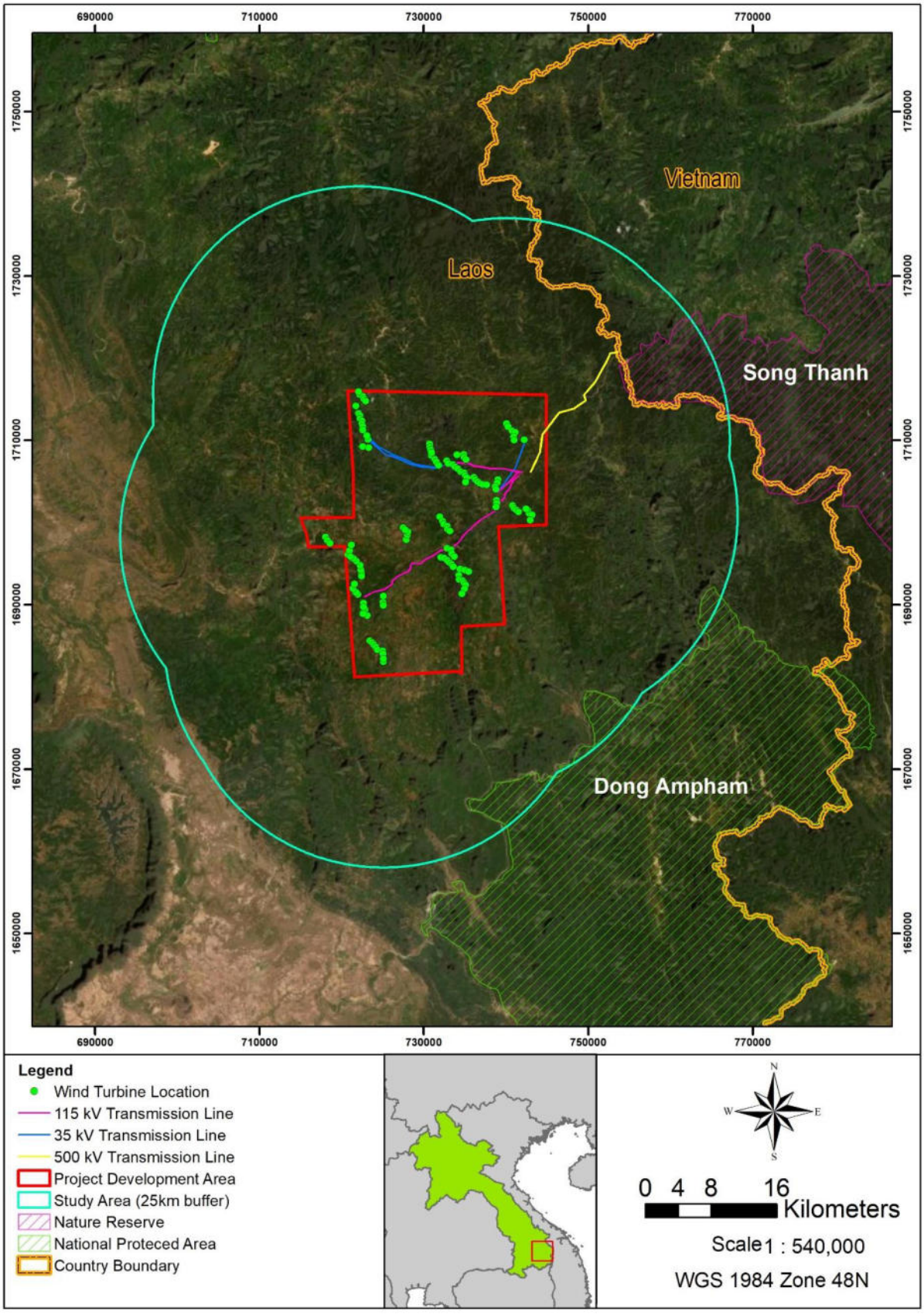
Key species recorded include three mammals endemic to this landscape; Owston's civet *Chrotogale owstoni*, the Annamite striped rabbit *Nesolagus timminsi*, and the large-antlered muntjac *Muntiacus vuquangensis*. The last one is listed as Critically Endangered (IUCN, 2018) and it is one of the highest priority species in the Annamites.

legislative framework and there has been almost no assistance or development of provincial and district PAs. As with their provincial counterparts, District Protected Areas have no national legal status and there appears to be no central compilation of their condition. The best known are more accurately described as community protected areas.

ICEM (International Centre for Environmental Management), 2003. *Lao PDR National Report on Protected Areas and Development.* Review of Protected Areas and Development in the Lower Mekong River Region, Indooroopilly, Queensland, Australia. 101 pp. Available online at: https://icem.com.au/documents/biodiversity/pad/lao_pdr_nr.pdf

41 Dudley, N. (Editor) (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN. x + 86pp. WITH Stolton, S., P. Shadie and N. Dudley (2013). IUCN WCPA Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types, Best Practice Protected Area Guidelines Series No. 21, Gland, Switzerland: IUCN. xxpp. Available online at: https://portals.iucn.org/library/sites/library/files/documents/pag-021.pdf

Figure 8-20: Protected Areas



8.3.7.2 Visual Baseline

Visual interferences may occur when new elements are introduced into a landscape or existing elements are altered or removed leading to a change in the way that stakeholders' perceive or experience landscape resources.

The proposed visual baseline has been developed according to the following tasks:

- Study area definition;
- View-shed analysis; and
- Viewpoint and sensitive receptor identification.

8.3.7.2.1 Study Area Definition and View-shed

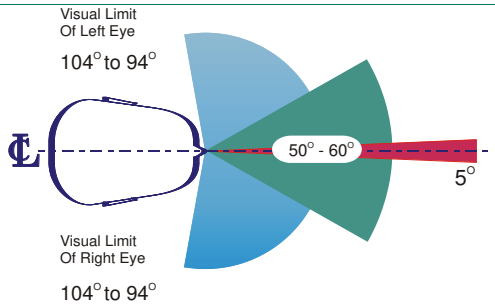
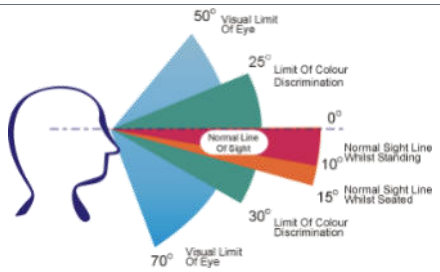
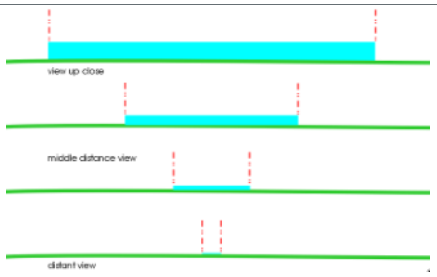
The visual study area is defined as the area within which the Project could be discernible by the human eye and could interfere with the main sensitivities identified in the local context.

To identify the study area, the Zone of Theoretical Visibility (ZTV) has been determined through computer analysis of topographical mapping to establish the theoretical distance from which the wind turbines could be visible in each direction.

The wind turbines are the major visual element of the proposed development and may visually impact the surrounding areas. As the viewer moves further away from these structures the visual impact decreases until it is no longer visible. However, before the point of non-visibility is reached, the wind turbines have reduced in scale such that they no longer have a significant visual impact.

Table 8-11 explains how a view-shed is defined and identified depending on the horizontal and vertical field of views.

Table 8-11: Field of View

Field of View	Diagram
A. Horizontal Field of View For most people, the horizontal central field of view covers an angle of between 50° to 60°. Within this angle, both eyes observe an object simultaneously but from a slightly different angle. This creates a central field of greater magnitude than that possible by each eye separately. This central horizontal field of view is termed the 'binocular field' (see green zone). Within this field images are sharp, depth perception occurs and color discrimination is possible. Research suggests that the visual impact of a project component will vary according to the proportion the binocular field it occupies. Project components that occupy 5%/2.5° or less of the horizontal central binocular field of vision are usually perceived as insignificant objects, whereas components that occupy 30° are considered to be visually dominating.	
B. Vertical Field of View The vertical central field of view has a similar set of parameters. The vertical binocular field is normally 25° above the vertical and 30° below the vertical. When project components exceed the 50° upper visual limit of the eye, they are considered to dominate the vertical central field of view. When project components occupy 0.5° they are not considered dominant, nor are they usually perceived as a significant change to the existing baseline condition when they are located within an anthropogenically modified landscape.	
C. Horizontal Versus Vertical Visibility Over Distance As a person moves further away from a project component, the visibility of the vertical dimension tends to reduce more significantly than the visibility of the horizontal dimension.	

The wind farm is comprised of a number of individual turbines of the same dimensions (110 m hub height and 171 m rotor diameter), with large separation distances between each individual turbine, about 300 m. When assessing the visual impact of the wind turbines, it is assumed that the largest horizontal component is the entire rotor, which would be a maximum of 171 m wide.

As shown in ***Table 8-12***, calculations suggest that the impact of a 171 m wide wind turbine rotor would reduce to be insignificant at about 3.8 km, as it would form less than 5% or 2.5° of the horizontal field of view (physical parameters are illustrated in ***Table 8-13***).

Table 8-12: Horizontal field of view

Horizontal Field of View	Impact	Distance from Observer to 171 m Turbine Rotor
<2.5° of view	The development will take up less than 5% of the central field of view. The development, unless particularly conspicuous against the background, will not intrude significantly into the view. The extent of the vertical angle will also affect the visual impact.	>3.9 km
2.5° – 30° of view	The development will usually have a moderate impact that may not be noticeable at the greatest distance of this range.	296 m to 3.9 km
>30° of view	Developments that fill more than 50% of the central field of vision will always be noticed and only sympathetic treatments will mitigate visual effects.	< 296 m

Source: taken from Guideline for landscape and visual impact assessment, Third Edition (GLVIA3), Landscape Institute and IEMA 2002 and Horner + Maclennan and Envision (2006) Visual representation of windfarms: good practice guidance, Inverness. Scottish Natural Heritage

A similar analysis can be undertaken based upon the vertical field of view for human vision. ***Table 8-13*** shows the relationship between impact and the proportion that the development occupies within the vertical line of sight.

Table 8-13: Vertical field of view

Vertical Line of Sight	Impact	Distance from Observer to a 195.5 m Turbine
< 0.5° of vertical angle	A thin line in the landscape.	>22 km
0.5° – 2.5° of vertical angle	The degree of visual intrusion will depend on the development's ability to blend in with the surroundings.	4.5 – 22 km
> 2.5° of vertical angle	Usually visible, however the degree of visual intrusion will depend on the width of the object and its placement within the landscape.	<4.5 km

Source: taken from Guideline for landscape and visual impact assessment, Third Edition (GLVIA3), Landscape Institute and IEMA 2002 and Horner + Maclennan and Envision (2006) Visual representation of windfarms: good practice guidance, Inverness. Scottish Natural Heritage

Based on the above, it is reasonable that distances greater than 22 km would result in an insignificant magnitude of visual impact from the wind turbines, as a fully visible wind turbine would be an insignificant element within the landscape.

Generally, the more conservative or worse-case distances form the basis for the assessment of visual impacts. Therefore, for this Project the greater impacts would be associated with the vertical field of view and so it is proposed to extend the view shed to 25 km for the wind farm.

Arc Map 10.8 was used to determine the ZTV for the Project. The current visibility within the ZTV will vary depending on the presence of intervening local topography and other features, such as vegetation and buildings. The present view shed analysis has been based solely on topography and did not take into account the potential screening granted by the local vegetation patches, which would further reduce the actual view shed. Moreover, it should be highlighted that a typical view shed assessment does not take typical meteorological conditions into account that can result in changes to real visibility. For example, rainfall and other atmospheric conditions (e.g., sand transported by the

wind) will alter the visibility of the Project. The diminution of visual clarity bought about by atmospheric conditions also increases with distance, and cloudy days can result in a natural attenuation of the visibility of the Project.

Three different view shed analyses were undertaken at different heights to provide a better understanding of the degree of visibility. These mapping outputs illustrate the number of wind turbines potentially visible from within the Study Area for the different turbine visibility elements.

Figure 8-21 and ***Table 8-14*** show the range of visibility options that have been mapped for turbines in the following GIS based analysis and ***Figure 8-22, Figure 8-23***, and ***Figure 8-24*** show the ZTV mapping.

Table 8-14: Mapping Turbine Visibility Elements

Zone	Extent That Wind Turbines Are Visible
Zone A	One or more wind turbines in their entirety
Zone B	The entire path of the blades of one or more wind turbines
Zone C	At least half of the path of one or more wind turbines
Zone D	Any part of the wind turbine blades of one or more wind turbines

Figure 8-21: Turbine Visibility Elements

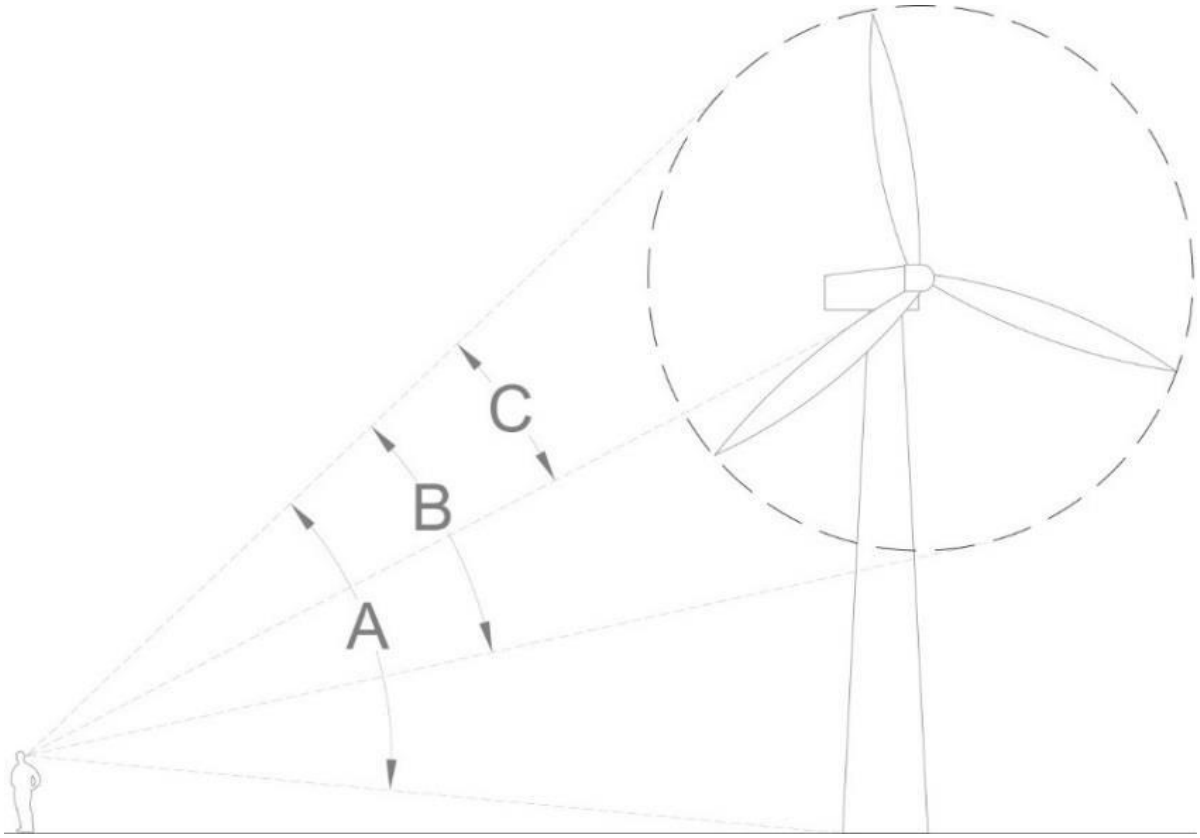


Figure 8-22: View shed Zone A: One or more wind turbines in their entirety

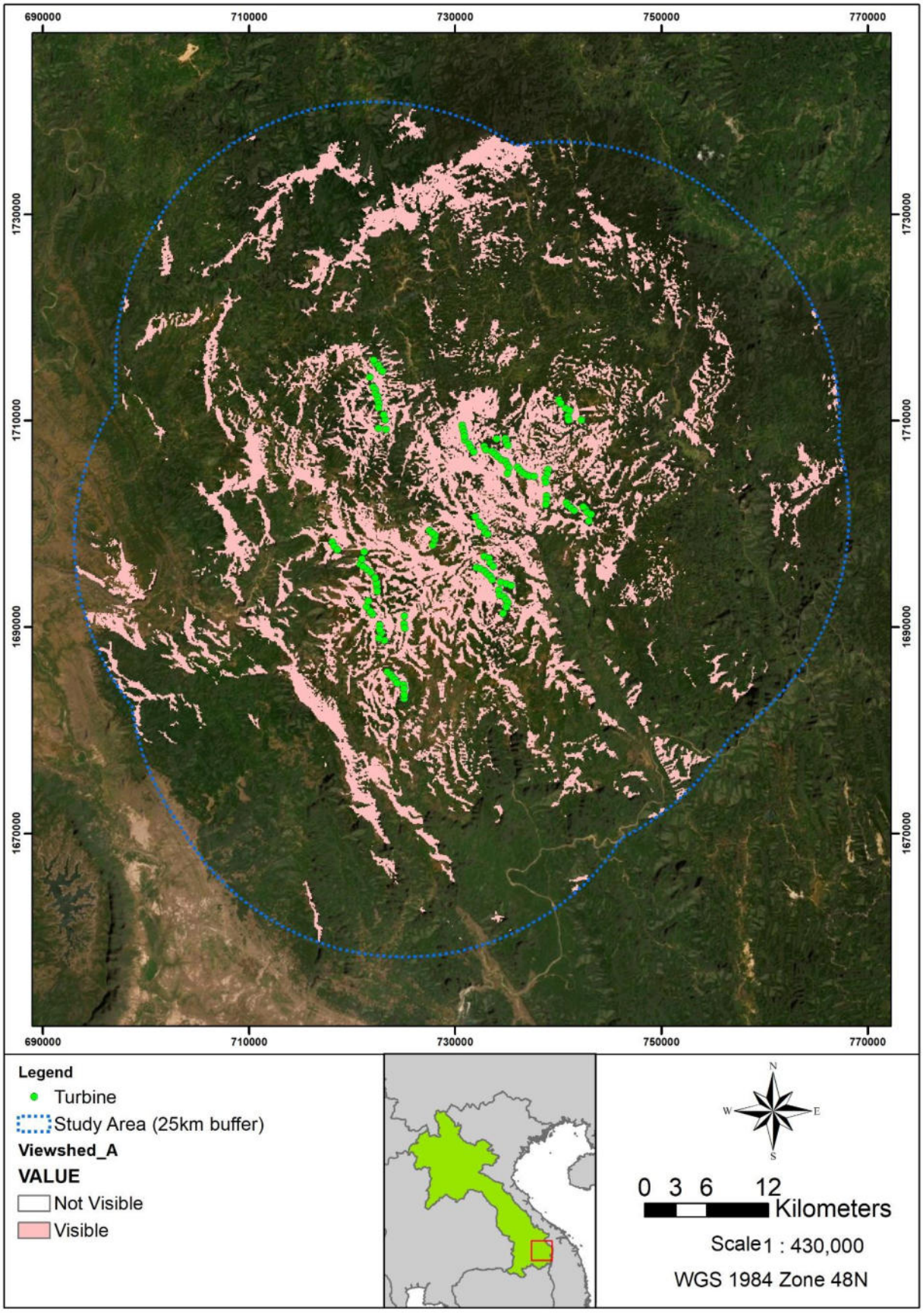


Figure 8-23: View shed Zone B: The entire path of the blades for one or more wind turbines

