Vegetation Types of Nepal

(A report based on review of literature and expert knowledge)

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1. Introduction

Ecosystem and Forest types Mapping Program (EFTMP) aims to generate a spatially explicit map of terrestrial ecosystems encompassing forest, grassland and agriculture and wetland ecosystems using the standardized ecosystem mapping procedures. Since an ecosystem is usually defined by a vegetation type in combination with other environmental parameters (Sayre et al. 2013), mapping of vegetation types is a prerequisite for ecosystem mapping. Further, vegetation classification is a prerequisite for mapping vegetation types. Therefore, EFTMP requires a seamless vegetation classification accurately representing the geographic distribution to deliver Nepal's ecosystem map.

Vegetation has been a significant focus of ecological study to explore the correlation and interaction between the vegetation types and their natural environment to understand their relationships and offer informed decision making for conservation and management of the natural resources (Addicott et al. 2021; Schwienfurth 1992). The ecologists/vegetation scientists classified the vegetation based on the qualitative and quantitative methods (Mucina 1997). The vegetation classification approaches generally apply field observations to categorise vegetation (e.g. Gellie et al. 2018) based on physiognomy, structure and floristic pattern/compositions, and ecological conditions attributing particular vegetation formation (Faber-Langendoen et al. 2016).

The scale, field data collection protocol, and analytical methods largely determine the vegetation classification (e.g. Singers and Rogers 2014; Nemani and Running 1996). Hence, the inconsistencies are inherent between various vegetation classification approaches between the jurisdictions (Gellie et al., 2018) and the countries (Faber-Langendoen et al., 2016). In this context, the International Vegetation Classification (IVC) has been developed based on the ecological vegetation (EcoVeg) classification approach, providing a comprehensive and consistent framework for multi-scale classification of all vegetation diversity across the world (Faber-Langendoen et al. 2020, 2017, 2016).

In Nepal, vegetation classification has a long history dated back to the 1950s. Schwienfurth (1957) studied Nepal's vegetation in the context of vegetation mapping of the Himalaya to explore the natural environment and the habitats in the mountain system through consolidating the personal observations of the botanical explorers (Schwienfurth 1957, 1992). Stainton (1972) and Dobremez (1976) extensively studied Nepal's ecology and vegetation and identified the forest and vegetation types occurring in varying physiographic and climatic conditions. Further, Dobremez and his colleagues (1969-1985) manually produced seven cartographic ecological maps based on field observations identifying the potential vegetation types across the country (TISC 2002). In 2015, Miehe et al. (2015) analyzed the field

observations and photos over the period of four decades and provided vegetation types for Nepal. However, Jackson (1994), BPP (1996) and TISC (2002) synthesized vegetation/ecosystem/forest types based on the earlier classifications by Stainton (1972) and Dobremez and his colleagues (1969-1985). Uddin et al. (2015) and the DFRS (2014, 2015) consolidated the vegetation/forest types into limited numbers for remote sensing analysis of land cover, whereas several studies classified vegetation at local or subnational scales for the respective study sites (Byers et al. 2014; Shrestha 2008).

Nepal's vegetation classification has not been reviewed and updated after Dobremez and his colleagues (1969-1985) using the ground data and information on the vegetation formation, species composition, growth form and floristic pattern. In addition, the inconsistent reporting of the vegetation types in Nepal has demonstrated a need for a comprehensive vegetation classification of Nepal, building on the past knowledge through new field data collection and consultation with and review by experts to provide a complete list of vegetation types. Furthermore, the vegetation classification should comply with the IVC approach.

This report reviews how various assessments classified and mapped vegetation types in Nepal in the past. Based on the review of the past vegetation classifications, the field data from the secondary sources (i.e., FRA) and experts' knowledge, Nepal's vegetation classification is proposed using the vegetation characteristics based on physiognomic-floristic-ecological classification approach consistent with the IVC.

2. A review of the past vegetation assessments in Nepal

Until the 1950s, vegetation assessment in Nepal was generally focused on botanical exploration, limiting it to the collection and identification of individual plant species. According to Stainton (1972), F. Buchanan Hamilton and N. Wallich, who came to Nepal as mountaineer parties, were the earliest explorers of Nepalese plants. They collected plants around Kathmandu valley and on the route up from the Indian plains to Kathmandu before 1949. O. Polunin in 1949 and D. G. Lowndes in 1950 collected plants from Langtang, Rasuwa Gadi and Chilime Khola area and Marsyangdi valley and Manang area, respectively, and provided them to the Herbarium of the British Museum. In 1952, the British Museum and the UK's Royal Horticultural Society jointly sponsored the first botanical exploration expedition involving O. Polunin, W. Sykes, and L. H. J. Williams. The second expedition took place in 1954, which comprised a team of J. D. A. Stainton, W. Sykes, and L. H. J. Williams. These two expeditions collected a large number of plant specimens from many parts of Nepal, such as from southwards to Butwal and northwards to Mustang, making a total of over 17,500 plant collections (including the previous ones collected by Polunin and Lowndes) in the Herbarium of the British Museum. Later in 1956, Stainton also collected plant specimens from Arun and Tamur valleys.

The assessment of vegetation as a plant community started with J. D. A. Stainton's work between 1962 and 1969. In these years, he visited different parts of Nepal mainly for what he calls "ecological observations" rather than plant collection as in his previous visits (Stainton 1972, p. 3). The notes taken during these observations resulted in his book "Forests of Nepal" published in 1972. This book is considered as the first systematic classification of Nepal's vegetation. Since then, several studies have been conducted at different scales to classify Nepal's vegetation types. The section below compiles the major classifications of Nepal's vegetation to date.

2.1 Stainton (1972)

Stainton (1972) classified Nepal's forest types based on his field observations carried out between 1962 and 1969. During these eight years, he effectively spent two and half years in the field. He made a total of 17 visits to many randomly selected transects in different parts of Nepal from the far east to far west and southern plains to high Himalayas to the north. Table 1 presents the routes Stainton followed during the survey. He surveyed some regions more than once but did not provide the exact reasons. However, it may be attributed to better understanding the vegetation phenology and seasonal variability.

Table 1: Survey routes followed while carrying out vegetation survey by Stainton (1972)