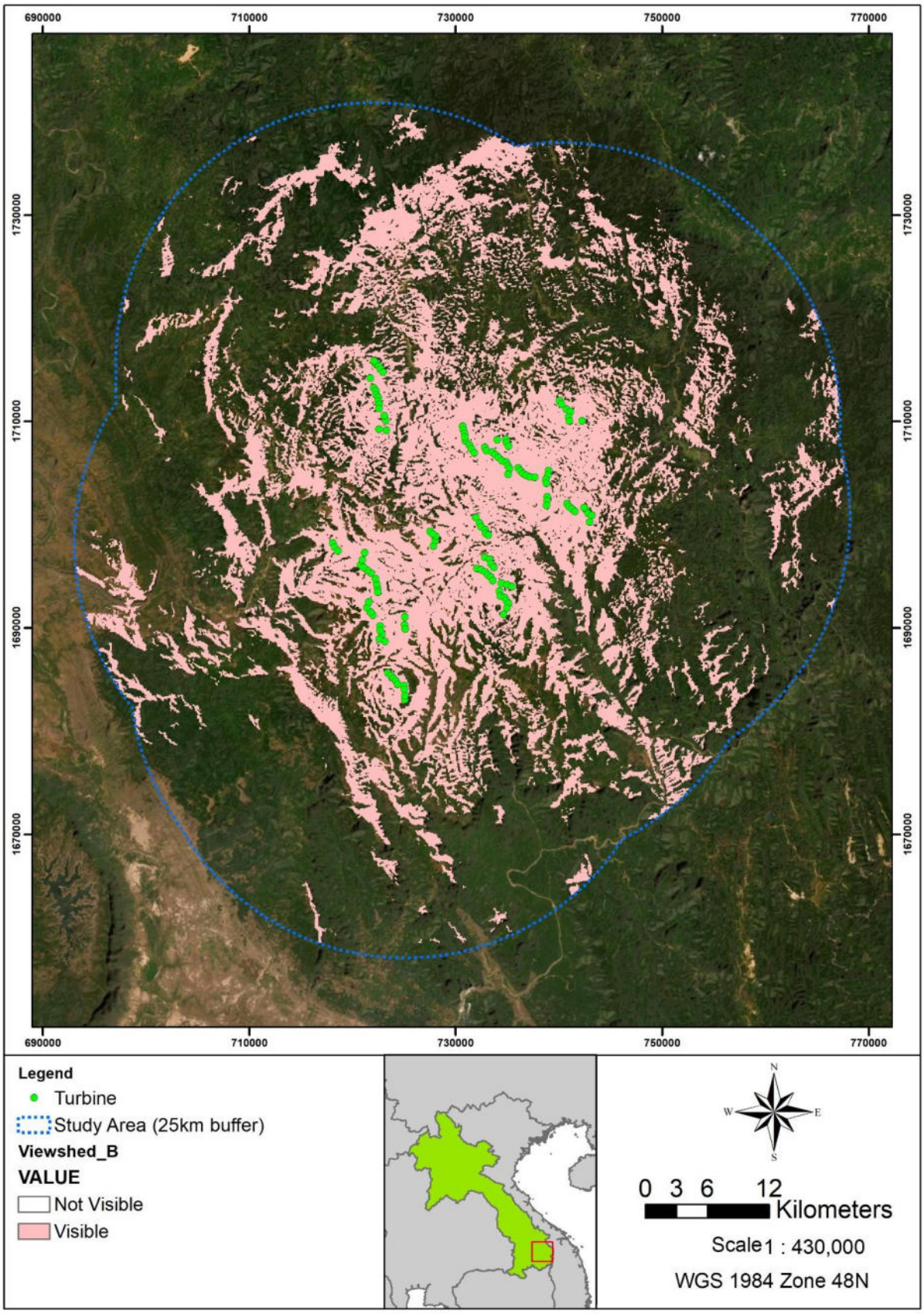
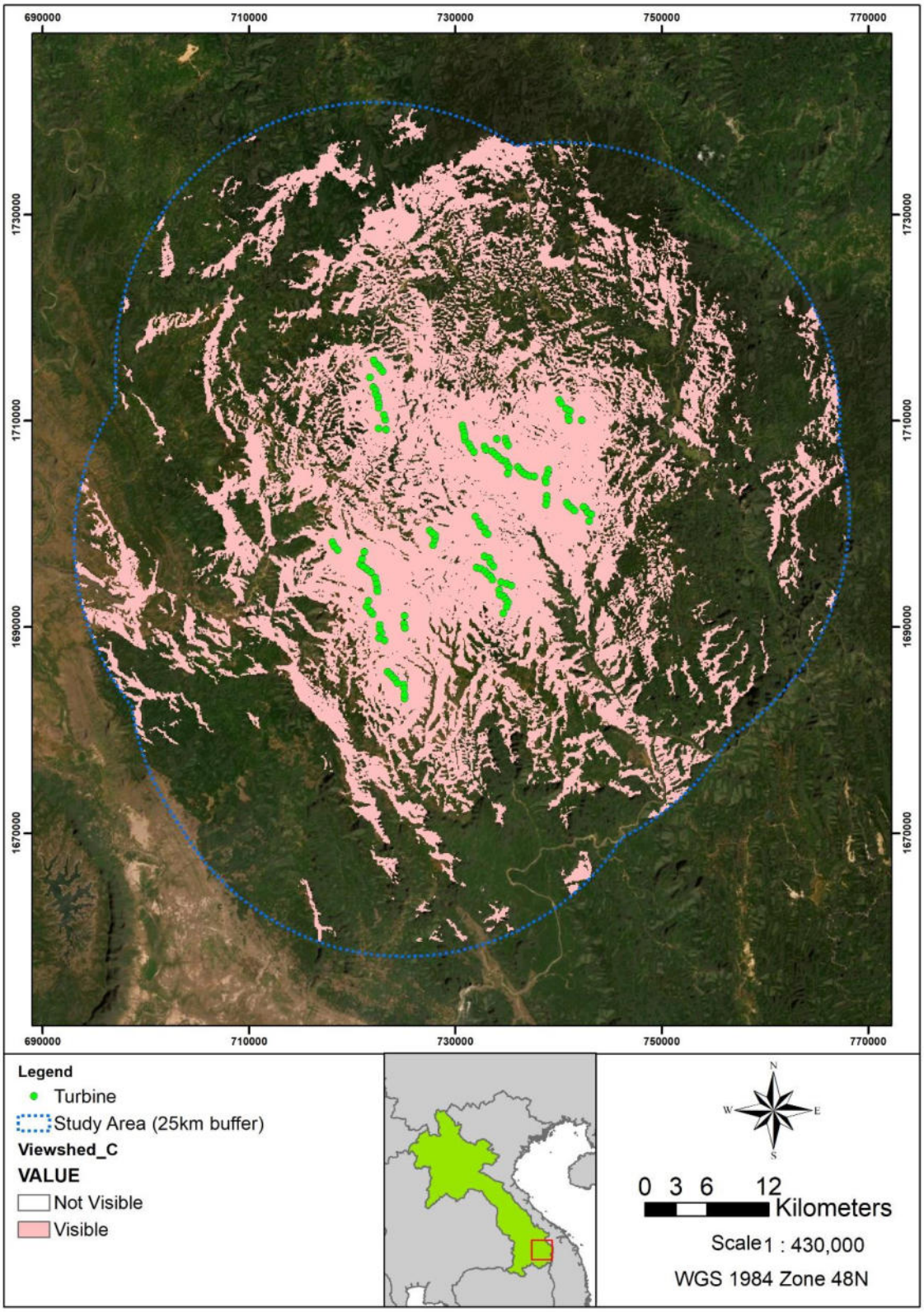


Figure 8-24: View shed Zone C: At least half of the path of one or more wind turbines



The results of the view shed assessment show that the visibility is strongly influenced by the morphology of the area. The roughness of the terrain makes the chance to see the wind turbines highly variable, both in their entirety and partially.

It should be emphasized that intervening vegetation is not included in this mapping and is likely to significantly reduce the visibility of wind turbines, in whole or in part, and therefore reduce the impact identified.

Regarding the potential visibility from local communities, wind turbines, either in whole or in part, will be visible from main residential areas, such as Ban Daktrab and Dakchueng. In addition, several settlements spread over the communes inside the Study Area, may be able to see the turbines.

8.3.7.3 Viewpoints Identification

In order to assess the visual baseline, 19 viewpoints have been identified within the Study Area, in order to be exhaustive of different landscape components. These viewpoints are referred to as Visual Sensitive Receptors (VSRs). They represent points within the view shed from where people will be able (or not) to see the Project, and where the quality of the landscape and visual resources of people could be affected by the presence of the Project.

It should be noted that, in order to screen the potential sensitive receptors, the following criteria have been used to assess the sensitivity of the VSRs:

- Value and quality of existing views;
- Type and estimated number of receiver population;
- Duration of frequency of view; and
- Degree of visibility.

Table 8-15 and ***Figure 8-25*** show the locations of the VSRs as representative of the general landscape character of the area, from locations within the Study Area varying in distance and elevation.

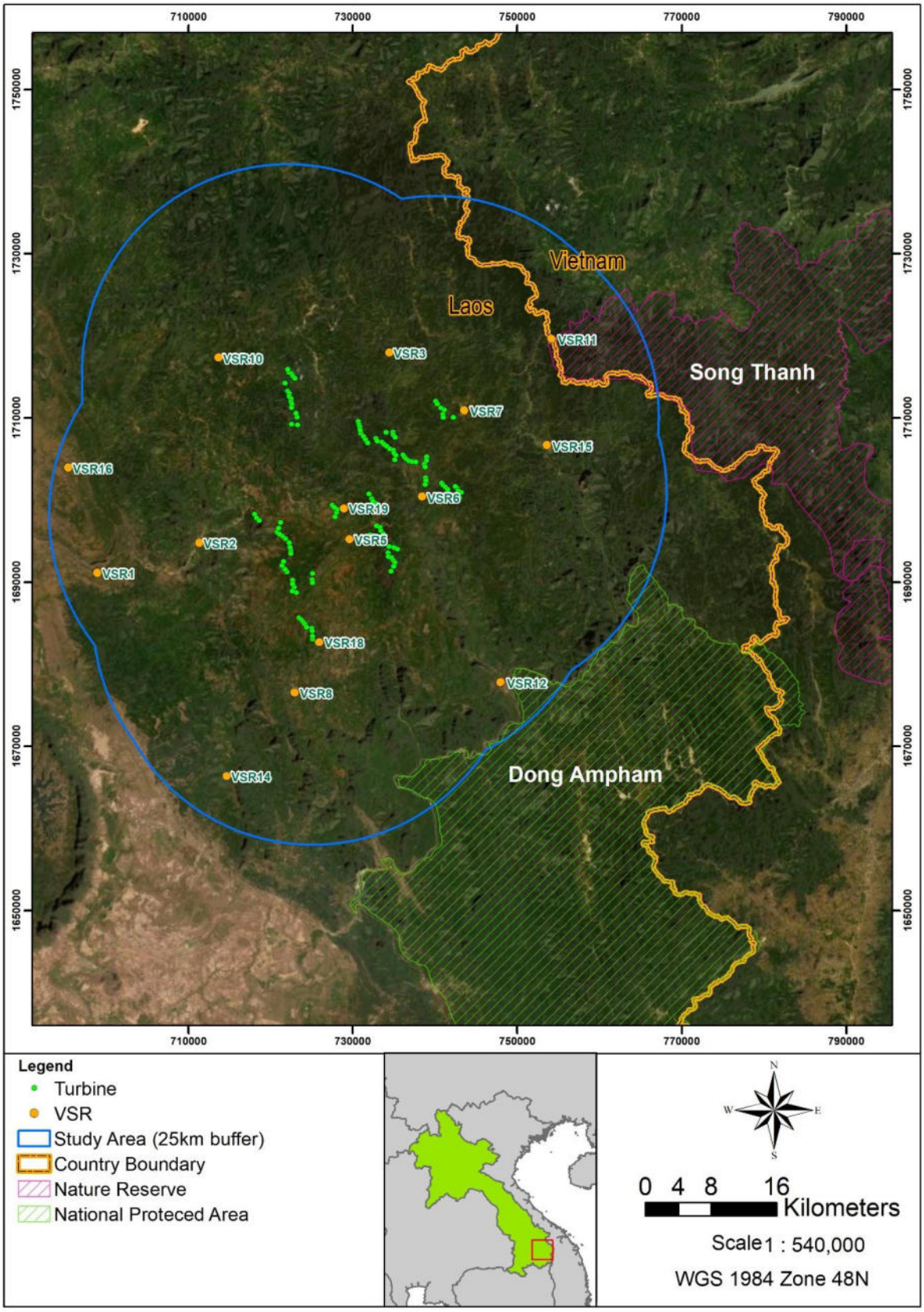
Table 8-15 provides the coordinates of the points and their distance from the closest turbine. The coordinates are expressed in WGS 1984/UTM Zone 48N (EPSG: 32648).

Table 8-15: Location of the proposed VSRs

VSR ID	X (East)	Y (South)	Type of Receptor
VSR01	698,867	1,691,144	Near village, along the road
VSR02	711,489	1,709,838	Near village
VSR03	710,714	1,694,729	Near village, along the road
VSR04	740,409	1,734,426	Near village
VSR05	706,005	1,720,205	Near village
VSR06	734,096	1,718,292	Near village
VSR07	723,632	1,726,066	Near village
VSR08	707,168	1,730,290	Near village
VSR09	718,416	1,704,511	Near village
VSR10	713,683	1,717,358	Near village – not accessible during the survey
VSR11	729,600	1,695,145	Near info centers and protected area, along the road and the national boundary
VSR12	729,412	1,705,295	Closed to protected area and lake
VSR13	738,352	1,700,353	Near village, along the road

VSR ID	X (East)	Y (South)	Type of Receptor
VSR14	714,606	1,666,434	Near village – not accessible during the survey
VSR15	727,631	1,734,549	Near village, close to the dam
VSR16	695,587	1,704,560	Mountain
VSR17	718,596	1,698,390	A school near the village
VSR18	725,898	1,682,732	Near village
VSR19	728,863	1,699,044	Near village

Figure 8-25: Location of the proposed VSRs



8.3.8 Natural Hazards

Based on the local ESIA (Sept 2020), natural disasters that are the most dangerous challenges to the Project development are floods, earthquakes, and landslides. The secondary data of natural disasters are summarized in the following points:

8.3.8.1 Floods

The topographic conditions of the Project area and nearby area is composed mostly of hills and high mountains, and there are no large rivers that will cause flooding in this area. And according to global flood data there is no historical flood event is recorded for the Project area.[42] [43]

In 2019 during August and September, Meteorology Station of Dak Cheung District recorded the maximum rainfall during the historical five (5) years (Table 8-2). In 2020 after two consecutive tropical storms lashed the region earlier September, Kaluem District (Jing, Songkhone, and Loy Villages) and Dakchung District (Darkdin Village) in Sekong province experienced the flooding of around 3,000 people were affected, and two people had lost their lives[44]. Increased flooding is currently being observed in the lower catchments and along the Mekong River.[45]

8.3.8.2 Earthquakes

Lao PDR is located in the central part of the Indochina Peninsular between latitude: 13°54'- 22°30' N and longitude: 100°05' - 107°59' E, which is not located on an area of the tectonic plate boundaries. Consequently, it has low record of earthquake occurrences.

According to data from the Meteorological and Earthquake Network Division, Department of Meteorology and Hydrology, Ministry of Natural Resources and Environment (as summarised in the EIA, 2020), earthquake events have occurred in Lao PDR is in 2007 in Xayaboury Province. The latest earthquake occurrence was in 2019 in the area of Hongsa District of Xayaboury Province. For Sekong Province, Attapeu Province, and the proposed Project area, there is no record of an earthquake occurrence since ever record in the history.[46] However, the design of the turbines considers standards relevant for earthquakes.

There is no record of earthquake occurrence in the Project site or in Sekong and Attapeu provinces. However, the Project will be designed in accordance with standards so that the Project is capable of withstanding an earthquake.

8.3.8.3 Landslides

Rainfall is the main cause of landslides (soil erosion). Other factors include the slope of the soil, rock conditions and improper land useactivities, dam construction, pumping of sand and gravel for using in construction work. Based on the local EIA (EIA, 2022), it is observed that they are mainly caused by the land use activities of the people, particularly agricultural activities that require regular soil digging, turning, harrowing that cause the erosion of soil into the water sources, especially during the rainy season.

According to the soil survey result and classification of agricultural and forest areas in Dak Cheung District, Sekong Province (2020), the soil in Dakcheung District is divided into six soil groups (ARENOSOLS, ACRISOLS, ALISOLS, REGOSOLS, LUVISOLS and CAMBISOLS), and is classified into 9 types of soil based on the original rocks, condition of the location, identified layer and identified characteristics of the soil. The soil area are primarily composed of heavy clay, clay loam and loamy

[42] Global Flood Map, Laos Flood Map | Map of Potential Flooding in Laos (globalfloodmap.org)
[43] Reliefweb, UNOSAT Training activities (reliefweb.int)
[44] Reliefweb MDRLA007dfr.pdf (reliefweb.int)
[45] UNDP, Project Document - Deliverable Description (undp.org)
[46] United States Geological Survey (USGS), https://earthquake.usgs.gov/

sand. The soil in Sanxay District is divided into six soil groups (ACRISOLS, ALISOLS, ARENOSOLS, CAMBISOLS, FLUVISOLS, LEPTOSOLS, LUVISOLS and REGOSOLS), and is classified into 13 types of soil based on the original rocks, condition of the location, identified layer and identified characteristics of the soil. The soil areas are primarily composed of clay loam, hard clay and loamy sand. Attapeu and Sekong District are identified as highly susceptible to landslides according to UNDP Support National Hazard Profile in 2020. The climate impacts on rural roads are mainly related to flooding and landslides given some of the road in both Provinces are unpaved. Increasing incidence of landslides is being observed in the upper catchments of the Sedon and Sekong rivers,.[47] The Project is at least 30 km distance to Sekong River. Landslide susceptibility within study area is reported to vary between Medium to Very High. This indicates that the project area is susceptible to landslides owing to factors such as land cover, soil type, and slope. Moreover, the landslide hazard map indicate the hazard due to landslides triggered by precipitation to vary between Low-High within Study area.

8.3.8.4 Cyclones

Cyclones (also known as hurricanes or typhoons) occur frequently in Laos PDR, being classified as a high hazard level natural disaster according to Think Hazard and information that is presently available. On average, it occurs approximately eight (8) times a year, with Xiangkhoang, Attapeu, and Salavan being the hardest hit regions. The cyclone season usually begins in April and ends in November, with the most severe cyclones usually occurring in August and September. As of recent, the most severe cyclone that Laos has experienced in the past year reached a wind speed of up to 41 km/h on September 24, 2021 and measured 37 kilometers in diameter. [48]

8.3.8.5 Lightning

One of the most common features of every rainy season in Laos is lightning and thunder. Although not as prevalent as the other natural hazards in Laos, lightning is a common event during thunderstorms. Most lightning events do not affect the people, animals, or possessions, directly, but when it does, people, animals, or possessions are affected, causing some socioeconomic losses. One main concern is that many houses or buildings in Laos are not equipped with lightning protection, and with the rising trajectory of oceanic temperatures due to climate change, storm intensity and frequency is likely to increase. [49]

[47] UNDP, Project Document - Deliverable Description (undp.org)

[48] WorldData. Typhoons in Laos - https://www.worlddata.info/asia/laos/typhoons.php

[49] The Laotian Times. Fierce Lightning, International Coverage Ignites Concern in Capital - https://laotiantimes.com/2016/09/05/fierce-lightning-international-coverage-ignites-concern-in-capital/

8.4 Biological Environment Baseline

8.4.1 Introduction

This section provides an overview of the baseline conditions in the biodiversity baseline study area, i.e. the EAAAs as depicted on the map that appears in ***Figure 8-1***. Included is a description of the identified legally protected areas and areas with recognized high biodiversity values (***Section 8.4.2***), habitats and species that occur in this area, and the important biodiversity values associated with the Project area. Information was compiled and evaluated from desktop studies, field surveys, and consultation with key experts and other stakeholders, to support a comprehensive understanding of the biodiversity values that are present in the EAAAs.