SN	Dates	Region	Survey routes
1	10 Apr – 10 Aug, 1962	Central	Langtang, Chilime, Satsae Khola to the south of Ganesh Himal – Gosaikund – Melamchi – Kathmandu; Satsae Khola to Prok on the upper Budhi Gandaki – Chilime – Langtang – Ganja La - Kathmandu
2	7 Apr – 30 Jul, 1963	West	Nepalgunj – Rapti Valley – Dang – Jajarkot – Kaigaon on the Jagdula Khola – Jumla – Rara – Maharigaon – Tibrikot – Dunaihi – Ringmo – Sya Gompa – Phijor – Ccharka – Tarap – Dunaihi – Mukut – Tukhucha – Pokhara
3	5 Apr – 26 Jul, 1964	Central and East	Kathmandu – Chaunrikharka – Thyangboche – Inukhu khola – Salpa Bhanjyang – head of Solu, Likhu and Khimti Kholas – Chaunrikharka – Rolwaling – Jatapokhari – Panch Pokhari – Jiri
4	17 Apr – 1 Jul, 1965	Far west	Dhangarhi – Silgarhi Doti – Khaptad – Chainpur on the Seti river; Chainpur – Kali Gad – Chainpur (westward circuit) – Manakot – Karnali river – Talkot – Chainpur (eastward circuit) – Kaligad – Marma on the upper Chamelia River – Baitadi – Pithoragarh (India)
5	12 Sep – 3 Oct, 1965	Central	Trishuli – Satsae khola – Gatlang – Langtang – Trishuli valley - Kathmandu
6	8-21 Mar, 1966	Central	East Rapti valley – Hetauda, Amlekhgunj, Narayangarh
7	16 May – 1 Aug, 1966	West	Pokhara – Dhorpatan – Jang La – Tibrikot – Jumla – Rara Lake – Maharigaon – Kaigaon – Gotam – south side of Hiunchuli Patan – Toridwari Bhanjyang – Ringmo – Sya Gompa – Tarap – Ccharka – Tukucha - Pokhara
8	5-21 Feb, 2067	Central	Godavari – Hariharpur Garhi – Dungrebas – Chisapani on the Kamala Khola - Janakpur
9	5-14 Mar, 1967	East	Dharan – west to confluence of Koshi, Arun and Tamur rivers – east along the Mahabharat lekhs – down to the plains at Dangi - Dharan
10	29 Mar – 28 May, 1967	East and Central	Bhadrapur – Ilam – Chyangtapu – Yampodin – Hellok – Taplejung – Chainpur – crossed Arun at Num – Cchoyang – Salpa Bhanjyang – Chaunrikharka on the Dudh Koshi river
11	21-28 Aug, 1967	Central	East Rapti valley – Hetauda, Amlekhgunj, Narayangarh
12	1-23 Sep, 1967	East	Dharan – Dhankuta – northward along the ridge to Milke Danda – Terhathum – Rakshi Danda (crossing Tamur) – down to Bhavar range – Dharan
13	27 Sep – 29 Oct, 1967	Central	Kathmandu – Trisuli – Satsae khola – crossed Budhigandaki at Khorlak – Barpak – Rupina La – Sisaghat – Lamjung Himal - Pokhara
14	7 Mar – 12 Apr, 1968	West	Nepalgunj – Surkhet – up the Karnali valley to Raskot – Punge Lekh into the Tila khola – Sam La into Sama khola – Jajarkot – Bheri valley - Nepalgunj
15	26 Apr – 17 Jul, 1968	West	Pokhara – Lamjung Himal; Pokhara – Dhorpatan – cross the Bheri at Gotam – Hurta – Munigaon – Bundi Lagna – Rara lake – down to Karnali (crossed at Khater khola) – up to Munya pass – Simikot – Chankheli pass – Mugu – Sisne Himal – Maharigaon – Kaigaon – Tibrikot – Tarakot – Jang La – Dhorpatan - Pokhara
16	15 Feb – 28	East	Dharan – eastward along the Mahabharat lekh – down to Mai khola –

	Mar, 1969		Sanichari – Mechikhola – west side of Singhalila ridge – Sandakphu – Ilam – Soktim – Mai khola – Dharan
17	9 Sep – 9 Nov, 1969	Central and East	Khumbu – Thyangboche – Everest basecamp; Khumbu – Aiselukharka – Halesi – Udayapur Garhi – down eastward to Trijuga khola – Dharan

Source: Stainton (1972)

Stainton identified nine regions/sub-regions across Nepal based on climatic and vegetation parameters and later used to classify Nepal's forest types (Table 2).

Table 2: Climatic and vegetational divisions of Nepal described by Stainton (1972)

SN	Area	Description
1	Terai, Bhabar, Dun valleys, and outer foothills	Terai is a part of the Gangetic plains between the outermost foothills and the Indian frontier. Bhabar is the gently sloping land formed of alluvial gravels washed down from the foothills and accumulated at their base. Dun valleys (*bhitri madhesh*) are the gently sloping valleys within the outer foothills. Outer foothills are Siwaliks or Chure hills.
2	The West Midlands	Areas that lie between the outer foothills and the main snow ranges to the west of the Kali Gandaki
3	The East Midlands	Areas that lie between the outer foothills and the main snow ranges to east of the Arun-Koshi watershed
4	The Central Midlands	Areas that lie between the outer foothills and the main snow ranges between the Arun-Koshi watershed and the Kali Gandaki (excluding the area to the south of Annapurna and Himal Chuli)
5	Country to the south of Annapurna and Himal Chuli	This is Pokhara area, a part of Central Midlands, but has been described separately as the vegetation here is different than other parts due to different rainfall pattern.
6	The Humla – Jumla area	The area bounded to the south by the long chain of lekhs, lying north of Jajarkot and Dailekh and extending between the Bheri and Karnali rivers
7	Dry river valleys	Valleys in upper parts of big rivers, such as the Bhote Koshi (Rongsha Chu), the Bheri and the Karnali, which are dry due to strong upward winds
8	Inner valleys	Valleys lying within the main Himalayan ranges that get significantly less monsoon rainfall than the similar altitudes on the southern sides of these ranges, such as Kambachen, Yangma and Walungchung valleys at the head of the Tamur, the Thudam and Barun valleys on the Arun, Khumbu, Rolwaling, and Langtang (the Trisuli eastwards), and the upper Bheri and upper Kali Gandaki (the Trisuli westwards).
9	The arid zone	The treeless areas north of Dhaulagiri and Annapurnal Himal, i.e. Dolpo, Mustang, and Manang

Source: Stainton (1972)

Vegetation types

Stainton (1972) classified Nepal's forest into 35 main types, with two sub-types for each of Sal Forest and *Schima-Castanopsis* Forest. The term 'forest' is broadly used to represent all forms of woodlands and scrubs excluding grasslands. The classification largely followed Champion (1936), and Osmaston (1927) in the western Nepal's case. The naming of forest type applied a

combination of the physiographic region (Bhabar, Terai), tree characteristics (deciduous and evergreen; broadleaf and conifer), climatic region (tropical, subtropical, temperate and alpine) and the dominant species. The distribution of each forest type has been described in terms of their occurrence in physiographic regions and other environmental parameters, including elevation, slope, and moisture condition. The species association of each forest type has been described providing the lists of species in the canopy, second storey and the under-storey layers observed in some locations. Table 3 presents forest types described by Stainton (1972).

Table 3: Forest types in Nepal as described by Stainton (1972)

SN	Forest Type	Distribution	Species association
Tropical and Subtropical			
1	Sal forest		
1.1	Bhabar and terai Sal forest	In most of the bhabar and terai region	**Canopy:** *Shorea robusta, Terminalia myriocarpa, T. Chubula, T. belerica, T. tomentosa, Anogeisus latifolia, Adina cordifolia, Lagerstroemia parviflora, Eugenia jambolana, Lannea grandis* **Second storey:** *Mallotus phillippinensis, Semecarpus anacardium, Dillenia pentagyna, Ehretia laevis, Croton oblongifolius, Litsea salicifolia*
1.2	Hill Sal forest	Up to 3500 ft, wetter faces in west, and dry south faces in central and east	**Canopy:** *Shorea robusta, Lagerstroemia parviflora, Anogeisus latifolia, Adina cordifolia, Bauhinia variegate, Dillenia pentagyna, Buchanania latifolia* **Second storey:** *Nyctanthes arbortristis, Kydia calycina, Leucomeris spectabilis, Glochidion velutinum, Symplocos racemosa*
2	Tropical deciduous riverain forest	Along streams of the Bhabar and dun valleys	**Canopy:** *Bombax ceiba, Adina cordifolia, Schleichera trijuga, Holoptlea integrifolia, Lannea grandis, Ehretia laevis, Lagerstroemia parviflora, Sterculia villosa, Sapium insigne, Garuga pinnata, Trewia nudiflora, Eugenia jambolana, Acacia catechu, Albizzia procera* **Second storey:** *Mallotus phillippinensis, Croton oblongifolius, C. caudatus, Holarrhena antidysenterica, Streblus asper, Cassia fistula, Aporosa diocia, Bridelia retusa, Alangium salviifolium*
3	Tropical evergreen forest	Below 3000 ft, in damp and shady sites, i.e. along water courses, in the terai, bhabar, dun valleys and outer foothills, usually surrounded by Sal forests	**Canopy:** *Eugenia jambolana, Phoebe lanceolata, Mangifera sylvatica, Diospyros species, Machilus villosa, Acer oblongum, Cedrela toona, Albizzia species, Michelia champaca, Garuga pinnata, Duabanga sonneratiodes, Acrocarpus fraxinifolius* **Second storey:** *Actinodaphne obovate, Litsea polyantha, Eriobotrya elliptica, Ehretia wallichiana, Ostodes paniculata, Olea glandulifera, Mallotus phillippinensis, Bischofia javanica, Murraya exotica, Sageretia oppositifolia*
4	Subtropical evergreen forest	In 3000-5500 ft, in high rainfall area on the outer foothills between the Koshi and the Mechi rivers	**Canopy:** *Eugenia tetragona, E. ramosissima, Acer oblungum, Acer thomsonii, Machilus villosa, Castanopsis indica, C. tribuloides, Phoebe lanceolata, Cinnamomum species, Turpinia nepalensis, Bassia butyracea, Lithocarpus spicata, Alnus nepalensis, Cedrela toona, Albizzia species* **Second storey:** *Ostodes paniculata, Leucosceptrum canum, Eurya acuminata, Talauma hodgsonii, Symplocos spicata, Mahonia napaulensis, Casearia graveolens*
5	*Terminalia* forest	Bhabar and dun valleys of the central and	*Terminalia myriocarpa* (east and central), *T. tomentosa* (western hills), *T. Chebula, T. belerica, Eugenia jambolana, Lagerstroemia*

		eastern part (Rapti valley); hills (the Bheri valley)	*parviflora, Dillenia pentagyna, Adina cordifolia, Cedrela toona*
6	*Dalbergia sissoo-Acacia catechu* forest	On new alluvium along the streams in the bhabar and dun valleys	**Canopy:** *Acacia catechu, Dalbergia sissoo* (frequently pure forests of each species) **Second storey:** *Pogostemon plectranthoides, Colebrookea oppositifolia*
7	Subtropical deciduous hill forest	In southern slopes of outer foothills up to 4000 ft, and in midlands up the river valleys, more abundant in the west than east	**Canopy:** *Anogeissus latifolia, Lagerstroemia parviflora, Adina cordifolia, Dalbergia latifolia, Ehretia laevis, Terminalia tomentosa, Flacourtia indica, Lannea grandis, Bauhinia variegata, Ougeinia dalbergiodes, Alangium salviifolium, Mallotus philippinensis* **Second storey:** *Woodforbia fruticose, Rhus parviflora, Alangium salviifolium, Butea minor, Phoenix humilis*
8	*Schima-Castanopsis* forest		
8.1	*Schima wallichii-Castanopsis indica* forest	Generally 2000-4500 ft, but common in 2500-5000 ft around Pokhara area, in both south and north faces	**Canopy at Higher range:** *Schima wallichii, Castanopsis indica, Bombax ceiba, Terminalia chebula, Eugenia jambolana;* **Canopy at Lower range:** *Shima wallichii, Castanopsis indica, Ilex doniana, Engelhardtia spicata* **Second storey:** *Macaranga pustulata, Rhus succedanea, Mallotus philippinensis*
8.2	*Schima wallichii-Castanopsis tribuloides* forest	2000-6000 ft, common in 4000-5500 ft, specifically in the Arun and Tamur valleys, in both faces (C. tribuloides extends to the west)	**Canopy:** *Schima wallichii, Castanopsis tribuloides, C. indica, Engelhardtia spicata, Alnus nepalensis, Lithocarpus spicata, Quercus glauca, Carpinus viminea, Eugenia frondosa* **Second storey:** *Callicarpa arborea, Wightia speciosissima, Macaranga denticulate, Helicia erratica, Rhododendron arboretum, Lyonia ovalifolia, Rhus semialata, Rhus succedanea, Wendlandia species*
9	Subtropical semi-evergreen forest	2000-5500 ft, at the base of big mountains, mainly side valleys of the Arun and Tamur, and around Pokhara	**Canopy:** *Schima wallichii, Castanopsis indica, C. tribuloides, Dalbergia hircina, Albizzia mollis, A. lucida, A. chinensis, Cedrela toona, Erythrina suberosa, Duabanga sonneratiodes, Macaranga pustulata, Eugenia species* **Second storey:** *Ostodes paniculata, Macaranga pustulata, M. denticulate, Mallotus nepalensis, Pandanus furcatus, Talauma hodgsonii, Bischofia javanica, Cyathea spinulosa*
10	*Pinus roxburghii* forest	3000-6500 ft, but as low as 1500 ft in outer foothills, also up to 9000 ft in Karnali, rare in the east	**Canopy:** *Pinus roxburghii (almost pure),* **Second storey:** *Inula cappa, Woodforbia fruticosa*
Temperate and alpine broadleaved			
11	*Quercus incana-Quercus lanuginosa* forest	4000-8000 ft, abundant in West, only on south faces in Central, a few patches in the Arun, Tamur valleys	**Canopy:** *Quercus incana* (Syn.: *Q. leucotrichophora), Q. lanuginosa (*Syn.: *Q. lanata),* **Second storey:** *Rhododendron arboretum, Lyonia ovalifolia, Rhus wallichii, Carpinus viminea, Myrica esculenta, Ilex dipyrena, Cornus capitata*
12	*Quercus dilatata* forest	7000-9500 ft, north or west faces with damp soil, common in West (rare in pure form)	**Canopy:** *Quercus dilatata (Syn.: Q. floribunda), Aesculus indica, Ilex dipyrena, Alnus nepalensis, Juglans regia, Acer species, Quercus incana, Q. semecarpifolia, Tsuga Dumosa, Abies pindrow, Betula alnoides* **Second storey:** *Symplocos species, Neolitsea umbrosa, Lindera pulcherrima, Rhododendron arboretum, Lyonia ovalifolia, Sourbus*

			cuspidate, Prunus cornuta
13	*Quercus semecarpifolia* forest	8000-1000 ft, on south face, mainly West	**Canopy:** *Quercus semecarpifolia, Pinus excelsa* **Second storey:** *Rhododendron arboretum, Lyonia ovalifolia, Acer species*
14	*Castanopsis tribuloides-Castanopsis hystrix* forest	6000-7000 ft, in East	**Canopy:** *Castanopsis tribuloides, Castanopsis hystrix, Quercus lamellose* **Second storey:** *Lindera pulcherrima, Neolitsea umbrosa, Machilus odoratissima, Symplocos species, Rhododendron arboreum*
15	*Quercus lamellosa* forest	6500-8000 ft, ridges in upper Arun and Tamur and southern slopes of Himal Chuli and Annapurna	**Canopy:** *Quercus lamellosa, Q. Lineata, Castanopsis tribuloides* **Second storey:** *Ilex sikkimensis, Ilex dipyrena, Litsea elongate, Machilus duthiei, Acer species, Lyonia ovalifolia, Rhododendron arboretum, Daphniphyllum himalayense, Prunus nepalensis*
16	*Lithocarpus pachyphylla* forest	8000-9500 ft, between Tamur and Sikkim border	**Canopy:** *Lithocarpus pachyphylla, Quercus lamellosa, Q. lieata* **Second storey:** *Ilex dipyrena, Ilex sikkimensis, Magnolia campbellii, Acer campbellii, Rhododendron grande, R. falconeri, Taxus species*
17	*Aesculus-Juglans-Acer* forest	6000-9000 ft (west midlands), 6500-9500 (Humla-Jumla area)	**West midlands: Canopy -** *Aesculus indica, Juglans regia, Acer caessium, Betula alnoides, Alnus nepalensis, Quercus dilatata, Q. semecarpifolia, Q. incana* **Second storey:** *Populus ciliata, Ilex dipyrena, Prunus cornuta, Machilus duthiei, Neolitsea umbrosa* **Humla-Jumla area: canopy -** *Aesculus indica, Juglans regia, Acer caesium, A. cappadocicum, A. sterculiaceum, A. acuminatum, Ulmus wallichiana, Populus ciliata, Betula utilis, Prunus cornuta* **Second storey:** *Euonymus species, Corylus colurna, Taxus species, Rhus species, Salix species*
18	Lower temperate mixed broadleaved forest	5000-7000 ft, mostly evergreen, usually north or west faces (side valleys of Arun and Tamur, and south of Annapurna and Himal Chuli)	*Machilus duthiei, M. odoratissima, Neolitsea umbrosa, Cinnamomum tamala*
19	Upper temperate mixed broadleaved forest	8000-10500 ft in central and east midlands, on north and west faces	*Magnolia campbellii, Acer campbellii, Osmanthus suavis, Schefflera impressa, Corylus ferox*
20	*Rhododendron* forest	8500 ft to alpine zone, mostly in east	**Lower range:** *Rhododendron grande, R. hodgsonii, R. falconeri* Ridge, south aspect: *R. abroreum* **Higher range:** *R. campanulatum, R. wallichii, R. thomsonii, R. campylocarpum* **Further higher range:** *R. fulgens, R. wightii*
21	*Betula utilis* forest	Treeline species, 11000-12500 ft	**Canopy:** *Betula utilis, Abies spectabilis* **Second storey:** *Acer pectinatum, A. caudatum, Juniperus recurva, Sorbus foliolosa, Rhododendron campanulatum, R. fulgens, R. arboretum, R. hodgsonii. Prunus cornuta, P. rufa*
Temperate and alpine conifer			
22	*Abies spectabilis* forest	10000 to treeline, mostly in central midlands	**Canopy:** *Abies spectabilis (Syn.: A. webbiana), Tsuga Dumosa* **Second storey:** *Betula utilis, Juniperus recurva, Sorbus cuspidate, S. foliolosa, Acer species*