Desktop studies considered global biodiversity datasets, as well as published and publicly available information. Key information sources included:

- The Integrated Biodiversity Assessment Tool (IBAT), which draws from:
  - The IUCN (International Union for Conservation of Nature) Red List of Threatened Species;
  - Key Biodiversity Area (KBA) database; and
  - The World Database on Protected Areas which encompass nationally and internationally recognised sites, including IUCN management categories I-VI, Ramsar Wetlands of International Importance (Ramsar site), and the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage sites.
- The IUCN Red List of Ecosystems.

Field data were collected to further inform the understanding of the important biodiversity values within the study area, and the findings are described in detail in ***Appendix S***. This included:

- A Rapid Ecological Assessment ("REA") (conducted between December 2020 and January 2021) to: (i) help ground truth the aerial habitat mapping, by identifying the main types of habitat and dominant vegetation at pre-selected survey points in each of the main turbine areas and transmission line; and (ii) provide an overview of the actual and likely species present, which in turn helps inform priority survey areas for the main wet and dry season follow up surveys;
- Monthly bird field survey campaigns across 12 months and covering all relevant seasons (December 2020 – November 2021);
- Five bat field survey campaigns, of which three campaigns were undertaken in the dry season (February and March 2021), and two campaigns were undertaken in the wet season (June and July 2021); and
- Two mammal, herpetofauna (reptiles and amphibians) and plant field survey campaigns in the wet season (July – August 2021), and dry season (November - December 2021) were undertaken based on the results of the REA [findings contained in the unpublished Biodiversity Assessment Report compiled by Phiapalath *et al.* (2022[50]).

To meet ADB SPS requirements, a Critical Habitat Assessment (CHA) was undertaken to identify the presence and extent of the important biodiversity values (i.e. natural habitat-associated values, critical habitat-qualifying values and other values of conservation and/or stakeholder concern) in the EAAA that could result in the categorization of the Project area as critical habitat. A summary of the approach and findings of the CHA is provided in ***Section 8.4.5,*** with the full details of the CHA presented in ***Appendix GT.***

[50] Phiapalath, P., Khotpathoom, T. and Souladeth, P. (2022). Biodiversity Assessment of Monsoon Windfarm Power Project. Unpublished report compiled for Environmental Resources Management (ERM), Thailand. Final draft report, January 2022.

8.4.2 Legally Protected Areas and Areas with Recognized High Biodiversity Values

Legally Protected Areas ("PAs") include areas that are legally designated or officially proposed for biodiversity protection and conservation.

For this ESIA, areas with recognized high biodiversity values include KBAs, AZEs, UNESCO World Heritage sites, Ramsar sites. These areas are defined as follows:

- **KBA**[51] - Key Biodiversity Areas are sites that contribute significantly to the global persistence of biodiversity and being applicable to terrestrial, freshwater, and marine ecosystems. Sites qualify as global KBAs if they meet one or more of eleven criteria, grouped into the following five categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability. KBAs typically include:
  - Important Bird and Biodiversity Areas ("IBA") identified by the BirdLife International Partnership;
  - Alliance for Zero Extinction sites ("AZE") containing 95% or more of the remaining population of one or more species listed as Endangered (EN) or Critically Endangered (CR) on the IUCN Red List;
  - KBAs identified through hotspot ecosystem profiles supported by the Critical Ecosystem Partnership Fund; and
  - A small number of other KBAs such as Important Plant Areas ("IPA"), and KBAs covering multiple taxonomic groups in freshwater, marine, and terrestrial systems.
- **UNESCO World Heritage site** – a site selected by UNESCO as having cultural, historic, scientific or other forms of significance. These areas are legally protected by international treaties and demarcated by UNESCO as protected zones.
- **Ramsar site** – wetlands of 'international importance' identified under the International Convention of Wetlands, called the Ramsar Convention, which is an intergovernmental treaty that provides the framework for the conservation and use of wetlands and their resources.

Three legally protected areas[52], and six areas with recognised high biodiversity values overlap with, or are located within the EAAAs for volant and non-volant species, defined for the Project.

These are summarised in ***Table 8-16***, and shown on the map in ***Figure 8-26***.

[51] IUCN Species Survival Commission and IUCN. A Global Standard for the Identification of Key Biodiversity Areas - https://portals.iucn.org/union/sites/union/files/doc/a_global_standard_for_the_identification_of_key_biodiversity_areas_final_web.pdf

[52] Phou Ahyon is a proposed protected area.

Table 8-16: Legally Protected Areas and Areas with Recognized High Biodiversity Values identified in the EAAAs

Name	Designation[1]	Overlap with the EAAAs	Overlap with Project footprint?	Details[2]
Dak Cheung Plateau	KBA, IBA	Yes	Yes	**Coordinates**: 15.356353, 107.135328 **IUCN Category**: - **Area Coverage**: 51 km^2 **Species of conservation importance**: ■ Black-crowned Barwing (*Actinodura sodangorum*), NT (Near Threatened) ■ Asian Elephant (*Elephas maximus*), EN (Endangered) ■ Pygmy Slow Loris (*Nycticebus pygmaeus*), EN ■ Tiger (*Panthera tigris*), EN ■ Impressed Tortoise (*Manouria impressa*), EN
Ngoc Linh	KBA, IBA, AZE, PA	Yes	No	**Coordinates**: 15.324767, 107.725319 **IUCN Category**: IV **Area Coverage**: 297 km^2 **Species of conservation importance:** ■ Brachytarsophrys intermedia, VU ■ Thorny Tree Frog (Gracixalus lumarius), EN ■ Appleby' Leaf-litter Toad (Leptobrachella applebyi), EN ■ Leptobrachium banae, LC ■ Chinese Edible Frog (Quasipaa spinosa), VU ■ Rhacophorus annamensis, LC ■ Misty Moss Frog (Theloderma nebulosum), EN ■ Black-crowned Barwing (Actinodura sodangorum), NT (Near Threatened) ■ Golden-winged Laughingthrush (Trochalopteron ngoclinhense), EN ■ Dhole (Cuon alpinus), EN ■ Stump-tailed Macaque (Macaca arctoides), VU ■ Northern Pig-tailed Macaque (Macaca leonina), VU ■ Red-cheeked Gibbon (Nomascus gabriellae), EN ■ Tiger (Panthera tigris), EN ■ Red-shanked Douc Langur (Pygathrix nemaeus), CR

Name	Designation[1]	Overlap with the EAAAs	Overlap with Project footprint?	Details[2]
				■ Poilane's Catkin Yew (Amentotaxus poilanei), VU ■ Eagle Wood (Aquilaria crassna), CR ■ Mann's Plum Yew (Cephalotaxus mannii), VU ■ Cinnamomum balansae, EN ■ Dipterocarpus baudii, VU ■ Knema saxatilis, VU ■ Knema sessiflora, VU ■ Madhuca pasquieri, VU ■ Schefflera kontumensis, EN
Phou Kathong	KBA, PA	Yes	No	**Coordinates**: 15.059711, 106.994783 **IUCN Category**: - **Area Coverage:** 1,080 km^2 **Species of conservation importance:** ■ Asian Elephant (*Elephas maximus*), EN
Phou Ahyon	KBA, IBA, AZE,PA[53]	Yes	Yes	**Coordinates**: 15.761714, 107.131703 **IUCN Category**: - **Area Coverage**: 339 km^2 **Species of conservation importance**: ■ Leptobrachium xanthops, EN ■ Vietnamese Cutia (Cutia legalleni), NT ■ Indochinese Fulvetta (Fulvetta danisi), LC (Least Concern) ■ Black-hooded Laughingthrush (Garrulax milleti), LC ■ Necklaced Barbet, (Psilopogon auricularis), LC ■ Yellow-billed Nuthatch (Sitta solangiae), NT ■ Stump-tailed Macaque (Macaca arctoides), VU ■ Red-shanked Douc Langur (Pygathrix nemaeus), CR

[53] Phou Ahyon is a proposed protected area.

Name	Designation[1]	Overlap with the EAAAs	Overlap with Project footprint?	Details[2]
Song Thanh	KBA	Yes	No	**Coordinates:** 15.473311, 107.650292 **IUCN Category**: Not Reported **Area Coverage**: 890 km^2 **Species of conservation importance**: ■ Stump-tailed Macaque (*Macaca arctoides*), VU ■ Northern Pig-tailed Macaque (*Macaca leonina*), VU ■ Red-cheeked Gibbon (*Nomascus gabriellae*), EN ■ Pygmy Slow Loris (Nycticebus pygmaeus), VU ■ Tiger (*Panthera tigris*), EN ■ Red-shanked Douc Langur (*Pygathrix nemaeus*), CR ■ Eagle Wood (*Aquilaria crassna*), CR ■ *Dalbergia balansae*, VU ■ *Dipterocarpus grandiflorus*, EN ■ *Dipterocarpus retusus*, EN ■ *Dipterocarpus turbinatus*, VU ■ *Hopea hainanensis*, EN ■ *Hopea odorata*, VU ■ *Hopea siamensis*, EN ■ *Hydnocarpus annamensis*, VU ■ *Knema pierrei*, VU ■ *Knema saxatilis*, VU ■ *Madhuca pasquieri*, VU ■ White Seraya (*Parashorea stellata*), VU ■ Indochinese Box Turtle (*Cuora galbinifrons*), CR
Upper Xe Kaman	KBA, IBA	Yes	No	**Coordinates**: 15.083333, 107.283333 **IUCN Category**: - **Area Coverage**: 297 km^2 **Species of conservation importance**: ■ Masked Finfoot (*Heliopais personatus*), EN

Key to table:

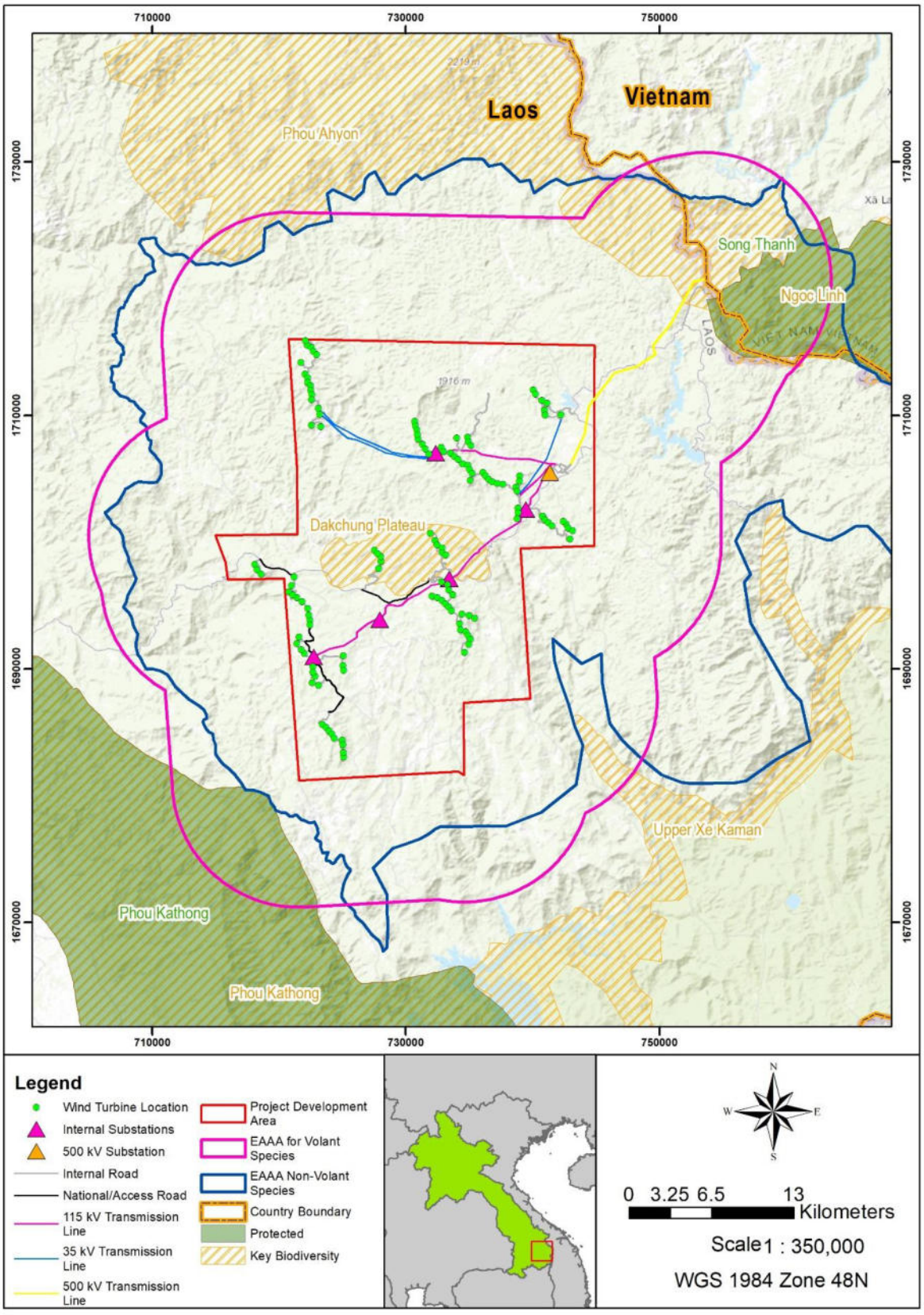
Name	Designation[1]	Overlap with the EAAAs	Overlap with Project footprint?	Details[2]

[1] KBA = Key Biodiversity Area, IBA = Important Bird Area, AZE = Alliance for Zero Extinction site, PA = Legally Protected Area

[2] CR = Critically Endangered, EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern

Source of information: IBAT (2020)

Figure 8-26: Legally Protected Areas, and Areas with Recognized High Biodiversity Values within and overlapping the EAAAs



8.4.3 Land Cover and Land Use

Several land cover and distinct land use types occur in the study area, including evergreen montane forest, wet evergreen forest, a mosaic of shifting cultivation, shrub land and grassland, waterbodies, and modified built-up areas.

Due to the high elevations and steep topography that characterises the ecoregion, the human population density is considered moderate, however anthropogenic impacts are pervasive in the form of regular burning to create open woodlands and shifting cultivation on the upper slopes. Wildlife poaching and excessive harvesting of forest products are also particularly threatening to the biodiversity of the region and according to the WWF, more than 75% of the ecoregion's natural habitat has been converted or degraded (WWF, 2021a).

A combination of remote sensing and field investigations (refer to the REA presented in ***Appendix S***) were used to identify the distribution of land cover types within the EAAAs. The full approach to identify and map land cover classes within the EAAAs is described in ***Section 2.5*** of ***Appendix T***.

The land cover and land use classes present in the EAAAs are further described in ***Table 8-17***, and their extent and distribution is shown spatially on the map in ***Figure 8-27***.

Table 8-17: Land Class Descriptions and Areas

Land Cover / Land Use Type	Description	EAAA Land Cover	Project Footprint Land Cover (ha)
Montane Forest	Montane (evergreen) Forest represents the dominant land cover and evergreen forest type in the EAAAs. This forest type occurs in mountainous areas, at elevations of more than 1,000 m amsl (above mean sea level), receiving higher rainfall. These forests vary in structure and composition depending on geological substrate and moisture availability, best represented by species of Fagaceae and typically having tall forest canopies reaching up to about 30m height, with epiphytes and orchids forming a notable part of the biodiversity. The majority of the EAAAs are heavily degraded and fragmented due to access, farming and harvesting activities by local communities, with patches of better condition montane forest found in the north-eastern section of the EAAA, close to the Lao-Vietnam border and forming part of the Southern Annamite Mountain range n forest, and in the northern central and western sections of the Project area.	Approximately 30.4% of the EAAA for Non-Volant Species (81,262.1 ha) is comprised of this habitat type. Approximately 28.7% of the EAAA for Volant Species (69,712.4 ha) is comprised of this habitat type.	Approximately 42.8% of the Project Development Area (30,218.3 ha) is comprised of this habitat type.
Wet Evergreen Forest	Wet Evergreen Forest has a similar forest structure and composition as montane forest but receives less precipitation. This habitat type typically comprises mixed stands of	Approximately 10.4% of the EAAA for Non-Volant Species (27,732.1 ha) is	Whilst this habitat type is not present within the Project Development Area

Land Cover / Land Use Type	Description	EAAA Land Cover	Project Footprint Land Cover (ha)
	semi-evergreen forest / coniferous forest, with varying compositions of broad-leaved trees and *Pinus* species. Dominated by species of Fagaceae, Myrtaceae, and Lauraceae, with high overall species richness. Existing disturbance, particularly habitat fragmentation caused by access roads, is noted for these forest areas. This type has been mapped as occurring along the valley to the north-east close to the Lao-Vietnam border and overlapping the EAAAs.	comprised of this habitat type. Approximately 7% of the EAAA for Volant Species (17,040.8 ha) is comprised of this habitat type.	itself, the transmission line towards Vietnam includes an area of Wet Evergreen Forest.
Agricultural-Shrub Land-Grassland Mosaic	Given the shifting agricultural pattern that characterises the study area, it was inherently difficult to classify many of the smaller, fragmented patches of open, transitional herbaceous and low-wooded vegetation amongst the broader contiguous forest communities. This habitat type has therefore been broadly mapped as a shrub land-grassland mosaic, comprised of the following sub-communities: ■ **Agricultural land** is used by local communities for rotational agricultural cropping, and to a lesser extent for commercial crop production such as coffee, sugarcane, and maize (ADB, 2016[54]; CEIC, 2021). Rice is cultivated in upland areas for mainly subsistence purposes (Alexander *et al.*, 2018). ■ **Shrub land** is scattered across the EAAAs where anthropogenic influences have modified the structural integrity of the area. This habitat type comprises small patches of vegetation that represent transitional evergreen/semi-evergreen forest-shrub areas that have been subject to degradation, forest regeneration and/or natural succession. ■ **Grassland** is typically a fire-adapted vegetation and habitat type found scattered throughout the	Approximately 58.7% of the EAAA for Non-Volant Species (156,798.4 ha) is comprised of this habitat type. Approximately 63.8% of the EAAA for Volant Species (154,916.5 ha) is comprised of this habitat type.	Approximately 56.3% of the Project Development Area (39,760.9 ha) is comprised of this habitat type.

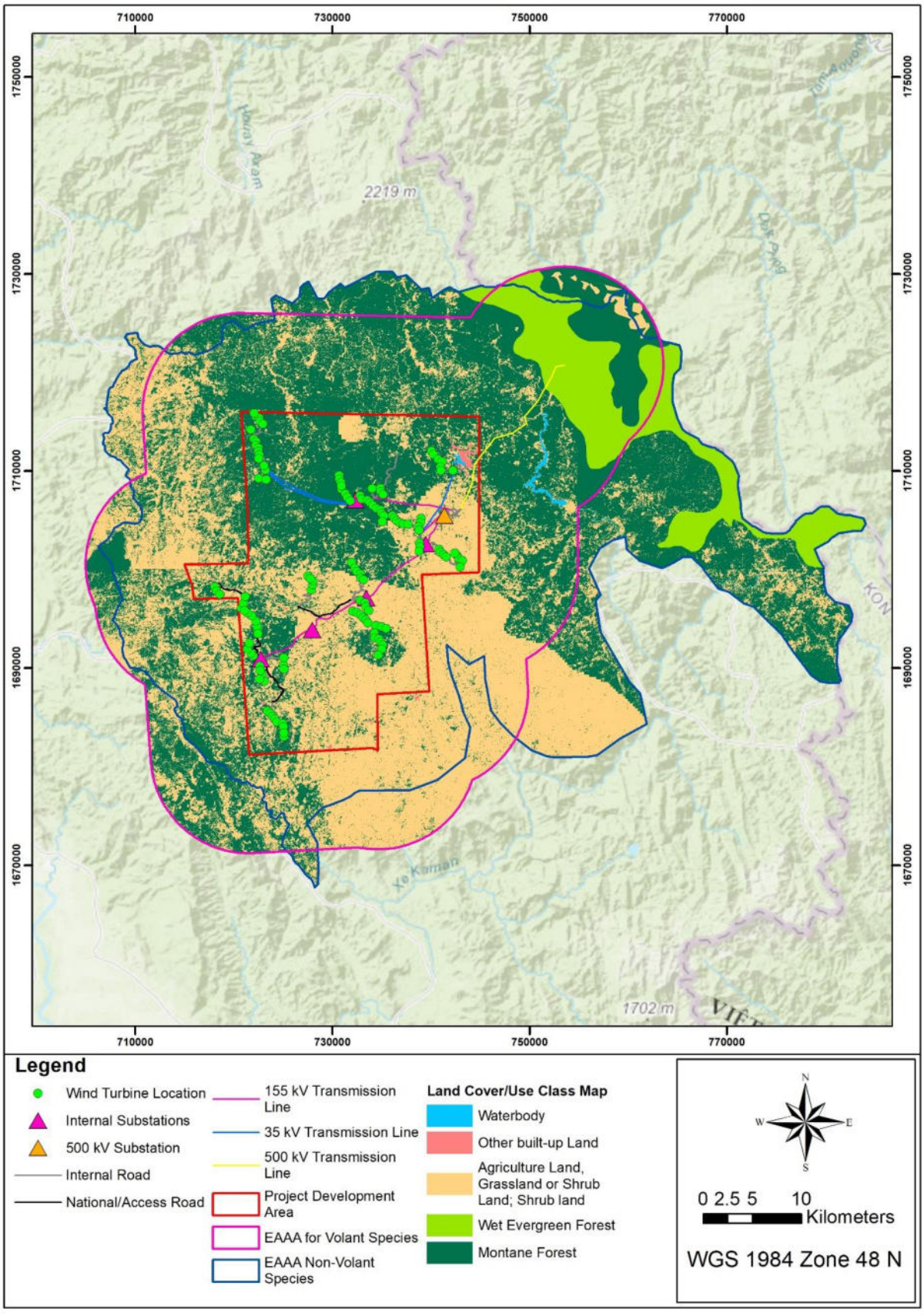
[54] Asian Development Bank: additional financing (2016). Proposed Administration of Grant. Lao People's Democratic Republic: Greater Mekong Subregion Biodiversity Corridors Project. Draft for submission to FIP Committee. Project Number: 40253. March 2016. Available online at: https://climateinvestmentfunds.org/sites/default/files/meeting-documents/fip-lao_pdr-004a-adb-protecting_forests_for_sustainable_ecosystem_services-annex12345678.pdf

Land Cover / Land Use Type	Description	EAAA Land Cover	Project Footprint Land Cover (ha)
	EAAA, and in the southern and central sections of the Project area. Such land cover is often due to herbivore activity or fire on plateaus such as on the Dak Cheung Plateau. Large native trees are systematically removed and key ecological processes are disrupted.		
Water Body	Rivers and streams occur at topographic low points in the landscape and along drainage lines throughout the Project area (Innogreen Engineering Co. Ltd. and Greener Consultant Co. Ltd, 2020), and wider EAAAs. Located within the Sekong River catchment area, this area is generally recognised for being ecologically unique due to the presence of unique habitats at high elevation and slopes (Meynell, 2014[55]). Of note, rivers and streams at Dak Cheung plateau appear to face relatively few impacts, except when in the vicinity of development works (Kottelat, 2011[56]).	Approximately 0.3% of the EAAA for Non-Volant Species (671.7 ha) is comprised of this habitat type. Approximately 0.3% of the EAAA for Volant Species (697.1 ha) is comprised of this habitat type.	Approximately 0.1% of the Project Development Area (79.5 ha) is comprised of this habitat type.
Built-up and Related Land	Artificial / man-made land use has removed most or all ecosystem attributes. Built-up land use in the Project area comprises residential buildings and basic infrastructure (e.g., roads, hospital, and school) (Innogreen Engineering Co., Ltd. and Greener Consultant Co., Ltd, 2020). These areas are located mainly in the north-east but smaller structures and roads are scattered throughout the landscape.	Approximately 0.2% of the EAAA for Non-Volant Species (491.8 ha) is comprised of this habitat type. Approximately 0.2% of the EAAA for Volant Species (590.6 ha) is comprised of this habitat type.	Approximately 0.8% of the Project Development Area (556.7 ha) is comprised of this habitat type.

[55] Meynell, P. (2014). The Sekong River in Viet Nam, Lao PDR: and Cambodia: An Information Sourcebook for Dialogue on River Flow Management. Bangkok, Thailand: IUCN. 139pp. Available online at: https://portals.iucn.org/library/sites/library/files/documents/2014-081.pdf

[56] Kottelat, M. (2011). Fishes of the Xe Kong drainage in Laos, especially from the Xe Kaman. Co0management of freshwater biodiversity in the Sekong Basin. October 2011. Available online at: https://wwfint.awsassets.panda.org/downloads/fishes_of_xe_kaman_2011.pdf

Figure 8-27: Land cover / land use in the EAAAs and Project area



Source of information: ERM (2022).

8.4.4 Birds

The sections below present a summary of the methodology and key findings of the bird field surveys undertaken for the Project. Further details are presented in ***Appendix S***.

8.4.4.1 Methodology

Detailed knowledge of bird distribution and flight activity is necessary in order to predict the potential effects of the wind farm on birds. Feedback from Multi-Lateral Agency ("MLA") consultation that took place between 22 August 2017 and 29 September 2017 identified bird surveys to international standards as survey priorities, with the peak bird migration season[57] being particularly important for survey. Bird Vantage Point ("VP") and transect surveys were therefore undertaken monthly from December 2020 – Nov 2021 (except for April and May 2021 when COVID-19 pandemic lockdown restrictions prevented surveys from taking place) to capture the annual seasonal variation expected at the Project area. ***Figure 8-28*** presents the locations of the bird VP and transect surveys undertaken.

8.4.4.1.1 Vantage Point Surveys

Given the extent of the Project area, it was not possible to undertake VP surveys for the entire wind farm. A sampling approach was therefore adopted that allows a representative proportion of the turbines in each of the main wind farm clusters to be surveyed. This approach enabled differences in species and collision risk between turbine clusters to be assessed, while providing for an overall collision risk determination across the entire windfarm. The data gathered used standard internationally recognised protocols based on Scottish Natural Heritage (now NatureScot) guidance[58,59].

A table has been included below which indicates VP survey alignment with the SNH (2017) guidance document. In summary, all guidance recommendations were fulfilled in VP survey design, apart from the following:

- The VPs and transects were positioned to cover a representative area of the project area, given the large size of the site;
- Suitable control sites were not determined or surveyed;
- Bird surveys were initially planned to cover a 12-month period, however April and May 2021 months could not be surveyed due to Covid-19 lockdown measures which prevented fieldwork at the time; and
- Monthly surveys would cover peaks in migrations, with the exception of the April 2021 survey which could not be completed due to Covid-19 lockdown restrictions in place at this time.

The SNH guidance indicates that "*Where bird survey methods differ from those outlined in this guidance, a clear rationale for using a different approach must be set out*". Given the large and

[57] The migration season in Southeast Asia generally begins in late September through into November, with a peak in October. Local bird experts have also indicated that in Laos, migration extends through to December. The East Asian - Australasian Flyway (EAAF) (which leads through Lao) stretches from the Russian Far East and Alaska, southwards through East Asia and South-east Asia, to Australia and New Zealand and encompasses 22 countries. Over 50 million migratory waterbirds, including 8 million waders, use the route annually.

[58] Scottish Natural Heritage August 2014. Recommended bird survey methods to inform impact assessment of onshore wind farms. Retrieved from https://www.nature.scot/sites/default/files/2018-06/Guidance%20Note%20-%20Recommended%20bird%20survey%20methods%20to%20inform%20impact%20assessment%20of%20onshore%20windfarms.pdf

[59] Scottish Natural Heritage. 2000. Wind farms and birds: Calculating a theoretical collision risk assuming no avoiding action. Retrieved from https://www.nature.scot/sites/default/files/2017-09/Guidance%20Note%20-%20Windfarms%20and%20birds%20-%20Calculating%20a%20theoretical%20collision%20risk%20assuming%20no%20avoiding%20action.pdf

discontinuous area occupied by the arrays, and uncertainties over specific turbine locations, a sampling rather than complete survey approach was adopted. Still, a representative portion of the habitats and site was covered and all the initial planned WTGs were included in the VP coverage. The survey could not account for all possible potential changes to WTG layout, and whilst an attempt was made to accommodate potential changes this could ultimately not be predicted with 100% accuracy, and as pragmatic an approach as possible was adopted. Whilst control monitoring sites were not surveyed initially, the use of suitable control sites can still be considered for the operational monitoring plan to be developed and implemented, taking into consideration other development planned for the region (e.g. Xekong WF and bauxite mining).

Recommended Bird Survey Methods (Scottish Natural Heritage, 2017)	**Comments on VP Survey Approach for Monsoon WF Project**
1 Appropriately skilled and experienced observers are essentially.	Third-party, independent and skilled bird experts with specialist experience in abundance and VP surveys were contracted.
2 In the absence of adequate existing information (e.g. none available, data greater than 5 years old, etc.), information must be gathered on site to ascertain the likely bird interest.	Latest available data from IBAT (IUCN), outcomes of the site REA (Rapid Ecological Assessment) and consultation with local bird experts was incorporated into survey design and the early identification of key bird species of interest.
3 The survey programme should retain flexibility to adapt to situations where one or more species (especially ones not typically chosen as a target or secondary species) unexpectedly present an issue (e.g. particularly high presence on the site).	A flexible survey programme was implemented to adapt to changes in layout and target species.
4 The survey area and design must adequately cover the entire development area, i.e. the largest possible layout, all the alternative layouts and ancillary structures and works. This includes access tracks; borrow pits, electrical substations and grid connections (both underground and overhead).	The VPs and transects were positioned to cover a representative area of the project area, given the large size of the site. A total of 14 VPs were selected to provide sampling coverage over the habitats associated with the different array areas, covering the turbine positions and included 2 VPs to survey the high voltage transmission line alignment to the Lao border with Vietnam in the east. The survey could not account for all possible potential changes to WTG layout, and whilst an attempt was made to accommodate potential changes this could ultimately not be predicted with 100% accuracy, and as pragmatic an approach as possible was adopted
5 The main breeding and wintering bird survey areas should extend at least 500m beyond the development/planning application boundary.	Considering a maximum 2km visibility range for each VP, the VP positioning covers the turbine arrays and extends a distance of at least 500m from each turbine in most instances.
6 Where there are adjacent or overlapping wind farm proposals being surveyed simultaneously we strongly recommend that the developers and consultants cooperate with each other over access and coordination of survey. Agreement to share data for the overlap area where appropriate or a revised survey schedule that avoids overlapping visits should be sought.	This was not a concern for the survey as no other similar survey work was not planned during the course of the baseline bird surveys.

Recommended Bird Survey Methods (Scottish Natural Heritage, 2017)	Comments on VP Survey Approach for Monsoon WF Project
7 All bird species have varied seasonal and within day activity patterns. Survey design should be based around the times when birds are likely to be most active.	Bird activity for most species is considered at its peak in the early morning and late evening. The surveys covered 12 hours between sunrise and sunset at each VP, thus covering peak activity periods.
8 Survey work should span all times of the year when the target species are present.	Bird surveys were planned to be undertaken on a monthly basis over a period of 12 months, from December 2020 to November 2021 inclusive to cover all relevant seasons when target and secondary bird species could be present. The survey team completed all the visits to all VP's in every month except April and May 2021, when Covid-19 lockdown restrictions prevented surveys taking place.
9 We recommend survey for a minimum of two years to allow for variation in bird use between years, unless it can be demonstrated that a shorter period of survey is sufficient.	The bird surveys were restricted to a period of 1 year. Variations in bird activity between years could therefore not be ascertained.
10 Where post-construction monitoring is a condition of consent, it is recommended that a comparable control or reference site is selected and surveyed at the time of the initial surveys. It is acknowledged that on a practical level it can be difficult to find suitable sites.	Suitable control sites were not determined or surveyed. Whilst control monitoring sites were not surveyed initially, the use of suitable control sites can still be considered for the operational monitoring plan to be developed and implemented, taking into consideration other development planned for the region (e.g. Xekong WF and bauxite mining).
11 Breeding bird surveys should cover the whole breeding season and be done between 8:30 hours and 18:00 hours. They should be carried out in a wind of Beaufort force 4 or less, and in dry weather.	Bird surveys were initially planned to cover a 12-month period, however April and May 2021 months could not be surveyed due to Covid-19 lockdown measures which prevented fieldwork at the time. Surveys were planned to coincide with suitable weather conditions as far as possible and where predictable.
12 All survey visits should be undertaken in the same season; splitting survey visits between years is not acceptable	All surveys were completed within the relevant seasons over the year-long survey period.
13 Where new above-ground grid connections are planned, the proposed connection route should be covered by VP observations to assess potential collision risk.	Survey design included 2 VPs to survey the cover voltage transmission line alignment to the Lao border with Vietnam in the east.
14 VP survey must not take place simultaneously with any other fieldwork on the site, that may cause disturbance and invalidate the VP survey results.	VP surveys were done separate to other fieldwork.
15 Detectability of birds to human observer's declines with distance. Potential detectability issues should be borne in mind when selecting VP locations to ensure they are as appropriate as possible for the species to be surveyed. It is very important that VPs are chosen to achieve maximum visibility with the minimum number of points. When selecting VPs, the aim should be to cover	A maximum visibility distance of 2 km from each VP was factored into survey design, together with terrain effects on visibility, to ensure complete coverage of all WTGs and TLs.

Recommended Bird Survey Methods (Scottish Natural Heritage, 2017)	Comments on VP Survey Approach for Monsoon WF Project
all of the flight activity survey area such that no point is greater than 2km from a VP. As detection of flight activity will decrease with distance, VPs should be located as close to the survey area as possible.	
16 The VP locations and associated viewsheds referred to in the environmental statement must be those used in the field.	VP locations referred to in the ESIA were those used in the field.
17 VPs should cover the defined survey area encompassing the proposed turbine envelope if known, or the maximum extent of potential turbine layouts. This should extend to 500m beyond the outermost proposed turbines to deal with inaccuracies of position for flight line observations.	VPs cover all WTGs known at the time and extending beyond the outermost proposed turbines to account for potential changes in layout as far as possible.
18 Where VPs are located within the survey area, they should not be used simultaneously with other VP locations which overlook them as the presence of an observer either sitting at or moving to/from the VP will probably affect bird behaviour.	VP surveys were done individually and separately to avoid disturbance from other observers.
19 Recommend scanning an arc of up to 180 degrees from each VP. Larger arcs cannot be scanned efficiently.	An arc of 180 degrees from each VP was used as the visual survey area.
20 The number of observers required to undertake watches will vary depending on the levels of target bird activity. If activity is predicted to be high and involves several target species, judgement should be exercised as to whether more than one observer may be required, in order that all activity of target species can be recorded.	This was factored into survey design.
21 Watches should be tailored to the ecology of the target bird species involved. This should provide a spread over the full daylight period available (from official local sunrise to sunset times) which will vary depending on the time of year. Observations should be collected between official sunrise and official sunset time.	VP surveys were undertaken from official local sunrise to sunset.
22 Watches should be spread across all calendar months when the species is present or likely to be so. The watches should be stratified according to the ecology of the target species present and should give a representative sample of site use.	All surveys were completed within the relevant seasons over the year-long survey period.
23 Migration watches should take account of key periods for the target species to be surveyed, and reference should be made to known peaks in their migration and weather patterns that can produce larger scale movements.	All surveys were completed within the relevant seasons over the year-long survey period. Monthly surveys would cover peaks in migrations, with the exception of the April 2021 survey which could not be completed due to Covid-19 lockdown restrictions in place at this time.
24 Watches should be taken under conditions of good ground visibility (>2km) and can be undertaken on showery days providing showers are not too frequent or prolonged.	VPs were coordinated with periods of good visibility.
25 The longer the overall survey period of VP survey, the more accurate and precise the sample of flight behaviour. We recommend a minimum of 72 hours per VP location	The total survey time at all VP's was 120 hours (12 hours per VP per month, over a period of 10 months, with April and May 2021 excluded due to

Recommended Bird Survey Methods (Scottish Natural Heritage, 2017)	Comments on VP Survey Approach for Monsoon WF Project
divided between seasons (36 hours breeding and 36 hours non-breeding) per year, as a standard for species where vantage point survey is required. Where proposed effort is less than 72 hours, this should be fully justified.	Covid-19 lockdown restrictions). The exception was VP's 12, 13, and 14 which were added a month after initial surveys started in response to layout changes, and where survey time was 108 hours. The recommended guideline of a minimum survey period of 72 hours per VP location was still attained.
26 Where a high level of migration movements are considered likely, or are known, to occur, sampling within this period should be stratified to ensure adequate data collection across the spring and autumn periods.	High levels of migration movements were not predicted and surveys confirmed that migration is not a major factor to account for in the project area and survey approach. All migrant species are IUCN LC, and most recorded flight times at collision risk height would not generate sufficient time at collision risk height to have a statistical probability of a collision within the lifetime of the wind farm.
27 Within each season, each part of the wind farm should be watched for at least 36 hours.	This was accomplished through the timing and spacing of VPs which allowed for each part of the WF to be observed for at least 36 hours in each season.
28 We recommend that VP watches are conducted as a series of watches each of not more than 3 hours' continuous duration at a time. They are designed to form a representative sample of bird flight activity and a sample of, for example 12 x 3 hour watches is better than fewer longer watches.	This was implemented as far as possible.
29 There should be suitable breaks of at least 30 minutes between watches to minimise observer fatigue.	Breaks were implemented
30 Watches can be suspended and then resumed to take account of changes in visibility.	This was implemented where necessary on a case-by-case basis.
31 The area in view is scanned until a *target species* is detected at which point it is followed until it ceases flying or is lost from view. The time the target bird was detected and the flight duration are recorded. The bird's flight height is estimated at the time of detection and then at 15 second intervals thereafter, using, for example, a count-down timer with an audible alarm. A 15 second interval is recommended as a practical compromise that aims to minimize dependency within data while maximizing the sample of observations.	This standard method was used: time detected and flight height recorded in 15 second intervals.
32 Flight heights should be classified into height bands, i.e. below the rotor- swept area, the rotor-swept area and above the rotor-swept area, allowing for observer error.	The recommended flight bands (below the rotor-swept area, the rotor-swept area and above the rotor-swept area) were used to record and classify flight heights based on turbine design information provided by IEAD.
33 Observation of target species takes priority over recording of secondary species.	Target species observations were given priority. Three species with higher IUCN conservation status were identified during the VP surveys. These were the great hornbill (VU), the mountain hawk-eagle (NT), and the rufous-bellied eagle (NT).
34 Static and flying birds should be recorded separately. Observers should record perched birds and birds on	Static and flying birds were recorded separately where relevant, as were perched birds.