			Third layer: Rhododendrons, *Daphne bholua*
23	*Tsuga Dumosa* forest	7000-11000 ft	**Canopy:** *Tsuga Dumosa, Abies spectabilis, Betula utilis, Quercus semecarpifolia* **Second layer:** *Acer sterculiaceum, A. cappadocicum, A. acuminatum, Sorbus cuspidate, Rhododendron arboreum*
24	*Pinus excelsa* forest	6000 ft to treeline	**Canopy:** *Pinus excelsa* (Syn.: *P. wallichiana*), *Picea smithiana, Abies spectabilis, Abies pindrow, Cedrus deodara* **Second layer:** *Quercus semecarpifolia, Betula utilis, Alnus nepalensis, Sorbus cuspidata*
25	*Picea smithiana* forest	7000-11000 ft, in rain shadowed areas west of Budhi Gandaki, abundant in Humla-Jumla area	**Canopy:** *Picea smithiana* (Syn.: *P. morinda), Pinus excelsa, Abies spectabilis* **Second layer:** *Quercus semecarpifolia, Betula utilis, Populus ciliate, Juglans regia, Sorbus cuspidate, Acer species, Taxus species*
26	*Abies pindrow* forest	7000-10500 ft, in the west, in north and west faces	**Canopy:** *Abies pindrow, Picea smithiana, Pinus excelsa* **Second layer:** *Tsuga Dumosa, Quercus dilatate, Q. semecarpifolia, Aesculus indica, Juglans regia*
27	*Cedrus deodara* forest	6500-9500, specifically Humla-Jumla area	**Canopy:** *Cedrus deodara, Pinus excelsa* **Second layer:** *Rosa sericea, Salix species, Berberis species, Prunus species*
28	*Cupressus torulosa* forest	7000-11000 ft, in the west,	**Canopy:** *Cupressus torulosa* **Second layer:** *Wikstroemia canescens, Colquhounia coccinea, Spiraea sorbifolia*
29	*Larix* forest	9500-13000 ft, Kambachen valley, Simbua khola (near Sikkim border), Langtang valley, near Rasuwa Garhi, Shiar Khola, Upper Budhi Gandaki valley	*Larix griffithiana* (near Sikkim border), *Larix potanini* (central Nepal, but naming uncertain)
Minor temperate and alpine associations			
30	*Alnus* woods	3000-9000 ft, along streams and in places with permanent water	*Alnus nitida* (along the Mugu Karnali at 7000-8000 ft), *Alnus nepalensis*
31	*Populus ciliata* woods	7000-10500 ft, in drier areas along streams, in inner valleys west of the Trisuli, common in Humla-Jumla area (e.g. Mugu Karnali)	*Populus ciliata, Cupressus torulosa, Picea smithiana, Pinus excelsa, Hippophae salicifolia, Myricaria species, Salix species*
32	*Hippophae* scrub	7000-10500 ft, mostly in the west, around Tukucha, Dhorpatan, Humla-Jumla area	*Hippophae salicifolia, Populus ciliata (Hippophae thibetana* in 11000-14500 ft in dry inner valleys), *Lonicera myrtillus, Salix species, Myricaria species, Berberis species*
33	Moist alpine scrub	Above treeline, up to 14500 ft, on wet areas	*Rhododendron species, Juniperus recurve, Salix sikkimensis, Lonicera species, Berberis species, Potentilla fruticosa*
34	Dry alpine scrub	Above treeline, up to 15500 ft, on dry sites	Inner valleys east of Langtang: *Juniperus wallichiana, Hippophae thibetana, Rhododendron anthopogon, R. lepidotum, R. nivale* Inner valleys west of Langtang: *Juniperus wallichiana, J. communis, J. squamata, Hippophae thibetana, Rhododendron anthopogon*

			Alpine steppes (Dolpo, Mustang, Manang): *Caragana brevifolia, Lonicera species, Caragana gerardiana, Potentilla fruticosa, Juniperus wallichiana, Berberis species*
35	*Juniperus wallichiana* forest	9500-10500 ft (e.g. around Dhorpatan)	*Juniperus wallichiana* (Syn.: *J. indica), Abies spectabilis, Betula utilis, Quercus semecarpifolia, Rhododendron arboretum, R. campanulatum, Prunus cornuta, Lonicera lanceolata*

2.2 Dobremez et al. (1970-1985)

J. F. Dobremez is the most prominent ecologist who extensively studied Nepal's vegetation distribution, diversity, ecology, and interactions between humans and the environment in the late 1960s and 1970s. Between 1969 and 1974 he organized eight separate expeditions, comprising French researchers and renowned Nepalese botanists. They spent a total of two years in the field and travelled over 15,000 kilometres. The regions they carried out vegetation survey are summarized in Table 4.

Table 4: Survey routes followed while carrying out vegetation survey by Dobremez (1976)

SN	Dates	Region	Survey routes
1	28 Mar – 1 July, 1969	Central	Bhairawa, Rupendehi (110 m) - Jomsom along the Kali Gandaki valley, Tilicho region north of Annapurna (5500 m), South of Annapurna, Lamjung Himal and Himal Chuli, Madi Khola and at the foot of the Himal Chuli, on the crest of Bara Pokhari Lekh, Dhaulagiri massif, the classic route from Pokhara to Dunai, Jumla, Gurjakhani, the foot of Pokhara, Kathmandu to Gosainkund.
2	2 June – 1 Sept 1970	Central	From Buri Gandaki to Sun Kosi, South of Kathmandu, to Hetauda. Lamosagu, Namche Bazar, Okhaldhunga and Aisyalukharka. Gokyo lakes (5,500 m) in the upper Sun Kosi, Jiri, Bigu and Barabhise, a second circuit: Helambu, the Langtang valley after crossing the Ganja La Pass (5,200 m), Panchsaekhola, Satsaekhola and Ankhu Khola.
3	29 Oct – 31 Dec 1970	Central	The valleys of Marsyandi and Budi Gandaki, Manaslu-Himal Chuli massif, Dudh Khola, Larkya La Pass (5,200 m), Budi Gandaki, Shyar Khola (Tsum) and Chuling Khola, Ankhu Khola.
4	27 Jun – 28 Oct, 1971	East	East of Helambu, the extreme east of Nepal, the the eastern Himalayas from 150 to 3800 m altitude
5	6 Aug – 19 Sept, 1972	East	Eeastern Nepal, Mulghat to Topke Gola by the Jaljale Himal (from 450 m to almost 5000 m of altitude),
6	4 Apr – 7 Jun, 1973	West	The extreme West of Nepal, From Dhangadi, Siwalik Doti, the Khaptar, the Seti to Chainpur, Bhajang, the tributary valleys Lachighad in east and Baulighad in west, Surmarowar Lekh, Kaligad Valley, Bajhang, Saipal Mounain in the extreme north of the Seti by the Suni Gad.
7	22 Mar – 5 Jun, 1974	West	A complete tour of Dhaulagiri, from Nepalganj to Pokhara, Bheri to Dunai, passing through Jajarkot and Tibrikot, the trans-Himalayan zone by the Suli Gad to the lake of Phoksundo, then by the Bara La pass to Tarap, Namgong, Simen, Tingyu and Charka, Muktinath Mustang, Pokhara.
8	Sept – Oct, 1974	West	West of Nepal in the Jumla region, Surkhet, Dailekh and Dillikot (Jumla), Mugu then to Simikot.