Recommended Bird Survey Methods (Scottish Natural Heritage, 2017)	Comments on VP Survey Approach for Monsoon WF Project
water bodies once only on arrival at the VP, and the area or site used marked on a map.	
35 Where bird survey methods differ from those outlined in this guidance, a clear rationale for using a different approach must be set out.	Given the large and discontinuous area occupied by the arrays, and uncertainties over specific turbine locations, a sampling rather than complete survey approach was adopted. Still, a representative portion of the habitats and site was covered and all WTGs were included in the VP coverage..

Expert ornithologists tracked and mapped birds throughout the turbine area, recording species, numbers, and estimating flight height during timed watches at a total of fourteen VPs to collect data to quantify the flight activity levels and species distribution across the Project area. Twelve of the VPs were selected to provide a representative sample coverage of the habitats associated with the different turbine arrays, while the remaining two VPs were dedicated to monitoring flight activity associated with the proposed transmission line from the windfarm area to the Lao-Vietnam border (VPs 9 and 10). ***Table 8-18*** presents the VP locations with respect to turbine arrays and the transmission line.

Table 8-18: Vantage Point (VP) relationship to Turbine Arrays and the Transmission Line4.4

Location	Vantage Points
East Central Arrays	1a, 3a, 2, 4
Southeast Array	5, 7a, 8
Ban Dakdonna Array	6, 11
Dak Cheung village Array	12
Northwest Array	13
Southernmost array	14
Transmission line	9 & 10

In line with GIIP for WF development project assessment, the VP surveys recorded all species observed, including migratory species, large soaring birds, raptors, flocking species and heavy-bodied birds with limited maneuverability and included resident species of high conservation status (i.e. IUCN globally threatened species (inter)nationally-recognised high conservation concern within the country). . Birds that entered the windfarm boundary were tracked and their height estimated at 15 second intervals. Three bands based on the Project's turbine hub height and rotor length specifications were used to estimate flight height[60]:

- **30 m or below**, allowing for the effect of downdraft and compensates for potential height estimation difficulties over undulating terrain;

[60] Note that the turbine design and operational specifications were revised after commencing the bird VP surveys. Collision risk modelling calculations therefore factored in these changes where needed. This is described in further detail in ***Section 9.4*** of this ESIA.

- **30 m to 150 m**, which was considered as the height at which there is a collision risk with turbine blades; and
- **150 m or above**, which was considered as the area that is above the collision risk height.

VP surveys included 12 hours survey time per VP, per month. Total survey time at each VP was estimated to be 120 hours, with the exception of VP 12, 13, and 14 which were added a month after surveys started in response to layout changes, and where survey time was 108 hours.

8.4.4.1.2 Transect Surveys

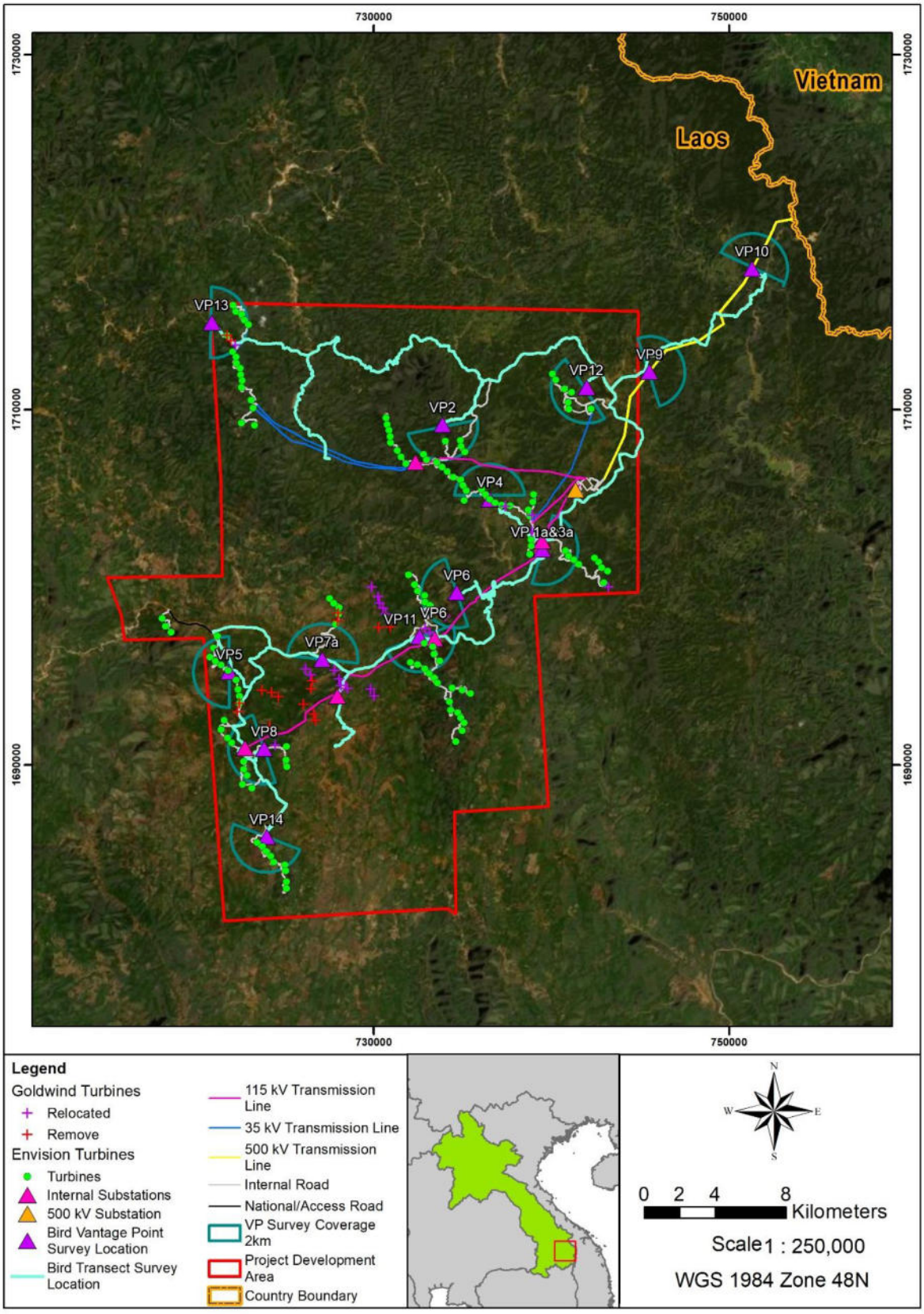
Transect surveys were conducted to record the variety of birds present in the Project area. Fourteen transect survey routes were selected based on the field surveyor's walking route from the nearest road to the VP. Surveys were undertaken twice in a day, during the morning and afternoon, prior to, and after each VP survey.

These transect surveys were designed to focus on identifying potential high priority species highlighted during expert consultation and an initial screening against the critical habitat criteria, which revealed that three restricted-range bird species are considered as potential high priority species (refer to ***Appendix T)***. These include:

- Chestnut-eared Laughing thrush (Garrulax konkakinhensis);
- Black-crowned Barwing (*Actinodura sodangorum*);
- Golden-winged Laughing thrush (*Garrulax ngoclinhensis*).

Given that these species are primarily understorey or ground dwellers that may be elusive, playback of recorded bird songs at intervals of 500m along each transect was also performed during the field surveys to increase the probability of encountering and confirming the presence of these particular species.

Figure 8-28: Map showing VP and transect locations for the bird survey relative to planned WF infrastructure



8.4.4.2 Survey Findings

8.4.4.2.1 Vantage Point (VP) Survey Findings

The VP surveys recorded a total of 24 species (excluding three flights of two unspecified species). Of the species recorded, all were raptors with the exception of two heron species (Chinese Pond Heron, *Aredola bacchus* and Cinnamon Bittern, *Ixobrychus cinnamomeu*s), a wader (Red-wattled Lapwing, *Vanellus indicus*) and the Greater Hornbill, *Buceros bicornis*.

All but three of the species recorded were of LC (Least Concern) conservation/threat status, with two NT (Near Threatened) and one VU (Vulnerable) species recorded.

The majority of species are confirmed resident bird species (13), although eleven species are confirmed migrants. These proved to be broad-front migrants, which is unsurprising given that there are no IBAs designated for migratory and/or congregatory species identified within the EAAAs (refer to ***Section 8.4.9*** for further information).

Table 8-19 indicates the list of twenty-four species, and their total flight time at all heights and collision risk height, from December 2020 to November 2021.

Table 8-19: Bird species recorded during VP surveys with corresponding flight times at all heights / collision risk height

Bird Species Recorded *(conservation-important / RL species indicted in '**bold**')*		IUCN RL[1,2]	Resident/ Migratory (based on IUCN)	**Vantage Point (VP)** *(*species presence recorded indicated by an 'x')*																**Flight Time / Height**	
Common Name	Scientific Name			1	2	3	4	5	6	7	8	9	10	11	12	13	14	1a & 3a	7a	Flight Time Total (seconds)	Collision Risk height (m)
Besra	*Accipiter virgatus*	LC	Altitudinal migrant	x		x	x		x		x		x	x						415	270
Black Baza	*Aviceda leuphotes*	LC	Migrant					x												120	30
Black Eagle	*Ictinaetus malaiensis*	LC	Resident	x	x	x	x	x	x	x		x	x	x	x	x		x	x	8 262	3 450
Black-winged Kite	*Elanus caeruleus*	LC	Resident				x											x		600	300
Changeable Hawk-eagle	*Nisaetus cirrhatus*	LC	Resident	x	x															72	0
Chinese Pond Heron	*Aredola bacchus*	LC	Migrant									x								90	0
Cinnamon Bittern	*Ixobrychus cinnamomeus*	LC	Migrant					x												120	0
Crested Goshawk	*Accipiter trivirgatus*	LC	Resident	x	x	x		x	x		x	x			x	x				1 506	465
Crested Serpent Eagle	*Spilornis cheela*	LC	Resident	x	x	x	x	x	x	x		x	x	x	x	x		x	x	5 105	975
Eastern Buzzard	*Buteo japonicas*	LC	Migrant															x		120	120
Eurasian Kestrel	*Falco tinnunculus*	LC	Migrant						x	x	x						x			610	90
Eurasian Sparrowhawk	*Accipiter nisus*	LC	Migrant					x			x						x			150	15
Great Hornbill	***Buceros bicornis***	**VU**	**Resident**										**x**							**135**	**15**
Grey-faced Buzzard	*Butastur indicus*	LC	Migrant		x	x	x	x	x	x						x	x			3 829	2 190

Bird Species Recorded *(conservation-important / RL species indicted in '**bold**')*		IUCN RL[1,2]	Resident/ Migratory (based on IUCN)	**Vantage Point (VP)** *(*species presence recorded indicated by an 'x')*																**Flight Time / Height**	
Common Name	Scientific Name			1	2	3	4	5	6	7	8	9	10	11	12	13	14	1a & 3a	7a	Flight Time Total (seconds)	Collision Risk height (m)
Japanese Sparrowhawk	*Accipiter gularis*	LC	Migrant			x	x													90	45
Jerdon's Baza	*Aviceda jerdoni*	LC	Resident	x			x	x	x			x	x			x				915	450
Mountain Hawk-Eagle	*Nisaetus nipalensis*	NT	Migrant		x		x													300	120
Northern Goshawk	*Accipiter gentilis*	LC	Migrant											x						82	45
Oriental Hobby	*Falco severus*	LC	Migrant	x				x	x		x			x			x	x		924	375
Oriental Honey Buzzard	***Pernis ptilorhynchus***	**LC**	**Migrant**	**x**	**x**	**x**	**x**		**x**			**x**		**x**	**x**	**x**		**x**		**2 310**	**1 110**
Osprey	*Pandion haliaetus*	LC	Migrant												x					600	375
Red-wattled Lapwing	*Vanellus indicus*	LC	Resident							x										30	0
Rufous-bellied Eagle	***Lophotriorchis kienerii***	**NT**	**Resident**		**x**		**x**													**180**	**60**
Shikra	*Accipiter badius*	LC	Migrant	x	x	x	x	x	x	x	x	x	x		x	x	x	x		1 288	180 Resident / migrant status of birds in Table 7.19 was reviewed using the latest IUCN information and

Bird Species Recorded *(conservation-important / RL species indicted in '**bold**')*		IUCN RL[1,2]	Resident/ Migratory (based on IUCN)	**Vantage Point (VP)** *(*species presence recorded indicated by an 'x')*																**Flight Time / Height**	
Common Name	Scientific Name			1	2	3	4	5	6	7	8	9	10	11	12	13	14	1a & 3a	7a	Flight Time Total (seconds)	Collision Risk height (m)
																					corrections have been made.

Key to table:

VU = Vulnerable; NT = Near Threatened; LC = Least Concern

8.4.4.2.2 Transect Survey Key Findings

The transect surveys recorded a total of 256 bird species, the majority of which are of LC status species (249 species), with six species being NT and one VU species recorded.

- Bird species with higher IUCN conservation status were identified as follows:
- Black-crowned Barwing, *Actinodura sodangorum* (NT),
- Blossom-headed Parakeet, *Psittacula roseata* (NT),
- Grey-headed Parakeet, *Psittacula finschii* (NT),
- Red-breasted Parakeet, *P. alexandri* (NT),
- Rufous-bellied Eagle, *Lophotriorchis kienerii* (NT),
- Wreathed Hornbill, *Rhyticeros undulatus* (VU), and
- Yellow-billed Nuthatch, *Sitta solangiae* (NT).

Of the four endemic bird species identified as potential high priority species of the Project, only the Black-crowned Barwing (*A. sodangorum)* wase recorded during field surveys.

Table 8-20 lists the key species of conservation importance recorded during the transect surveys in alphabetical order.

For a comprehensive list of bird species recorded, the reader is referred to the baseline report contained in ***Appendix S***.

Table 8-20: Bird species with elevated threat status recorded during transect surveys

S/N	Common Name	Scientific Name	Transect No.	Status	IUCN RL Status
1.	Black-crowned Barwing	*Actinodura sodangorum*	4	Resident, endemic	NT
2.	Blossom-headed Parakeet	*Psittacula roseata*	1a & 3a	Resident	NT
3.	Grey-headed Parakeet	*Psittacula finschii*	1a & 3a, 4	Resident	NT
4.	Red-breasted Parakeet	*Psittacula alexandri*	5	Resident	NT
5.	Rufous-bellied Eagle	*Lophotriorchis kienerii*	2, 4	Resident	NT
6.	Wreathed Hornbill	*Rhyticeros undulatus*	6	Resident	VU
7.	Yellow-billed Nuthatch	*Sitta solangiae*	10	Resident	NT

Key to table:

VU = Vulnerable; NT = Near Threatened

8.4.5 Bats

8.4.5.1 Methodology

The baseline assessment for bats comprised a desktop review, followed by passive and active sampling for bats within the Project area. Both published and unpublished records of bats from southern Lao PDR (specifically from Saravan, Sekong, Champasak and Attapeu provinces) were reviewed prior to the field survey. Surveys across a total of five bat field survey campaigns were undertaken, which included three campaigns in the dry season (February and March 2021), and two campaigns in the wet season (June and July 2021).

Field survey methods included Key Informant Interviews ("KIIs"), roost surveys, live-sampling with harp traps and mist nets, and acoustic sampling using ultrasound detectors:

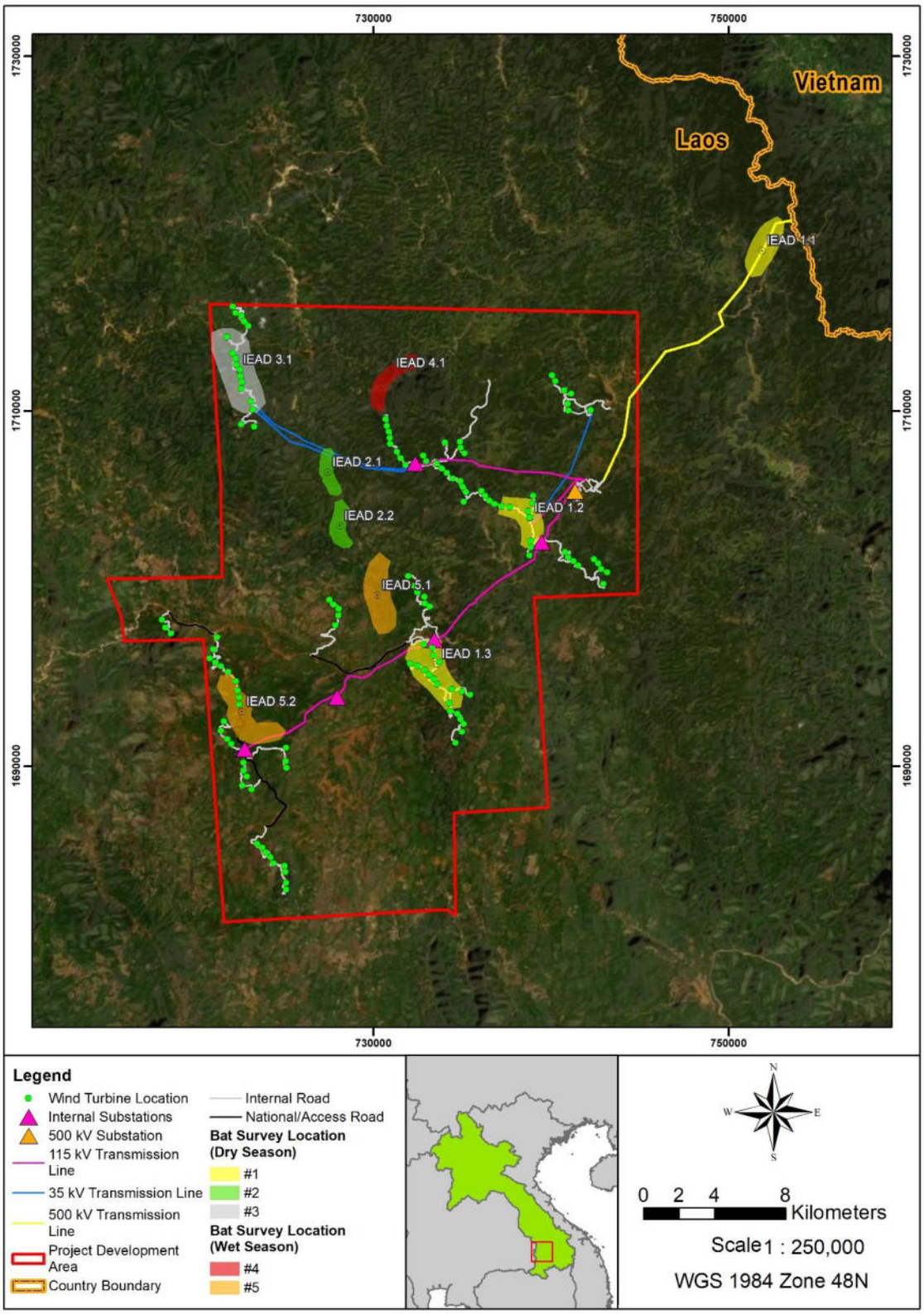
- KIIs were undertaken to determine location of significant bat colonies (> 100 individuals) within or in the vicinity of the Project area, with a specific focus on cave roosts and flying fox (*Pteropus* spp.) colonies. These were undertaken with 22 residents with a combined total of 625 years of local experience.
- Mist nets and harp traps were employed for live captures in 55 locations in the Project area, and five locations along the proposed transmission line route. All captured bats were measured, photographed, and identified in the field using the appropriate guides/monographs. They were subsequently released at the site and night of capture.
- Acoustic sampling using Song Meter 4 full spectrum (SM4) bat detectors (Wildlife Acoustics, USA) and 10 AudioMoth full spectrum (AM) bat detectors (Open Acoustic Devices, UK) were deployed each survey night to record insectivorous bat calls. SM4 detectors were deployed in a new location each night, while AMs were deployed at static locations to maximize coverage of representative habitats in each survey zone. Phonically distinct bat species were identified to the lowest possible taxonomic level possible based on the calls recorded.

Figure 8-29 that follows and ***Table 8-21*** presents the bat survey locations and itinerary for field surveys undertaken in the Project area.

Table 8-21: Itinerary for Bat Field Surveys

Survey Dates	Season	Sampling Nights	Survey Zone
3–7 February 2021	Dry season	4	Bat 1.1
7–11 February 2021		4	Bat 1.2
11–15 February 2021		4	Bat 1.3
23 February – 1 March 2021		6	Bat 2.1
1–7 March 2021		6	Bat 2.2
16–28 March 2021		12	Bat 3.1
17–29 June 2021	Wet season	12	Bat 4.1
14–20 July 2021		6	Bat 5.1
20–26 July 2021		6	Bat 5.2

Figure 8-29: Map showing the locations of bat surveys (wet and dry seasons) relative to planned WF infrastructure



Source of information: ERM (2022).

8.4.5.2 Survey Findings

8.4.5.2.1 Literature Review and Interview Findings

The literature review revealed that although a total of 56 bat species are known to the southern Lao PDR to date based on records (defined here as the Salavan, Champasak, Sekong and Attapeu provinces), only two species have been documented in Sekong Province (where >80% of the project area is located) prior to the survey.

All but two of the 56 species are currently recognised as species of Least Concern (LC) by the IUCN (2021), the exceptions being, *Hypsugo dolichodon* and *Murina walstoni* (DD: Data Deficient).

Consistent with key informant interviews and observations throughout the survey, the review also revealed that limestone karst outcrops, significant cave bat roosts (>100 bats) and flying fox colonies are unlikely to occur in the Sekong portion of the project area.

8.4.5.2.2 Trapping and Acoustic Survey Findings

During the field surveys undertaken, a total of 468) bats representing 29 species, arranged in five families, were captured in live traps. An additional six species were recorded during the acoustic surveys conducted. All species are Least Concern (LC) in terms of conservation / threat status with the exception of *Rhinolophus francisi* (NE: Not Evaluated).

The findings included ten bat species which are the first records for southern Lao PDR, and two first country records for Lao PDR (see ***Table 8-22*** below).

For the comprehensive list of bat species recorded, the reader is referred to the baseline report contained in ***Appendix S.***

Table 8-22: New records for bat species in southern Lao PDR and Lao PDR

S/N	Common Name	Scientific Name	Capture Method	IUCN Red List Status	First Record for Southern Lao PDR	First Record for Lao PDR
1.	Horsfield's Fruit Bat	*Cyanopterus horsfieldii*	Trapping	LC	X	
2.	Blanford's Fruit Bat	*Sphaerias blanfordi*	Trapping	LC	X	
3.	Long-tongued Fruit Bat	*Macroglossus sobrinus*	Trapping	LC	X	
4.	Francis's Woolly Horseshoe Bat	*Rhinolophus francisi*	Trapping and Acoustic detecting	NE	X	X
5.	Thai Horseshoe Bat	*Rhinolophus siamensis*	Trapping and Acoustic detecting	LC	X	
6.	Wall-roosting Mouse-eared Bat	*Myotis muricola*	Trapping and Acoustic detecting	LC	X	
7.	Elery's Tube-nosed Bat	*Murina eleryi*	Trapping	LC	X	
8.	Fiona's Tube-nosed Bat	*Murina fionae*	Trapping	LC	X	
9.	Formosan Golden	*Harpiola isodon*	Trapping	LC	X	X

S/N	Common Name	Scientific Name	Capture Method	IUCN Red List Status	First Record for Southern Lao PDR	First Record for Lao PDR
	Tube-nosed Bat					
10.	Lesser Hairy-winged Bat	*Harpiocephalus harpia*	Trapping	LC	X	

Key to table:

NE = Not Evaluated; LC = Least Concern

8.4.6 Land Mammals (non-volant species)

8.4.6.1 Methodology

Through interviews with the local villagers in the area, the survey team attained a good indication of the locations of opportune areas for encountering or observing signs of terrestrial (land) mammal activity. This informed the sampling design, with a focus on including key habitats in survey transects.

Transect surveys were conducted to record animals present in the Project area. These surveys took place in the morning, from 07:30 to 11:30 and in the afternoon to early evening from 13:30 to 17:30. Evidence such as tracks, calls, scat, scratch marks on trees, hollows, roosting sites, feeding sites were recorded. Spotlighting surveys were undertaken at night from 19:30. Key sites such as mineral licks, along stream channels and drainage lines, and beneath fruit trees were the focus of observations and all evidence found was photographed and collected where necessary. Listening posts were also conducted in the mornings from 05:30 to 08:00 to monitor gibbon activity by listening for their calls.

Camera traps (30 units) were deployed for a period of 5 months from late April to September 2021, resulting in a total of 3 233 trapping days. 20 camera trap units were installed in the Project area, with the remaining 10 units installed along the route of the Transmission Line to the north-east. Cameras were not installed systematically along a particular grid system, but rather at key locations where mammal activity was estimated to be significant and at an appropriate height to maximize the likelihood of recording priority small and larger mammal species.

A summary of the total survey effort for mammal surveys is included in the Table below.

Table 8-23: Summary of mammals surveys effort

Method	Purpose	Number	Timing	Effort	Total effort
1 Transect Surveys	Slow transect walk through forest habitat to detect animals directly, by calls and any other evidence such as footprint, tracks, scratch, droppings	5 survey blocks	7.30am to 11.30am and late afternoon from 1.30pm to 5.30pm	8 hours per day, 3-4 days per survey block	120 – 160 hours per season (wet season and dry season: total = 240 – 320 hours)
2 Gibbon listening Posts	To record gibbon calls and record activity	8 listening posts	5.30am to 11.30am	4 hours per post day	32 hours
3 Camera traps	Camera traps set at different heights to record nocturnal activity and targeting both large and small mammal species	30 camera traps installed but only	5 months (Jul-Dec)	29 nights	3,233 days

Method	Purpose	Number	Timing	Effort	Total effort
		29 successful			

8.4.6.2 Survey Findings

A total of 59 mammal species were reported as being potentially present in the Project area (based on the desktop survey and available species records), with 44 species confirmed through the field surveys conducted. The majority were directly confirmed in the field with evidence from the field assessment (both direct observations and indirect evidence of activity obtained from identifying tracks, droppings and feeding sites, and the results of camera trapping).

Most of the mammal species identified were considered to have low populations in the area, with the exception of Pangolins and Chinese Serow. The low estimated population of almost all the important mammal species was based on the species encounter rate per effort expressed per number of days survey effort (transect walks, camera traps and Gibbon listening posts) and distance covered on foot (km) of the survey team. This was also supplemented by anecdotal accounts from local villagers interviewed during consultations. Per species of mammal: Gibbon (6 records, 0.04km/group), Douc (5 records, 0.02km/group), Sambar (6 records, 0.04km/animal), Great Hog Badger (2 records, 0.02km/animal), Pig-tailed Macaque (2 records, 0.01km/group) Otter (1 record), Spotted Linsang (1 record).

The several pieces of quantitiatve, semi-quanitiative and qualitative sampling information gained from the survey work and interviews with community members is considered reasonable and adequate to provide an estimate of mammal population size. This is aligned with the approach to estimating biological populations based on sampling a reasonable representative selection of habitats and projecting this over the broader areas.Estimates of the size of biological populations have traditionally been derived from standardized methods such as distance sampling within representative habitats (Marsden et al., 2016[61] ; Carbone et al., 2001[62] ; Kühl et al., 2008[63]). Marsden et al. (2016) demonstrated the relationship between estimated population size/abundance and species encounter rate for bird species through sampling and the suitability of using encounter rate with a reasonable level of confidence such that species encounter rate can be used as a viable surrogate for estimating species abundance. Similarly, Carbone et al. (2001) earlier identified a similar relationship between density and rates of camera-trap capture for tigers, and despite its limitations, the method was welcomed by researchers as a useful tool for abundance estimation in various species, from large carnivores and forest ungulates to ground-dwelling birds. According to Marsden et al. (2016), species

61 Marsden, S.J., Loqueth, E. Takuo, J.M., Hart, J.A., Abani, R, Ahon, D.B., Annorbah, N.N.D., Johnson, R. and Valley, S. 2016. Using encounter rates as surrogates for density estimates makes monitoring of heavily-traded grey parrots achievable across Africa. Oryz, 2016 (50 (4): pp 617-625. Doi:10.1017/S0030605315000484. Available online at: https://www.researchgate.net/publication/281777653_Using_encounter_rates_as_surrogates_for_density_estimates_makes_monitoring_of_heavily-traded_grey_parrots_achievable_across_Africa

62 Carbone, C., Christie, S., Conforti, K., Coulson, T., Franklin, N, Ginseberg, J.R., N., Ginsberg, J.R. et al., 2001. The use of photographic rates to estimate densities of tigers and other cryptic mammals. Animal Conservation, 4. 75-79. Available online at: https://www.researchgate.net/publication/231743535_The_use_of_photographic_rates_to_estimate_densities_of_tigers_and_other_cryptic_mammals

63 Kühl, H., Maisels, F., Ancrenaz, M. and Williamson, E.A., 2008. Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations. Gland, Switzerland: IUCN SSC Primate Specialist Group (PSG). 32 pp. Available online at: http://apes.eva.mpg.de/eng/pdf/guidelines/Best_Practice_Surveys_Monitoring_Great_Apes_ENGLISH_march09.pdf

encounter rates have long been used in conservation ecology but more recently have become less favorable often because of bias associated with variation in detectability across species and habitats, and the need for actual population estimates. There are of course several issues and factors producing noise in the relationship between population density and species encounter rate and ideally abundance estimates for species of conservation importance should derive from high-quality data collected during standardized surveys over long time periods, allowing for the accumulation of sufficient numbers of records to facilitate precise density estimation and should account for uncontrollable variables such as differences in detectability across sites and species, patchy distributions, variable abundance, cryptic habitats, species mobility, external threats, topographic variations, vegetation and altitudinal differences (Marsden et al., 2016). Hindering such efforts is the lack of the necessary expertise to design and execute the surveys, and analyse the resulting data, a lack of economic resources and logistical difficulties of surveying large and remote areas. An encounter rate method can still be a useful tool, in this case for assessing species abundance in situations where economic resources and/or distance sampling skills are lacking. Under-predicting density using the surrogate method is also not as great a problem in conservation compared to mistakenly predicting high density.

A number of ***Table 8-24*** and include several CR (4 species), EN (7 species) and VU (10 species ***Table 8-24*** also includes species reportedly occurring in the area based on information obtained from villagers (particualrly local hunters who suggested that they had recently hunted the species), however their presence could not be confirmed with confidence through during the field survey work undertaken the expert opinion of the biodiversity team who completed the mammal survey and reviewed by Dr. Rob Timmins (Senior Biologist of WCS/Independent Researcher) who was consulted as an external expert. The full 'List External Experts for Consultations' is provided in Annexure 10 of the Biodiversity Assessment Report (Phiapalath et al., 2022) contained in **Appendix S.**.

The key species of conservation importance are primarily forest-dwelling species, associated with primary and secondary tropical and subtropical montane evergreen and semi-evergreen forests in broadleaf and mixed broadleaf-coniferous forest types (IUCN Red Data List: online at https://www.iucnredlist.org/). The exceptions in this case include the Chinese and Sunda Pangolin which occur in a wider range of habitats, including primary and secondary forests, broad-leaf and coniferous forests, shrub lands, grasslands and agricultural fields. Owston's Civet and Greater Hog Badger also typically utilize a variety of habitats and the Smooth-coated Otter requires a source of freshwater (rivers, streams, wetlands, etc.).

In Lao PDR, the Chinese Serow (*Capricornis milneedwardsii*, VU) is thought to be widely distributed in mountainous regions, although data on population size and trends is lacking. According to Thuc *et al.* (2014[64]), the species typically inhabits hilly or rugged mountainous areas with steep slopes and rocky outcrops, preferring secondary forests to primary forest and is likely to tolerate moderately degraded forest habitat.

As a result of forest habitat fragmentation, land claims for animal ranching, subsistence hunting and other human pressures, the land mammal group is considered to be under considerable threat in Laos PDR, possibly significantly higher than the other faunal groups (Phiapalath *et al.,* 2022). There is however evidence to suggest that some of the larger mammal species that have disappeared from the surrounding region may still occur within the protected 'Sacred Forest' of Phou Koungking identified, where these species can take refuge away from human pressures due to local beliefs and superstitions preventing ordinary access to this forest habitat (Phiapalath *et al.,* 2022). Refer also to

[64] Thuc, P.D., Baxter, G., Smith, C. and Hieu, N. (2014). Population status of the Southwest China Serow *Capricornis milneedwardsii*: A case study in Cat Ba Archipelago, Vietnam. In Pacific Conservation Biology Vol 20 (4): 385-391. Available online for download at: https://www.researchgate.net/publication/265848893_Population_status_of_the_Southwest_China_Serow_Capricornis_milneedwardsii_A_case_study_in_Cat_Ba_Archipelago_Vietnam

the findings of the social survey for more information on the 'Sacred Forest' appearing in ***Chapter 8*** of the ESIA, specifically ***section 9.5.8*** 'Impact on Cultural Heritage').

Note that bat species (also mammals) have been discussed separately as a component of the volant (flying) species documented in ***section 8.4.5***.

For the comprehensive list of mammal species recorded, the reader is referred to the baseline biodiversityassessment report contained in ***Appendix S***.

Table 8-24: Mammals with elevated threat status

Common Name	Scientific Name	IUCN Red List Status	Confirmed species (surveyed)	Credible accounts (villagers): *medium confidence*	Reported by villagers but presence unlikely: *low confidence*
Bengal Slow Loris	*Nycticebus bengalensis*	EN		X	
Pygmy Slow Loris	*Nycticebus pygmaeus*	EN		X	
Stump-tailed Macaque	*Macaca arctoides*	VU			X
Northern Pig-tailed Macaque	***Macaca leonina***	**VU**	**X**		
Northern Buff-cheeked gibbon	***Nomascus annamensis***	**EN**	**X**		
Silver langur	*Trachypithecus sp.*	EN			X
Red-shanked Douc Langur	***Pygathrix nemaeus***	**CR**	**X**		
Annamite Striped Rabbit	*Negolagus timminsi*	EN		X	
Black Giant Squirrel	***Ratufa bicolor***	**NT**	**X**		
Chinese Pangolin	***Manis pentadactyla***	**CR**	**X**		
Sunda Pangolin	***Manis javanica***	**CR**	**X**		
Dhole	*Cuon alpinus*	EN			X
Binturong	*Arctictis Binturong*	VU			X
Owston's Civet	***Chrotogale owstoni***	**EN**	**X**		
Smooth-coated Otter	***Lutrogale perspicillata***	**VU**	**X**		
Asiatic Black Bear	***Ursus thibetanus***	**VU**	**X**		
Sun Bear	***Ursus malayanus***	**VU**	**X**		
Greater Hog Badger	***Arctonyx collaris***	**VU**	**X**		
Chinese Serow	***Capricornis milneedwardsii***	**VU**	**X**		

Common Name	Scientific Name	IUCN Red List Status	Confirmed species (surveyed)	Credible accounts (villagers): *medium confidence*	Reported by villagers but presence unlikely: *low confidence*
Sambar Deer	***Cervus unicolor***	**VU**	**X**		
Chinese Goral	*Naemorhedus greseus*	VU			X
Large-antlered muntjac	*Muntiacus vuquangensis*	CR		X	

Key to table:

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened

8.4.7 Herpetofauna

8.4.7.1 Methodology

Data collection was comprised of both field surveys and interviews with local villagers. Field surveys were conducted during both the day and night, with a focus on the wet season sampling when activity is considered highest. Daylight surveys were undertaken both in the morning, from 08:00 to 11:30, and the afternoon from 14:00 to 17:30 in the early evening. Attention was given to micro-habitats such as fallen logs, amongst leaf litter on the forest floor, trees, burrows, and tree hollows which in turn were situated around focal habitats such as waterbodies and wetlands. Nocturnal surveys utilised a direct encounter method and were conducted from 19:00 to 22:00. Unfamiliar species were captured for photographing, detailed identification, and DNA sampling.

8.4.7.2 Survey Findings

The numerous small streams in the Montane Forest habitats at altitudes exceeding 1000m amsl are likely to host some important and endemic herpetofauna species (i.e. amphibians and reptiles). A combined total of 71 species of herpetofauna (amphibians and reptiles) were recorded through field surveys conducted, of which 30 reptile species and 41 amphibian species were identified.

Several reptile species with elevated global threat status according to IUCN were recorded through the field surveys conducted, including:

- Red River Krait (*Bungarus slowinskii*, VU), a venomous species of snake endemic to mainland SE Asia (Laos and Vietnam);
- Impressed Tortoise (*Manouria impressa, EN),* a terrestrial forest-dwelling species and resident of SA Asia*;*
- Asiatic Softshell Turtle (*Amyda cartilaginea, VU),* a semi-aquatic species common to inland freshwater ecosystems*;*
- Chinese Softshell Turtle (*Pelodiscus sinensis, VU),* a semi-aquatic species common to inland freshwater ecosystems*;*
- Tiny Bubble-nest Frog (*Gracixalus supercornutus, NT),* a forest dwelling, semi-aquatic frog known from Lao PDR and Vietnam*;* and
- Firth's Litter Toad (*Leptobrachella firthi, EN),* a forest dwelling frog closely associated with small, shallow rocky streams within montane evergreen forest and particularly where riparian vegetation is absent.
- These are primarily forest-dwelling species, confined to secondary or primary evergreen forest in the mountainous regions of SE Asia, with several species (i.e. frogs and turtles) requiring

freshwater habitats either to survive or complete their life-cycles (IUCN Red Data List: online at https://www.iucnredlist.org/) (refer also to ***Table 8-25***)

Local records were also documented for several additional EN and VU species of snake, tortoise and turtle, also listed in ***Table 8-25****,* although these species were not encountered during the field surveys undertaken. The full list of local records and least concern species recorded through field surveys and interactions with local villagers is contained in Annexure 3b of the 'Biodiversity Assessment Report' (***Appendix S***) and a review of species status revealed that none of these are endemic species to Laos PDR, with most species occurring also in neighbouring Viet Nam and Cambodia.

Herpetofauna are considered to be one of the least-known or documented groups of vertebrates in Lao PDR, with several species records considered previously unknown to science. Four species identified during field surveys (not appearing on the IUCN RDL) are also considered first records for Lao PDR (***Table 8-25***)., 2 reptile species were second records of Laos and 2 species have not been described yet and could possibly be new to science, including *Rhacophorous sp.* and *Quasipaa sp.* (*previously undiscovered potentially requiring further investigation*[65]), which could also be local endemic species potentially.