Source: Dobremez (1976)

Dobremez (1976) synthesized the findings in a book, 'Le Népal Écologie et Biogéographie' (Nepal Ecology and Biogeography) published by the National Center for Scientific Research, France, Paris. He identified 77 vegetation types in six geographic zones. He described each vegetation type in terms the ecology, floristic structure, and species composition with the species names in the upper and lower tree layers, superior and lower shrub layers, and the herbaceous layer. Table 5 summarizes the vegetation types identified by Dobremez (1976) translated from French to English using the Google Translator.

Table 5: Vegetation types in Nepal as described by Dobremez (1976)

SN	Vegetation Type	Distribution	Species association
		Tropical Zone	
1	*Shorea* and *Dillenia pentagyna* forest	Lower tropical floor, covering the plains of Tarai up to an altitude from 400 to 450 m	**Upper tree layer:** *Shorea robusta, Salmalia malabrica, Adina cordifolia, Bauhinia valhii, Spatholobus roxburghii* **Lower tree stratum:** *Dillenia pentagyna, Mitragyne parviflora, Amoora decandra, Trewia nudiflora, Bauhinia malabrica* **Superior shrub layer:** *Mallotus philippinensis, Giochidion velutinum, Callicarpa macrophylla* **Lower shrub layer:** *Solanum torvum, Phoenix humilis, Cassia tora, Ziziphus rugosa*
2	*Shorea robusta* and *Dillenia indica* Forest	Lower tropical floor - Eastern Tarai	*Shorea robusta, Dillenia indica, Sloanea sterculiaceus, Combretum decandrum, Ardisia solanacea, Acacia intsia, Acacia pennata, Dalbergia assamica, Dalbergia stipulacea, Dalbergia sericea, Terminalia belerica, Terminalia chebula, Melia dubia, Antidesma acuminatum, Bridelia tomentose, Trema politoria, Butea minor, Desmodium laxiflorum, Onychium siliculosum*
3	Riparian forest of *Dalbergia sissoo* and *Acacia catechu*	Lower tropical floor - boarding rivers in Tarai	*Dalbergia sissoo, Acacia catechu, Salmalia malabarica, Bauhinia malabarica, Phyllanthus emblica, Randia dumetorum, Zizyphus rugosa, Albizia procera, A. lebbeck, Acacia megaladena, A. farnesiana, Adathoda vasica, Alstonia scholaris, Eranthemum pulchellum, Piptadenia oudhensis, Calotropis gigantea, C. procera*
4	*Shorea robusta* and *Duabanga sonneratioides* riparian forest	Lower tropical floor - Chure slopes	*Shorea robusta, Duabanga sonneratioides, Macaranga denticulate, Macaranga pustulata, Mallotus philipinensis, Hedychium coccineum, Hedychium thyrsiforme, Lygodium flexuosum, Eranthemum pulchellum*
5	*Shorea robusta* and *Cycas pectinata*	Lower tropical floor - Eastern Tarai	**Tree stratum:** *Shorea robusta, Duabanga sonneratioides, Lagerstroemia parviflora, Adina cordifolia, Terminalia tomentosa, Dalbergia sissoo* **Shrub and herbaceous layers:** *Cycas pectinata, Trema politoria, Garcinia xanthochymus, Caesalpinia digyna, Antidesma acuminatum, Bridelia tomentosa, Reissantia arborea, Cassine glauca, Meliosma simplicifolia, Melastoma malabathricum, Brassaiopsis glomerulata, Ardisia solanacea, Maesa Montana, Calotropis gigantean, Thunbergia fragans*
6	Large-grass pseudo-steppe	Lower tropical floor - on alluvial deposits with alternating	**Characteristic species:** *Saccharum spontaneum, Phragmites karka, Arundo donax lmperata cylindrical, Erianthus ravennae, Andropogon spp., Aristida ascensionis*

		flooding	**Xerophilic shrubs:** *Phyllanthus emblica, Zizyphus rugosa, Zizyphus maurztzana, Albizia lebbek*
7	*Shorea robusta* and *Terminalia tomentosa* forest (Chure slopes)	Upper tropical floor - Chure slopes	**Dominant tree stratum:** *Shorea robusta, Terminalia tomentosa* **Less frequent species:** *Michelia kisopa, Walsura trijuga, Pinus roxburghii, Gmelina arborea, Michelia champaca, Albizia lebbek* **Shrub layer:** *Semecarpus anacardium, Phyllanthus emblica, Mallotus phillipinensis*
8	*Shorea robusta* and *Terminalia tomentosa* forest (Eastern facies)	Upper tropical floor - Eastern region	*Shorea robusta, Terminalia tomentosa, Malotus albus Rhamnus nepalensis, Bauhinia malabarica, Castanopsis tribuloides, Clerodendron infortunatum, Pteris longifolia, Clerodendron serratum, Peperomia exigua, Aspidopterys nutans, Actiniopteris*
9	*Shorea robusta* and *Terminalia tomentosa* forest (Western facies)	Upper tropical floor - Western region	*Anogeissus latifolius, Bauhinia variegate, Schleichera trijuga, Buchanania latifolia, Bauhinia valhii, Shorea robusta, Leucomeris spectabilis, Wendlandia exserta*
10	*Shorea robusta* forest	Upper tropical floor - slope of Maharabharat Lekh	*Shorea robusta, Castanopsis indica, Bauhinia purpurea, Oroxylum indicum, Holmskioldia sanguinea, Terminalia tomentosa, Duabanga sonneratioides, Ficus glaberrima, Mallotus phillipinensis*
11	Riparian forest with *Shorea robusta* and *Mimosa rubicaulis*	Upper tropical floor - river banks	*Shorea robusta, Mimosa rubicaulis, Salmalia malabarica, Cedrela toona, Albizia mollis, Alstonia scholaris, Caesalpinia sepiaria, Cudrania javanensis, Cryptolepis buchanani, Pandanus furcatus, Deeringia amaranthoides*
Sub-Tropical Zone			
12	Riparian forest of *Cedrela toona-Albizia mollis*	Lower subtropical level - a thin strip along torrents and rivers	*Cendrela toona, Albizia mollis, B. rugulosa, B. macrophylla, Cryptolepis buchanani, Bischofia javanica, Celtis australis, C. tetrandra, Dobinea vulgaris, Dichroa f ebrifuga, Rhynchoglossum obliquum, Onychium japonicum, Microlepis speluncae, Odontosoria chinensis, Pilea scripta, Houttuynia cordata, Macaranga denticulate, Coniogramme fraxinea, Porana paniculata*
13	Hygrophilous forest of *Lagerstroemia parviflora*	Lower subtropical level – on the slopes of rivers adjacent to the riparian forest	**In addition to the species of the preceding group,** *Lagerstroemia parvifzora, Schima wallichii, Homalium nepalense, Wendlandia coriacea, Myrica esculenta, Achyranthes aspersa, Acer oblongum, Walsura trijuga, Melia azadirachta, Albizia gamblei, A. lucida, A. myriophylla, Dendrocalamus hamiltonii, Ariopsis peltata*
14	Mesohygrophilic forest of *Schima wallichii - Castanopsis indica* (Annapurna Type)	Lower subtropical level Riparian forests – annual rainfall > 1000 mm or number of rainy days >100/year	*Schima wallichii, Castanopsis indica and Engelhardtia spicata, Lagerstroemia parviflora, Duabanga sonneratioides, Alnus nepallensis, Litsea lanuginose, Cinnamonum glanduliferum, Myrica esculenta, Maesa chisia, Maesa macrophylla, Meliosma pungens, Fraxinus floribunda, Michelia champaca, Machilus edulis, Grewia vestita, Callicarpa arborea, C. macrophylla, Cyathea spinulosa, Cyathea gigantean*
15	Mesohygrophilic forest of *Schima wallichii - Castanopsis indica* (Central Nepal Type)	Lower subtropical level Riparian forests – on the most watered slopes or in the valley bottoms	**Tree stratum:** *Schima wallichii, Acer oblongum, Castanopsis tribuloides, Quercus glauca, Michelia kisopa, Eugenia jambolana, Machilus odoratissima, Chaerospondias axillaris* **High shrub layer:** *Litsea lanuginose, Osmanthus fragrans, Litsea lancifolia, Myrsine capitellata, Mallotus phillipinensis, Callicarpa macrophylla, Turpinia nepalensis*

			Lower strata: *Clerodendron kaempferi, Daphne papyracea, Ardisia macrocarpa, Carex spp., Cissampelos pareira*
16	Mesohygrophilic forest of *Schima wallichii - Castanopsis indica* (East Nepal Type)	Lower subtropical level Riparian forests	**In addition to the species of the preceding group,** *Michelia velutina, M. champaca, AIbizia gamblei, A. lucida, A. myriophylla, Terminalia myriocarpa, Erythrinu variegata*
17	Mesophilic forest of *Schima wallichii-Pinus roxburghii*	Lower subtropical level Riparian forests where the eastern and western Himalayan species meet; rainfall between 1000-1500 mm	**Canopy layer:** *Pinus roxburghii* with an under-storey of *Schima wallichi, Helicia nilagirica, Myrica esculenta, Engelhardtia spicata, Myrsine Africana, Mallotus phillipinensis* Low density of trees favours heath shrubs including *Melastoma normale, Oxyspora paniculata, Phyllanthus parvifolius, Bauhinia variegate, Clematis connate, C. grewiif lora, C. grata*
18	*Pinus roxburghii* xerophilic forest	Lower subtropical level, rainfall <1000 mm and low number of rainy days	*Pinus roxburghii* (mostly pure stand), somewhere associated with *Olea cuspidata, Pistacia rntegerrima, Olea glanduligera, Pistacia khinjuk, Rhus cotinus, Punica granatum* (only in western Nepal), *Pectalis saussunia, Inula cappa, Lilium wallichianum, Pogostemon glaber* (western and central Nepal)
19	*Alnus nepalensis* forest	Upper subtropical level, >1500 m (West/Centre), >1300 (East)	*Alnus nepalensis, Dichroa febrifuga, Lyonia ovalifolia, Dobinea vulgaris*
20	*Rhododendron arboreum* and *Lyonia ovalifolia*	Upper subtropical level	**Dominant species:** *Rhododendron arboreum and Lyonia ovalifolia* **Associated species:** *Quercus glauca, Fraxinus floribunda, Q. leucotricophora (Q. incana), Castanopsis tribuloides Q. lanata* In the East, species includes *Phryma leptostachya, Prunus cerasoides, P. wallichii, Camellia kissi etc.*
Temperate Zone			
21	*Cedrus deodara* forest	Hill floor - very rare forests west of Jumla and in the upper Bheri valley ("Mediterranean" climate of Nepal)	**Tree layer:** *Cedrus deodara, Cupressus torulosa, Quercus incana, Olea cuspidata* **Shrub layer:** *Rhus cotinus, R. punjabensis, Pistacia integerrima, Punica granatum*
22	*Quercus incana* forest	Hill floor - a characteristic group of western Nepal	**Tree layer:** *Quercus incana, Q. lanata, Michelia kisopa, Machilus duthiei, Acer oblongum, Aesculus indica, Juglans regia, Elaeagnus kanai* **Shrub layer:** *Rhus cotinus, R. punjabensis, Pistacia integerrima*
23	*Quercus lanata* forest	Hill floor – western Nepal on the southern slopes	**Tree layer:** its floristic composition is very close to that of the preceding group and enriched with several oriental species (hygrophiles) including *Rhododendron arboretum, Lyonia ovalifolia, Myrica esculenta, Machilus duthiei, Symplocos crataegoides, Litsea umbrosa* **Shrub layer:** *Hypericum uralum, Randia tetrasperma, Prinsepia utilis, Dendrobenthamia capitata*
24	*Quercus lanata-Pinus excelsa* forest	Hill floor – wetter parts of Kathmandu and Jiri (hygrophilic character)	*Quercus lanata, Pinus excelsa*, trees of Symplocaeae and Lauraceae families
25	*Abies pindrow*	Hill floor – western	**Tree layer:** *Abies pindrow, Aesculus indica, Juglans regia, Acer*

	forest	Himalaya, rare groups on the hilltop	*sterculiaceum* **Shrub layer:** *Deutzia hookeriana, Ilex dipyrena, Corylus colurna, Euonimus fimbriatus*
26	*Quercus glauca* forest	A secondary species found in the Quercus forests of the hilltop, Mesohygrophilic stands	**Tree layer:** *Quercus glauca;* includes some hygrophilic species but mainly occurs with mesophilic species such as *Q. dilatata* (localised), *Betula alnoides* (dominant), *Picea smithiana, Pinus excelsa, Litsea elongata, Quercus lamellosa, L. umbrosa, Q. oxyodon, Magnolia campbelli* **Shrub layer:** *Prinsepia utilis, Colquhounia coccinea, Daphne papyracea, Euonimus fimbriatus, Sarcoccoca hookeriana, Clematis barbellata*
27	*Quercus lamellosa* and Lauraceous forest	Rainfall >1500 mm and rainy days >75, hygrophilic group, on slopes, very humid microclimate, West limit Myagdi Khola (Annapurna-Dhaulagiri region)	**Tree layer:** *Pieris Formosa, Magnolia campbellii, Erhetia macrophylla, Polygala arillata, Sarcopyramis nepalensis;* In the lower part (1900-2100 m), Laurel species are numerous: *Litsea umbrosa, Neolitsea lanuginose, L. citrate, Lindera pulcherrima, L. elongate, Symplocos crataegoides;* In altitude 2100-2600 m, tree layer includes Lauraceae, *Quercus lamellosa, Lithocarpus spicata, Quercus glauca, Q. oxyodon* **Shrub layer:** *Colquhounia coccinea, Hydrangea anomala, H. normale, Gaultheria fragrantissima*
28	*Castanopsis tribuloides* forest	In the east of Sunkosi river, in 1700-2100 m	*Castanopsis tribuloides, Castanopsis hystrix, Camellia kissi, Lithocarpus fenestrate, Machilus duthiei, M. edulis, Cinnamonum glanduliferum*
29	*Quercus lamellosa* and *Castanopsis hystrix forest*	Humid area on the hilltop	Species endemic to East Himalayas such as *Quercus lamellosa, Symplocos glomerata, Castanopsis hystrix, Symplocos phyllocalyx*
30	*Pinus excelsa* and *Juniperus indica* forest	1450-4000 m (Central western Nepal); Rainfall 750-2500 mm; most xerophilic of the mountain groups	**Tree layer:** *Pinus excelsa, Juniperus indica, Cupressus torulosa* (upper stratum), *Prinsepia utilis, Rhododendron lepidotum, Berberis aristata, Rosa sericea* **Shrub layer:** *Tanacetum nubigenum, Leontopodium stracheyi, Erigeron bellidioides*
32	*Pinus excelsa* forest	In all the great internal valleys up to the level of the Everest massif, Kali Gandaki and in Ghustung Khola on both sides of the Dhaulagiri Massif	**Tree layer:** *Pinus excelsa, Tsuga dumosa, Taxus baccata, Acer stachyophyllum, A. caudatum* (rich in species than the previous groups; at rainfall >1000 mm: deciduous species such as Maples, Oak, Birches **Shrub layer:** *Deutzia staminea, Prinsepia utilis, Holboellia latifolia, Viburnum cylindricum*
32	*Picea smithiana* and *Pinus excelsa* forest		**Tree layer:** *Picea smithiana, Pinus excelsa, Tsuga dumosa* **Shrub layer:** *Sarcoccoca hookeriana, Buddleia tibetica, Dendrobenthamia capitata, Ribes alpestre*
33	*Quercus semecarpifolia* forests – west Nepal	2000-5000 m altitudinal range, up to subalpine level	**Tree layer:** *Quercus semecarpifolia, Pinus excelsa* (non constant), *Rhododendron arboretum, Prunus padus* **Shrub layer:** *Viburnum grandiflorum, V. cordifolium, Buddleia tibetica, Deutzia staminea*
34	*Quercus semecarpifolia* forests – Typical facies	Marsyandi to the crests which separate Arun from Tamur	**Tree layer:** *Quercus semecarpifolia, Tsuga dumosa, Ilex dipyrena, I. fragilis* **Shrub layer:** *Colquhounia coccinea, Elsholtzia fruticosa, Sarcoccoca hookeriana, Daphne papyracea*
35	*Quercus*	Rainfall over 3500	Species of the previous group and some additional East