Table 8-25: Herpetofauna with elevated threat status, first records for Lao PDR or potential new species to science

Class	Common Name	Scientific Name	Evidence	IUCN Red List Status	Comments
REPTILES	**Red River Krait**	***Bungarus slowinskii***	**Field observation**	**VU**	Not endemic
	King cobra	*Ophiophagus hannah*	Local record	VU	Not endemic
	Black and White Spitting Cobra	*Naja siamensis*	Local record	VU	Not endemic
	Burmese Python	*Python bivittatus*	Local record	VU	Not endemic
	Elongated Tortoise	*Indotestudo elongata*	Local record	EN	Not endemic
	Impressed Tortoise	***Manouria impressa***	**Field observation**	**EN**	Not endemic
	Keeled Box Turtle	*Cuora mouhotii*	Local record	EN	Not endemic
	Asiatic Softshell Turtle	***Amyda cartilaginea***	**Field observation**	**VU**	Not endemic
	Chinese Softshell Turtle	***Pelodiscus sinensis***	**Field observation**	**VU**	Not endemic
	-	***Acanthosaura prasina***	**Field observation**	**-**	First record for Lao PDR
AMPHIBIANS	**-**	***Kurixalus bannaensis***	**Field observation**	**-**	Not endemic, possibly rare
	Tiny Bubble-nest Frog	***Gracixalus supercornutus***	**Field observation**	**NT**	Not endemic

65 There is considerable uncertainty at this stage for previously undescribed species potentially new to science, unless specimens are analyzed as candidate new species. *Rhacophorus sp.* is certainly undescribed species, and as for the *Xenophrys maosonsis,* this is a complex species and the one found will be split as a new species in the near future.

Class	Common Name	Scientific Name	Evidence	IUCN Red List Status	Comments
	-	***Rhacophorus sp.***	**Field observation**	-	First record for Lao PDR & possibly 'new species to science'
	Maoson Horned Toad	***Xenophrys cf maosonensis***	**Field observation**	-	Not endemic
	-	***Quasipaa sp.***	**Field observation**	-	Not endemic, possibly 'new species to science'
	Spinyback Torrent Frog	***Amolops spinapectoralis***	**Field observation**	**LC**	First record for Lao PDR, Not endemic
	-	***Limnonectes poilani***	**Field observation**	**LC**	
	Firth's Litter Toad	***Leptobrachella firthi***	**Field observation**	**EN**	
	Truong DSon Bug-eyed Frog	***Theloderma truongsonensis***	**Field observation**	**LC**	

Key to table:
EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient; LC = Least Concern

For a comprehensive list of herpetofauna (reptiles and amphibians) recorded, the reader is referred to the baseline biodiversity assessment report contained in ***Appendix S***.

8.4.8 Ichtyofauna (fish)

8.4.8.1 Methodology

For fish species, existing databases and IBAT results were screened to determine the potential for conservation important fish species to occur within the study area. This was supplemented by fish surveys conducted on the small streams above SB1 and SB2 using a standard fish netting approach (catch and release).

8.4.8.2 Desktop Survey Findings

Fish species that are endemic to Lao PDR and/or with elevated conservation/threat status that were assessed at a desktop level in terms of their likelihood of occurrence in the area of study are listed below in ***Table 7.25***. Based on the desktop assessment, only two endemic fish species of Least Concern are predicted to possibly occur in the study area, including *Schistura imitator* and *Schistura clatrata.*

Table 7.25: Endemic fish species assessed at a desktop level

Common Name	Scientific Name	IUCN Red List Status	Likelihood of Occurrence	Comments
-	*Poropuntius bolovenensis*	EN	Unlikely	This species is an upland species found only on the Boloven Plateau, Paksong District, Champasak Province, southern Lao PDR. Consultations with a regional fish expert suggests that the Bolaven Plateau is unlikely to be hydrologically connected with the Dakchung Plateau and its surrounding area (M.Kottelat pers. comm., October 11, 2021).
	Schistura bolavenensis	EN	Unlikely	Same comment as above.
-	*Poropuntius lobocheiloides*	EN	Unlikely	Same comment as above.
-	*Poropuntius solitus*	EN	Unlikely	This species is only known from tributaries of the Xe Kong River on the eastern half of the Bolaven Plateau, Lao PDR. Consultations with a regional fish expert suggests that the Bolaven Plateau is unlikely to be hydrologically connected with the Dakchung Plateau and its surrounding area (M.Kottelat pers. comm., October 11, 2021).
-	*Poropuntius consternans*	EN	Unlikely	Same comment as above.
-	*Devario salmonatus*	DD	Unlikely	Same comment as above.
-	*Serpenticobitis octozona*	DD	Unlikely	This species is found in the Sekong drainage in Lao PDR. Consultation with a regional fish expert revealed that the most recent (and likely only) field survey of the area was briefly undertaken in 2011 (Kottelat, 2011. This species was not detected during surveys then. (M.Kottelat pers. comm., October 11, 2021). While endemic to the Sekong drainage, no other information reviewed suggests that suitable habitat does not occur across this species' range.
-	*Schistura imitator*	LC	**Possible**	This species has only been recorded from the Sekong basin, southern Lao PDR. Consultation with a regional fish expert revealed that the most recent (and likely only) field survey of the area was briefly undertaken in 2011 (Kottelat, 2011. This species was not detected during surveys then (M.Kottelat pers. comm., October 11, 2021). In accordance with the precautionary principle, as the EAAA

Common Name	Scientific Name	IUCN Red List Status	Likelihood of Occurrence	Comments
				for the Project comprises more than 10% of the species' range (c.15.8%), and limited surveys have been located within the Se Kong basin, it is possible that this species could occur.
-	*Schistura clatrata*	LC	**Possible**	Same comment as above.

Key to table:
EN = Endangered; DD = Data Deficient; LC = Least Concern

8.4.8.3 Field Survey Findings

Sampling of the small streams above SB1 and SB2 identified a total of 9 species of fish, most being species of least concern and common resident species. There were endemic fish recorded upstream of the project site and at high elevation belonging to the following genera: *Schistura, Annamia, Vamanenia* and *Poropuntius.* Given the location at high elevations above the project area and potential area of impact of the project, further analysis of fish species was considered not relevant to the project. This desktop information is reflected in Annexure 8 of the 'Biodiversity Assessment Report' (Phiapalath *et al.*, 2022) located in ***Appendix S***.

8.4.9 Flora

8.4.9.1 Methodology

To carry out vegetation surveys within the classified forest habitats, 30 sample plots (10mx10m quadrats) measuring 100m^2 were identified, with six plots sampled per Survey Block (5 survey blocks in total). Additional smaller plots were surveyed for tree saplings (5x5m quadrats, 25m^2), and for communities dominated by herbs and grasses, 2mx2m (4m^2) quadrats were used. The average elevation of these plots was 1,312m above sea level; ranging from 1,029m above sea level to 1,615m. Plant species were identified and listed, with their frequency of occurrence and densities assessed and species grouped according to their respective family, number of seedlings recorded, and undergrowth vegetation described (e.g. moss, herbs, ferns, etc.). Where possible and necessary, samples of fruit/leaves were collected to aid in the identification of plants that could not be easily or readily identified in the field.

Some species that were found just adjacent to the relevant sample plots were also recorded to provide a comprehensive list of plants in the survey area. Non-tree species were counted to obtain a biodiversity baseline but excluded from the forest habitat analysis.

8.4.9.2 Survey Findings

Five survey blocks in total were sampled, with the vegetation communities and habitats encountered being primarily Wet Evergreen Forest at the lower altitude, with Montane Evergreen Forest occurring at higher altitudes (typically above 1000m amsl). Some of the forest communities were found to be degraded as a result of agricultural activities in the area.

Structurally, the forest communities were found to be relatively open, having little to no emergent layer in the sub-canopy, which was occupied instead by fallen trees, moss, rocks and lichens. Shrub layers were short and included younger trees, wild gingers and weeds. A relatively high tree density and canopy cover was encountered, with mean canopy height estimated to range from 14m to 35m from ground level and with a mean canopy cover of 85 - 90%. The forests sampled at lower elevations exhibited 3 layers of forest structure (canopy, understorey and shrub layer), with the higher elevation forests missing the emergent understorey layer)

A total of 626 plants, representing 538 species from 178 families were recorded, of which some 250 tree species belong to 58 families.. The Rubiaceae, Lauraceae and Fagaceae, Annonaceae and Fabaceae were the dominant tree families sampled within the forest habitats, with 83 species recorded in total within the forest habitats sampled.

Two globally threatened species of flora were recorded, including:

- *Zingiber mellis* (EN), a rhizomatous herb common to higher-altitude, broad-leaved moist montane evergreen forest; and
- Soum dok-noi (*Pittosporum pauciflorum*, VU), a small tree / shrub species confined to areas of mixed montane forest (IUCN Red Data List: online at https://www.iucnredlist.org/).

In addition, the following 3 Near-Threatened (NT) species were recorded in the area:

- Phaya mai (*Nageia fleuryi*), a tree (conifer);
- Peak habai (*Pinus dalatensis var. bidoupensis),* a sub-montane and montane pine tree, endemic to Indonesia and China (IUCN Red Data List: online at https://www.iucnredlist.org/); and
- Kor langbian (*Quercus langbianesis*), an uncommon oak tree species.

Globally, these tree species have a relatively large distribution and are not yet considered as globally threatened species. That being said, despite limited information on population trends for these species, their respective habitats are under threat from agricultural activities, logging and wood harvesting activities which could potentially shift their threat status to VU in the future (IUCN Red Data List: online at https://www.iucnredlist.org/).

Findings of the flora survey are also considered significant to the scientific community, since 10 plant species were listed as rare or possibly new species to science and 29 first recoded plant records of Lao PDR.

Table 8-26: Plants with elevated threat status

Family	Common Name	Scientific Name	IUCN Red List Status	Survey Block (1-5)
Podocarpaceae	Phaya mai	*Nageia fleurryi*	NT	2, 5
Pinaceae	Peak habai / Dalat pine	*Pinus dalatensis var. bidoupensis*	NT	2
Pittosporaceae	Soum dok-noi	*Pittosporum pauciflorum*	VU	4, 5
Fabaceae	Kor langbian)	*Quercus langbianesis*	NT	4
Zingiberaceae	-	*Zingiber mellis*	EN	3

Key to table:
EN = Endangered; VU = Vulnerable; NT = Near Threatened

For a comprehensive list of flora recorded, the reader is referred to the baseline biodiversity assessment report contained in ***Appendix S***

8.4.10 Summary of the Critical Habitat Assessment

8.4.10.1 Introduction

A Critical Habitat Assessment (“CHA”) was completed for the Project, in support of the Project’s alignment with the applicable international standards, which include the Asian Development Bank’s

Safeguards Policy Statement ("ADB SPS"). The complete CHA is contained in ***Appendix T*** of the ESIA.

8.4.10.2 Critical Natural and Modified Habitats

The ADB SPS differentiates between three categories of land and water areas based on habitat condition and biodiversity value:

- **Natural habitat**: includes areas where the biological communities are formed largely by native flora and fauna, and where human activity has not essentially modified the area's primary ecological functions (ADB SPS, 2009);
- **Modified habitat**: where the natural habitat has apparently been altered, often through the introduction of alien species of plants and animals (ADB SPS, 2009) and includes areas that may still contain a large proportion of native flora and flora, and/or where human activity has substantially modified an area's primary ecological functions and species composition (IFC PS6, 2019); and
- **Critical habitat**: is considered a subset of natural and modified habitat (identified irrespective of the condition of these areas) and encompasses areas with high biodiversity value associated with the presence of significant types of biodiversity (ADB SPS, 2009).

8.4.10.3 Assessment Approach

The approach to the CHA was as follows:

- EAAAs (Ecologically Appropriate Assessment Areas) were identified and delineated for volant (flying) species, and non-volant (non-flying) species, respectively, to determine the spatial extent and scope of the CHA;
- Modified and natural habitats were identified / differentiated and mapped;
- A desk-based review of available information on the biodiversity features within the EAAA was undertaken to inform the CHA;
- The key findings of the baseline biodiversity surveys for fauna and flora were reviewed, with a key focus on species of conservation importance such as globally/nationally threatened plants and animals recorded, with consultation with specialist to verify results;
- Biodiversity features identified as present or likely to occur within the volant and non-volant EAAAs were screened against the six qualifying criteria for 'critical habitat' provided in the ADB SPS and the ADB Environment Safeguards, 'A Good Practice Sourcebook' (aligned also with IFC PS6), including:
  - **Criterion 1** - *Habitat required for the survival of critically endangered or endangered species,*
  - ***Criterion 2*** - *Areas with special significance for endemic or restricted-range species,*
  - ***Criterion 3*** - *Sites that are critical for the survival of migratory species,*
  - ***Criterion 4*** - *Areas supporting globally significant concentrations or numbers of individuals of congregatory species,*
  - ***Criterion 5*** - *Areas with unique assemblages of species that are associated with key evolutionary processes or provide key ecosystem services,*
  - ***Criterion 6*** - *Areas with biodiversity that has significant social, cultural or economic importance to local communities, and*
  - *In addition, legally protected or officially proposed areas for protection.*

8.4.10.4 Findings of the CHA

The Project area has been described to be located in a mosaic of evergreen forest, shifting cultivation, shrub land and grassland, waterbodies, and built-up areas. In several areas, there has been extensive modification for agriculture and clearance of forests by local communities predominantly. The EAAAs assessed therefore contain both natural and modified habitat in terms of the ADB SPS definitions for these types:

- areas of natural habitat are concentrated in the northern and eastern sections and represent approximately 41% (109,665 ha) of the EAAA for non-volant species and 36% (86,753 ha) of the EAAA for volant species; and
- modified habitat (59-64% of EAAAs) is mostly found in the central and southern sections of the EAAAs, comprising primarily agricultural areas (currently or historically cultivated lands) that have been cleared and transformed through human activity and associated disturbance of the native vegetation and soils.

The EAAAs for volant and non-volant species associated with the Project both qualify as critical habitat in terms of criteria 1, 2 and 5, as key habitats were identified as supporting populations of CR/EN species, endemics and/or range-restricted species, and were also considered important in providing key ecosystem services. In addition, two Protected Areas (PAs) and five Key Biodiversity Areas (KBAs) overlap with the EAAAs and also qualify the EAAAs as critical habitat in terms of the ADB SPS (2009). This has been summarised below in ***Table 8-27.***

The two natural forest types, Montane Forest and Wet Evergreen Forest, are considered the most important ecosystems in the EAAAs in terms of providing key ecosystem services, and equally the most important habitats for supporting CR/EN species, endemics and range-restricted species.

Table 8-27: Summary of the Critical Habitat Assessment findings

ADB SPS qualifying criteria for Critical habitat	Qualifies as Critical habitat?	Relevant Habitat Types	Rationale
Criterion 1: Habitat required for the survival of critically endangered or endangered species.	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest ■ Natural / Modified Wet Evergeen Forest	■ 13 fauna (mammals, reptiles and birds) represented with CR or EN threat status[66]. ■ 1 species of EN plant. ■ For modified forest habitats, fewer species are likely represented than for natural areas but still some CR or EN species may utilise these habitats.
Criterion 2: Areas with special significance for endemic or restricted-range species.	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest ■ Natural / Modified Wet Evergeen Forest	■ Two mammal, twobird and two reptile species are also endemic and/or range-restricted. ■ 2 species of endemic and range-restricted fish may possibly occur in the EAAAs. ■ There are three species of amphibians and 10

[66] Ten mammals, two reptile and one bird species

ADB SPS qualifying criteria for Critical habitat	Qualifies as Critical habitat?	Relevant Habitat Types	Rationale
			species of plants that were recorded during field surveys that may potentially be 'new to science'. These species could be local endemicsFewer species are likely to represented in modified habitats than for natural areas but still some endemic and/or range-restricted species may utilise these habitats.
Criterion 3: Sites that are critical for the survival of migratory species.	No	n/a	■ The requirements / thresholds for these criteria have not been met in terms of the key species identified.
Criterion 4: Areas supporting globally significant concentrations or numbers of individuals of congregatory species.	No	n/a	
Criterion 5: Areas with unique assemblages of species that are associated with key evolutionary processes or provide key ecosystem services.	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest ■ Natural / Modified Wet Evergeen Forest	■ The broader landscape contains a number of KBAs specifically designated for endemic species, which overlap with or are located within the EAAAs. ■ There are also three species of amphibians and 10 species of plants that were recorded during field surveys that may potentially be 'new to science'. ■ Given the potential for the forest ecosystems to provide key ecosystem services at both a local/regional and global scale, which are also considered 'Priority ecosystem services' as per the definition provided in IFC PS6 for this criterion, the forest ecosystems are considered to qualify as critical habitat.
Criterion 6: Areas with biodiversity that has significant social, cultural or economic importance to local communities.	**No**	**n/a**	■ 'Sacred forest' areas appear to be associated principally with existing cemeteries, rather than the forest and biodiversity that just happen to be where

ADB SPS qualifying criteria for Critical habitat	Qualifies as Critical habitat?	Relevant Habitat Types	Rationale
			these sites are located. Therefore, strictly speaking the associated forest does not qualify either EAAA as critical habitat in terms criterion 6.
Additional: legally protected areas or areas officially proposed for protection (such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites).	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest Natural / Modified Wet Evergeen Forest	■ Phou Ahyon is a proposed protected area which overlaps with the Project footprint (see also ESIA Table 7-16). As such, despite lack of clarity in the ADB SPS, paragraph 30 (see below) does apply. (i) Act in a manner consistent with defined protected area management plans. (ii) Consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project. (iii) Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area.

8.4.10.5 Implications of the CHA for the Project

Requirements in terms of natural habitat identified

There are a number of Project components that overlap with terrestrial and aquatic areas that are designated as 'natural habitat' and in these instances, the ADB SPS requires that the Project does not significantly convert or degrade areas of natural habitat, and mitigation measures are designed to achieve at least an overall no net loss of biodiversity.

Requirements in terms of critical habitat identified

Both the volant and non-volant EAAAs assessed qualify as comprising critical habitat, based on several of the ADB SPS critical habitat-qualifying criteria (as per ***Table 8-27***).

Where impacts do occur to identified 'critical habitats', the Project is required to fully exercise the mitigation hierarchy, and demonstrate an overall net gain of critical habitat-qualifying biodiversity associated with Project site. This is aligned with ADB SPS, paragraph 28 – "*No project activity will be implemented in areas of critical habitat unless the following requirements are met:*

i. There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.

ii. The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.

iii. Any lesser impacts are mitigated in accordance with para. 27', whereby mitigation measures will be designed to achieve at least no net loss of biodiversity."

Requirements in terms of legally protected areas

Legally protected areas or areas officially proposed for protection are also to be considered as critical habitats in terms of the ADB SPS. Phou Ahyon is a proposed protected area and will be crossed by the transmission line. As such, despite lack of clarity under ADB SPS Safeguard 1, paragraph 30 does apply. *The borrower/client will meet the following requirements:*

i. Act in a manner consistent with defined protected area management plans.

ii. Consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project.

iii. Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected

8.5 Social Baseline

8.5.1 Introduction

This section presents a description of the socio-economic characteristics of the Project Area of Influence (AoI), and where available utilizes national and regional level data for providing a more cogent understanding of the context. This social baseline analysis is based on:

- Social baseline provided in the local EIA (2022);
- Primary data collected by conducting a systematic socio-economic household survey, key informant interviews targeting the AoI, to supplement the available surveys and studies; and
- Secondary data collated from published literature as well as national and regional data sources.

Focus group discussions (FGDs) and key informant interviews (KIIs) were chosen as the qualitative data collection methodology to:

- Provide detailed information rapidly;
- Provide information on the many non-measurable issues (for example, access to natural resources or the structure of social institutions); and
- Ensure a more inclusive, participatory approach than what would have been possible with individual questionnaires.

However, due to the Covid-19 pandemic, government restrictions were imposed on the districts where the Project is located, for the majority of the duration in the second half of 2021. As such, the Project was not able to undertake FGDs. The local villagers were also hesitant to engage in group activities due to the risk of spreading Covid-19.

The Project team was apprehensive of potential risks associated with the undertaking of the social baseline plan, therefore a modification to the plan was implemented with an aim to fill the gaps while respecting the needs to have a Covid-19-safe field operation during the pandemic.