	semecarpifolia forests – Annapurna facies	mm, western limit	Himalayan species such as *Rhododendron dalhousiae* (epiphyte), *Vaccinium retusum, V. nummularia, Polygala arillata*
36	*Rhododendron* facies	Very wet areas, replaces *Q. semecarpifolia*	*Rhododendron arboreum var. cinnamomeum, Rhododendron barbatum*
37	*Tsuga dumosa* Facies	Favoured by shade and coolness, steep slopes of deep ravines	*Tsuga dumosa, Sarcoccoca hookefiana, Taxus baccata*
38	Riparian facies	Hygrophilic species along the edge of rivers	*Populus ciliata* (in the west), *Betula alnoides*, *Hippophae salicifolia* with *Alnus nepalensis* up to 2650 m
39	Mountain Heathland	Deforested area for temporary dwellings	**Shrub layer:** *Viburnum erubescens, Leptodermis lanceolata, Elsholtzia fruticosa, Rhododendron lepidotum, Cotoneaster microphylla*
40	*Lithocarpus pachyphylla* forest	Endemic to East Nepal-Sikkim-Assam	**Tree layer:** *Lithocarpus pachyphylla, Sorbus hedlundi, Acer sikkimense, Symplocos phyllocalyx*
41	*Daphniphyllum himalayense* forest	Upper mountain	*Daphniphyllum himalayense* with *Rhododendron arboreum var. campbelliae, R. barbatum and R. grande*
		Subalpine Zone	
42	*Abies spectabilis* and *Quercus semecarpifolia* forest	Lower subalpine level, up to 3800-3900 m, *Q. semecarpifolia:* West of Dhaulagiri meridian	**Tree layer:** *Abies spectabilis, Quercus semecarpifolia, Tsuga dumosa, Taxus baccata, Rhododendron arboretum* **Shrub layer:** *Piptanthus nepalensis, Viburnum cotinifolium, V. cordifolium, V. coriaceum*
43	*Abies spectabilis* forest (Typical region)	Lower subalpine level, *A. spectabilis* dominates from $83^0$30' to $87^0$30' E.	**Tree layer:** *Abies spectabilis, Acer caudatum, A. caesium, Acer pectinatum* **Shrub layer:** *Viburnum cotinifolium, V. cordifolium, Spiraea hypericifolia, S. bella*
44	*Rhododendron* forest	Lower subalpine, high rainfall, 10-12 m high	*Rhododendron arboreum, R. barbatum*
45	*Juniperus indica* forest	Lower subalpine level, mountain peaks and ridges, reduced humidity, up to 30 m high	*Juniperus indica, Juniperus recurva,* occassionally associated with Fir trees in driest area both in tree and ground creeper forms.
46	*Larix potanini* forest	Lower subalpine xerophilic and mesophilic associations; Hygrophilic association (*L. griffithiana*); Northern slopes in the upper Budhi Gandaki	**Tree layer:** *Abies spectabilis, Larix potanini, Betula utilis, Juniperus recurva, Rhododendron campanulatum* The shrub stratum is comparable to that of the subalpine group at *Quercus semecarpifolia* and *Abies spectabilis* forests.
47	*Larix griffithiana* forest	Lower subalpine level, more humid area – southern slopes of Ganesh Himal, Chhulin Khola valley	The floristic composition is similar to that of the Hygrophilous *Abies species* (Fir) forests.

48	*Larix potanini* and *L. griffithiana* forest	Lower subalpine level, internal valleys with average rainfall 1000-1500 mm – northern slopes of the Tsum (Shiar Khola) and Langtang valley	*Larix spp.* (Larch) accounts between 10 to 40 % of the tree layer. The floristic-ecological characteristics are similar to those of the Fir (*Abies spp.*) forests.
49	*Populus ciliata* forest	Lower subalpine level, along the riverbanks, West of 85^0E	**Tree layer:** *Populus ciliata, Hippophae rhamnoides, Primula involucrata*
50	The Himalayan larch forest	Lower subalpine level	On dry condition – *Larix potanini (Larix himalaica* in Tibet*)*; Moist condition – *Larix griffithii*
51	Xerophilic forest of *Larix potanini*	Lower subalpine level, Upper valley of Shiar Khola, 15-20 m high	Generally pure stand of *Larix potanini* **Shrub layer:** *Betula utilis, Rosa sericea*
52	*Larix griffithiana* hygrophilous forest	Lower subalpine level, in the highest valleys of the extreme East of Nepal	Pure stand of *Larix griffithiana,* sometimes mixed with few Firs, Maples and Rhododendrons
53	*Rhododendron* subalpine forest	Lower subalpine level, East of the Arun Valley, <10 m high, covered with Lichens, Mosses, Hepatics and Hygrophilous Ferns	Replaces *Abies spectabilis* in the humid area, **Tree layer:** *Rhododendron arboreum var. Campbelliae, R. hodgsoni, R. grande, R. lepidotum* **Shrub layer:** *Viburnum cotinifolium, V. cordifolium, Spiraea hypericifolia, S. bella* *Upper level > 3500 m: Betula utilis, Rhododendron campanulatum, R. campylocarpum, R. lanatum, R. wightii*
54	Xerophilic forest of *Betula utilis*	Upper subalpine level, the limit of vegetation in the arid zones of north-western Nepal	**Tree layer:** *Betula utilis, Prunus rufa*; *Pinus excelsa* (in the upper Kali Gandaki, north of Dolpo) **Shrub layer** (Steppe species): *Caragana gerardiana, Ephedra gerardiana, Lonicera spp.*
55	Mesophilic forest of *Betula utilis* (Typical facies)	Upper subalpine level, 3700-4000 m except in drier region	**Tree layer** (3-10 m): *Betula utilis* (60 %), *Sorbus foliolosa* (10 %), *Acer caudatum* (5 %), *Sorbus microphylla* **Shrub layer:** *Rhododendron anthopogon, Rhododendron setosum, Lyonia viliosa*
56	*Juniperus indica* forest	Upper subalpine level, on the crests and peaks of slopes, common in the dry areas in West	Pure stand of *Juniperus indica*
Alpine Zone			
57	Pioneer species group on scree	Lower alpine level, 3950 – 4100 m up to 4500 m, large number of small woody species	Characteristic species on medium sized rocks (5-20 cm) (siliceous or weakly carbonated crystalline or metamorphic) - *Eriophyton wallichianum, Marina polyphylla, Silene nigrescens*
58	Pioneer species group on torrential gravels	Lower alpine level, Torrential alluviums well supplied with water and generally humid	Characteristic species: *Hippophae rhamnoides, Myricaria rosea, Oxyria digyna, Senecio bracteolatus, Primula sikkimensis*
59	Pioneer species	Lower alpine level,	Characteristic colonizing species: *Cotoneaster microphylla,*