The modification of the social baseline plan consisted of:

- KIIs with village leaders, teachers, healthcare workers, religious leaders, and others; and
- FGDs (in the KII format) with representatives of women groups, youth groups, livelihood groups, ethnic minority groups.

8.5.2 National Socio-economic Overview

This section presents national-level overview of demographics, institutional context, and the economy of Laos.

An overview of the national socio-economic conditions provides a context for the socio-economic conditions and characteristics of the Project-affected population to be understood more thoroughly, which in turn, provides a strong basis for the potential socio-economic impacts on the Project-affected population to be assessed, particularly in the area of vulnerability to change.

8.5.2.1 Demographic Information

8.5.2.1.1 The Lao PDR population

Lao PDR is a land-locked country in mainland Southeast Asia bordering Myanmar, Cambodia, China, Thailand, and Vietnam, with a total area of approximately 237,000 km^2. The landscape is mostly mountainous (80%) with some plains and plateaus (20%) found mostly among the Mekong river plains.[67] The country has 7.2 million people live in 18 provinces in 2020, with an estimated annual growth rate of 1.5%.[68] The male and female population of Lao PDR are 3.65 million and 3.62 million respectively, with a corresponding share of 50.2% and 49.8%. The country has a total of approximately 1.3 million households with average household size of 5.3 people per family and population density of 31 people per km^2.

8.5.2.1.2 Ethnicity and Religion

The country is one of the most ethnically diverse countries in mainland Southeast Asia. The Lao government currently recognises 160 ethnic subgroups within 50 ethnic groups.[69] Out of the total population, the Lao ethnic group accounted for 53 percent, followed by Khamu (11%), Hmong (9%) and other ethnic groups (27%).

Laos is official language and over 80 languages used by different ethnicities in Lao PDR and the most common are Khmu and Hmong languages. Other minority languages include Akha, Arem, Bana, Katu, Ksingmul, Maleng, Lamet, Phai, Tai Daeng, Phu Thai, and Tai Dam.

The most vulnerable ethnic minorities have very few assets, are geographically isolated (mostly highlands), and face language and cultural barriers.

Buddhism is the pre-dominant faith practiced by the population in Lao PDR. Sixty-five percent of the population are Buddhist, while Christians constituted nearly 2%, and 32% reported themselves as having no religion or being animist.[70]

8.5.2.1.3 In-migration and out-migration

A significant portion of the population (35%) still resides in rural areas and work in an agriculture sector dominated by subsistence farming; however, the pace of urbanization (population growth in urban areas) is relatively fast at a rate of at 3.1% per annum in 2015, the highest urbanization rate in the Asia Pacific region.[71]

[67] Land-Links, 2013
[68] Lao Statistic Bureau, 2020a
[69] IWGIA, 2021
[70] IFAD, 2012
[71] UN-Habitat & ESCAP, 2015, p. 23

In addition, there is a strong in-migration trend in Lao PDR, where one in ten residents moved into an area from another province.[72] In the last thirty years, rural to urban migration seems to be a recent phenomenon resulted from networks constructed around the country.[73]

According to United Nations data, there are 1.3 million Lao nationals living abroad, with Thailand the largest destination country (approximately 300,000). Lao migrant workers are predominantly employed in domestic work, construction, manufacturing, agriculture, seafood processing and entertainment work, mainly in neighbouring border provinces and larger cities in Thailand. Financial remittances from these workers are a significant source of income in the Lao People's Democratic Republic, totalling an estimated USD 265 million in 2020.[74] It is within the context of this cross-border movement that the migrating population is at the risk of being trafficked for forced labour, sexual exploitation, and child labour.[75]

8.5.2.1.4 Poverty, inequality and human development index

Lao PDR is classified as a low and middle income country (LMIC) and a least develop country (LDC) by the United Nation. LDCs are low-income countries confronting severe structural impediments to sustainable development. They are highly vulnerable to economic and environmental shocks and have low levels of human assets.[76]

Lao's Gross Domestic Product (GDP) per capita is USD 1,789, with GDP growth rate at 7.2 percent on average over the last 20 years.

The poverty rate of Lao PDR has declined from 24.6% in 2012/2013 to 18.3% in 2018/2019 (Lao Statistics Bureau, 2020b); however, the poverty rate in Lao PDR is now expected to increase to 21.5% due to the impact of Covid-19 (Government of the Lao PDR, 2021). Although the poverty rate has been rapidly reduced in rural areas (while urban poverty reduction has stagnated), the gap in poverty rate between rural (23.8%) and urban (7.0%) poverty rates remain – rural poverty rate is 3.4 times higher than that of urban areas as reflected in increased Gini[77] index from 0.31 in 1992/93 to 0.39 in 2018.[78][79]

In 2019, Lao PDR's Human Development Index (HDI)[80] was 0.61, ranking 137th out of 189 countries indicating a medium human development progress. The Lao PDR HDI comes with a Gender Inequality Index (GII)[81] of 0.46, raking 113th out of 162 countries suggesting a relatively low inequalities between women and men, and the Multidimensional Poverty Index (MPI)[82], which is the share of the population that is multidimensional poor, adjusted by the intensity of the deprivations, is 0.11.[83]

In 2021, the new prime minister announced seven priorities, vowing to tackle public debt and revenue leakages, boost exports, counter corruption and create more job opportunities. The government has

[72] Lao Statistics Bureau, 2016, p. 56

[73] Bouté, 2017, as cited in UCRSEA, 2017

[74] ILO, 2021

[75] US Department of State, 2021

[76] UN Department of Economic and Social Affairs, n.d.

[77] The Gini Index is a summary measure of income inequality. The Gini coefficient ranges from 0, indicating perfect equality (where everyone receives an equal share), to 1, perfect inequality (where only one recipient or group of recipients receives all the income). Thus, values indicating greater inequality.

[78] Lao Statistics Bureau, 2020b

[79] The World Bank, n.d.

[80] The HDI is a summary measure for assessing long-term progress in three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living.

[81] GII reflects gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activities

[82] MPI identifies multiple overlapping deprivations suffered by individuals in 3 dimensions: health, education and standard of living.

[83] UNDP, 2020a

also pledged to foster quality growth and reduce reliance on the natural resource sector, to increase access to basic public services, especially health and education, and to place more emphasis on human resource development.

A brief country overview of Lao PDR is presented in ***Figure 8-30***.

Figure 8-30: Lao PDR Country Brief Overview

Capital	Vientiane
Area	237,000 km^2
Population	7.2 million
GDP	USD 17.95 billion (2018)
GDP Growth Rate Projection	-1.8 to 1% in 2020, usually around 6.8% annually
Inequality (Gini Coefficient)	41.1 (medium)
Human Development Index (HDI)	0.64
Income Status	Lower middle income
Poverty rate	21.5%
Key export	Hydropower, tourism, wood, clothing, coffee, rubber, metal

8.5.2.2 *Institutional Context*

Lao PDR's system of governance has four levels: national, provincial, district and village with provincial, district, and village levels classified under local governance. The institutional context is summarised below:

- **The National Assembly:** is the supreme organ of the state and the only body with constitutional and legislative power to draw up, adopt, and amend the constitution and to make and amend laws, to legislate and implement state plans and budgets, and overseeing the activities of the executive and the judiciary bodies. Each National Assembly has a term of five years. Elections for the new National Assembly must be completed no later than 60 days before the old National Assembly expires.
- **The President:** The President is the Head of State of the Lao PDR and represents the Lao people of all ethnic groups both domestically and internationally. The President is elected by the National Assembly by a two-thirds majority vote of the members present. The term of office of the President is the same as that of the National Assembly. The main function of the President is to maintain the regular and coordinated operation and stability of the national government, safeguard the independence and territorial integrity of the country.
- **The Government:** The government is the executive body of the National Assembly and the highest body of state administration of Lao PDR. It oversees performance of state functions in all areas: political, economic, cultural, social, national defense, security and foreign affairs.
- **Local government:** The Lao PDR divides local government into three levels: provincial, district and village. Each level includes: provinces and cities; districts and municipalities; villages. Each level has the governing bodies: Provincial governor, district heads and village heads, and mayor for municipality.
- Courts and the Public Prosecutor's Office

- **People's Court:** The People's Court is a state judicial body that has the power to protect and enhance the effects of the revolution, political system, economy, culture and society; Punish and educate violators of the law, educate citizens to respect the rules and regulations.

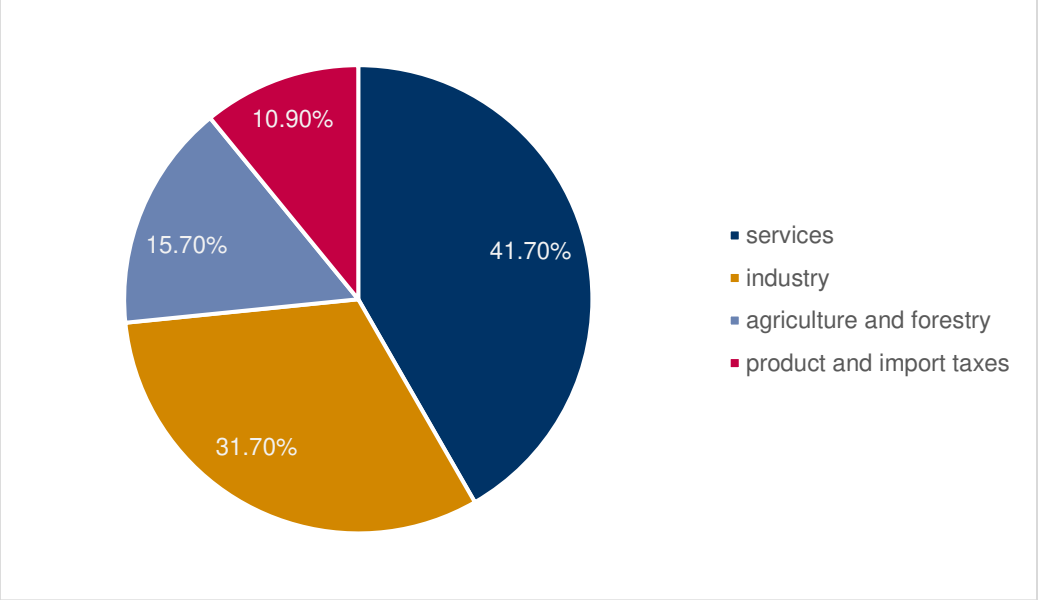
- The court system of the People's Courts of the Lao People's Democratic Republic consists of: The People's Supreme Court; Court of Appeal; Provincial, city people's courts; District People's Court and Military Court.
  - **Public Prosecutor's Office:** The People's Procuratorate is the body that monitors the implementation of the law, which consists of: the Supreme People's Procuratorate; Appellate Public Prosecutor's Office; Provincial and city Public Prosecutor's Office; District Public Prosecutor's Office and Military Prosecutor's Office.[84]

8.5.2.3 Economy and Industry

Lao PDR is one of the fastest growing economies in the region, with an average growth rate of 7.5% between 2010 and 2017. Its GDP is driven by energy (hydroelectricity) and mining, timber and non-timber forest products (NTFPs), followed by services and agriculture. Its manufacturing sector has also been steadily growing. The breakdown of the sectoral origins of Lao PDR GDP in 2018 was 41.7% services, 31.7 % industry (including construction and mining), 15.7 % agriculture, forestry, and fishing, and 10.9% product and import taxes.

With a total population of 7.2 million, Lao PDR's population growth is moderate at 1.45 % annually. The majority of the workforce is concentrated in the agricultural sector and lives in rural areas. The agricultural sector is low-tech, labour intensive and has low productivity, i.e. it does not contribute much to GDP growth.[85]

Figure 8-31: Lao PDR's Main GDP Contributor



Source: Ministry of Planning and Investment, 2020. Socio-economic Development Annual Report 2018-2019.

In 2020, like many countries around the world, Lao PDR's economies were impacted by Covid-19 outbreak and its containment measures. Economic growth declined to an estimated 0.4% in 2020, the lowest level in three decades, and a second wave of the pandemic in 2021 has led to a growth rate of

[84] Government of the Lao PDR, 2003 & 2014; OCSC, n.d.
[85] WB Lao Economic Monitor, April 20

just 2.2% forecast for 2021.[86] The agriculture and industry sectors are expected to drive growth, supported by solid external demand as key trading partners recover. However, the services sector – especially hospitality, transport and other tourism-related services – are struggling to recover as the second Covid-19 wave (since mid-April, 2021) has reversed the initial recovery in Q1 2021.[87]

8.5.2.4 Renewable Energy Planning and Development

8.5.2.4.1 Current Status of Power Generation

Lao PDR has capitalized on its estimated 26,000 MW of technical hydropower potential and aims to become the Battery of Southeast Asia by exporting electricity to neighbouring markets. A large investment program increased the installed capacity in the system from only 640 MW in 2000 to around 9,480 MW by 2020. The Mekong Infrastructure Tracker shows that most power generation is supplied from 63 hydropower dams totalling 7,559 MW in generation capacity. The remaining power is produced by the Hongsa coal plant (1,878 MW), a few biomass plants (35 MW), and eight solar projects (42 MW).[88]

Although approximately 70% of Lao PDR's generation capacity has been dedicated for export, domestic demand has been growing rapidly. Lao PDR's per capita electricity consumption is among the lowest in Association of Southeast Asian Nations (ASEAN) but is rising rapidly at an average rate of 14.5% annually over the past 10 years. By 2019, 100% of households nationally had access to electricity.[89]

8.5.2.4.2 Lao PDR Renewable Energy Planning and Development

The Renewable Energy Development Strategy in Lao PDR of 2011 aims to encourage the development of renewable energy sources at a national level. The Strategy gives:

- an overview of renewable energy and its potential in the country;
- lays out strategy and policy; and
- presents possible implementation measures for renewable energy deployment

The national energy target laid out in the strategy aims to achieve a renewable energy share of:

- 30% in total energy consumption by 2025.
- 10% in total transport energy consumption (using biofuels) by 2025.

Key objectives of the policy are encouraging domestic and foreign investment in renewable energy at the local (village) level to enable a better electricity supply, create socio-economic benefits and sustain an environmentally and socially sustainable development.

Policy priorities are focussed on small power development for self-sufficiency and grid connection, biofuels production and marketing, i.e. through financial incentives to investors and by improving law and regulations on renewable energy. The policy also includes large-scale projects.

8.5.3 Overview of Affected Villages

The Project area including wind turbine towers, transmission line, and access roads are located in the administrative boundaries of 24 villages in Dak Cheung District of Sekong Province and 8 villages in

[86] The World Bank, n.d.b

[87] The World Bank, 2021

[88] Stimson, 2021. *An overview of policies and trends on energy, transportation, water, and industrial infrastructure in the Lao People's Democratic Republic*. Retrieved from: https://www.stimson.org/2021/lao-peoples-democratic-republic/

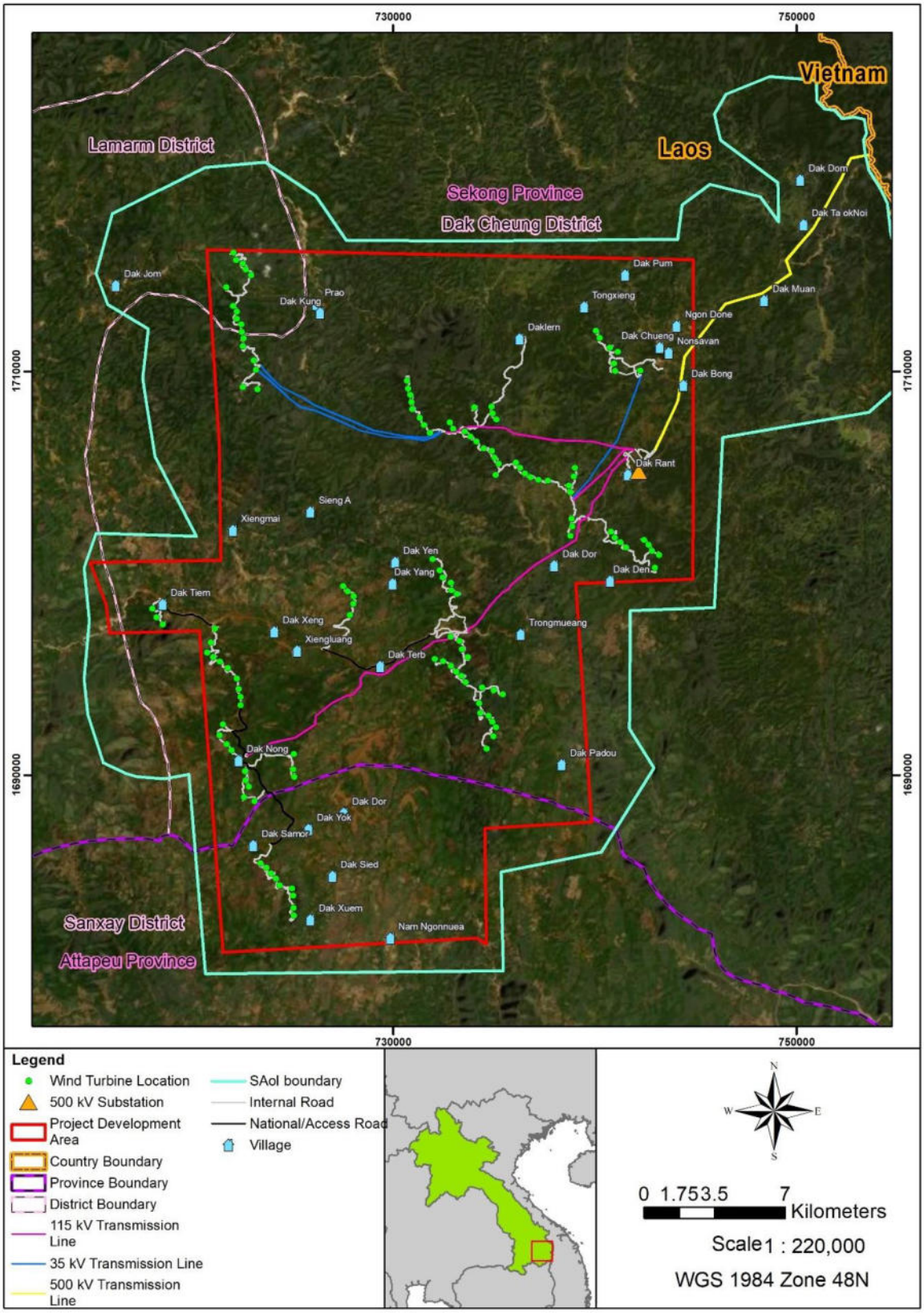
[89] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=LA

Sanxay District of Attapeu Province (***Figure 8-32***). These 32 villages form the Project-affected population/ communities/ villages and the key focus for social impact assessment.

The following section presents the main socio-economic characteristics of the Project's affected villages including: demographic information, livelihood engagement, income and expenditures, land use and tenure, household assets, access to infrastructure and public services, social network and cohesion and vulnerability.

The information for this section were collected through KIIs with relevant stakeholders including livelihood groups, women group, local authorities, youth, and healthcare personnel and socio-economic household survey as outlined in ***Table 8-2***. A total of 449 out of 2,761 households (16.3%) and 2,984 out of 16,851 people (17.7%) of the 32 affected villages were engaged in Project's household socio-economic survey (referred to ***Appendix U*** for socio-economic household survey database) undertaken in November and December 2021. It is noted that Nonsavan was not included in the HH socio-economic survey as it was later identified as affected village during the DMS survey conducted in May-June 2022.

Figure 8-32: Affected Villages



Source: Innogreen/ERM, 2021, It should be noted that the administrative boundary provided from GIS data is inaccurate. The GIS Data shows that Dak Jom Village is located within Lamarn District; however, based on site visit and engagement with local authorities and villagers it is noted that Dak Jom village is located in and reports to Dak Cheung District.