	group on moraines	Moraine alluviums generally dry and may form reliefs	*Polygonum vacciniifolium, P. affine, Pedicularis sculleyana, Sedum himalayanum, S. bupleuroides*
60	Mesophilic Junipers Heathland	Dry parts of the lower alpine level, in the inner valleys and behind the line of crest of the great Himalayas, covers about 50% of the ground surface.	Prominent species: *Juniperus squamata* (most xerophilic, widespread in the West), *Juniperus indica, Juniperus recurva* Other Species: *Berberis angulosa, Lonicera myrtillus, L. hispida, Ephedra gerardiana, Cassiope fastigiata, n*umerous grasses
61	Mesohygrophilic *Rhododendron* Heathland	Dry parts of the lower alpine level, also grow in more humid conditions	**Characteristic species:** *Lonicera myrtillus, L. hispida, Potentilla fruticosa, Salix daltoniana, Spiraea arcuata, Codonopsis thalictrifolia* ***Herbaceous species:*** *Anemone rivularis, Cyananthus lobatus, C. microphyllus, Arisaema flavum, Anaphalis nubigena* etc. In the East, includes East Himalayan species: *Rhododendron elaeagnoides, R. wightii, Paroxygraphis sikkimensis, Aletris pauciflora*
62	Lower Alpine Meadow	Lower alpine level, plants grow after the snow melts and bloom during the monsoon. Maximum bloom between 1-15 August.	**Characteristic species:** **Initial group of species -** *Oxygraphis glacialis, 0. Polypetala, Paroxygraphis sikkimensis, Androsace selago, A. villosa* **Second group of species -** *Caltha scaposa, Primula strumosa, P. aureate, P. denticulate, P. stuarti* **Characteristic species of dry Meadows:** *Onosma bracteatum, Calophaca crassicaulis, Megacarpaea polyandra, Gentianella moorcroftiana, Aster falconeri* **Characteristic species of humid Meadows:** *Pedicularis megalantha, P. siphonantha, P. trichoglossa, P. elwesii, P. nepalensis* Species such as *Poa pagophila, Pleurospermum apiolens, P. rotundatum, Polygonum milletii* occur on both climates.
63	Vegetation on scree	Upper alpine level (up to 5000 m)	**Characteristic species:** *Anaphalis cavei, Chrysanthemum gossypinunz, Arenaria glanduligera, Corydalis meifolia*
64	Meadows on the fine and homogenous soil	Upper alpine level, soil types podzols, nanopodzols, rankers; dominated by grasses	**Characteristic species:** dominated by grasses or *Cyperaceae including Carex pisanensis, C. nakaona, Kobresia royleana, K. nepalensis*
65	Vegetation on soil with heterogenous structure	Upper alpine level	**Characteristic species:** *Chamephytes, Rhododendron nivale* (up to 5000 m), *Lonicera hispida, L. myrtillus, Pincushion species* (very high), Other species: *Androsace globifera, A. lehmanni, Saxifraga engleriana, S. diapensia*
66	Upper Alpine vegetation	Upper alpine level, up to driest area 6000 m with normal limit of 5500 m, up to 5000 m in Annapurna region	**Characteristic species:** *Corydalis nana, Saussurea gossypiphora, S. graminifolia, Waldheimia glabra, Saxifraga engleriana* etc. Species of genera - Ranunculus, Aster, Sedum, A stragalus, Pedicularis, Phlomis, Carex, and Crucifers
67	*Olea cuspidata* Steppe	Steppe (arid region), wooded steppe, rainfall 350-500 mm, 4-5 m high, density <100 tree/ha, Bheri	**Characteristic species:** *Olea cuspidate, Pistacia integerrima, Capparis spinosa, Acer pentapomicum, Punica granatum, Woodfordia fruticosa, Zanthoxylum alatum, Oplismenus compositus, Eriophorum comosum*

		valley near Dunai and western Nepal	
68	*Cupressus torulosa* Steppe	Steppe (Arid region), Wooded steppe, rainfall 350-500 mm, 4-5 m high, density <100 tree/ha, Kali Gandaki Valley and south of Dolpo	**Tree layer:** *Cupressus torulosa* and associated species include *Abelia triflora, Colquhounia coccinea, Wikstroemia canescens, Plectranthus rugosus, Buddleia tibetica, Rosa sericea, Berberis aristata, Berberis mucrifolia, Cotoneaster microphylla, Spiraea arcuata, Leptodermis lanceolata, Arisaema flavum, Ceratostigma ulicinum, Incarvillea grandiflora, Ephedra gerardiana, Caragana brevispina*
69	*Juniperus indica* Steppe	Steppe (Arid region), Wooded steppe, rainfall 350-500 mm, 4-5 m high, density <100 tree/ha	**Tree layer:** *Juniperus indica* **Shrub layer:** *Juniperus squamata, Rosa sericea, Berberis aristata, Myricaria germanica, Potentilla fruticosa, Syringa emodi, Lonicera quinquelocularis, L. spinosa, L. minutif olia, Caragana brevispina* **Herbaceous layer:** *Hordeum brevisubulatum, Stipa capensis, Tanacetum nubigenum, Androsace villosa, Leontopodium stracheyi, Micromeria nepalensis, Stellera chamaejasme;* Lamium (only in Western Nepal)
70	*Caragana nepalensis* Steppe	Arid zone, rainfall 250-300 mm, up to 2 m high, the least xerophilic species, exposed slopes to the south of the Langtang valley, species rich, dense	**Characteristic species:** *Caragana nepalensis, Elsholtzia fruticosa, Aster albescens, Rhododendron lepidotum, Cotoneaster microphylla, Berberis aristata, Marina longifolia, Artemisia vulgaris, Rosa sericea, Pennisetum flaccidum, Polygonum campanulatum, Juniperus squamata, Pedicularis gracilis*
71	*Caragana brevispina* Steppe	Arid zone (2700-3500 m), 40-50 cm high	**Dominant species:** *Caragana brevispina* **Shrub layer** (20-40%): *Caragana brevispina, Rosa sericea, Rhododendron lowndesii, Ephedra gerardiana, Berberis mucrifolia, B. angulosa, Lonicera hypoleuca, L. minutifolia*
72	*Caragana gerardiana* steppe	Arid zone, very thick tufts, 50 cm high	**Characteristic species:** *Caragana gerardiana, Berberis pl. sp., Artemisia sacrorum, A. maritime, A. sieversiana, A. annua, A. vestita*
73	*Caragana pygmaea* and *Lonicera spinosa* Steppe	Arid zone, above 4000 m, sometimes up to 5000 m, very low organic matter content	**Dominant species:** *Caragana pygmaea, Lonicera spinosa* **Companion species:** *Androsace sessiliflora, Physochlaina praealta, Incarvillea younghusbandii, Nepeta leucophylla* etc. **Other species:** *Potentilla fruticosa, Berberis koehneana, Lonicera myrtillus, Juniperus squamata*
74	*Juniperus squamata* Heathland	Alpine steppe level, dry zone between 4000-5000 m	**Characteristic species (Shrub layer):** *Juniperus squamata, Rhododendron nivale, R. anthopogon, R. lepidotum*
75	Alpine Meadows	Alpine steppe level, dry zone between 4000-5000 m	*Pennisetum flaccidum* exists in upper Bheri. Meadows of *Bromus littledalea* occur at the same level as the steppe vegetation of *Caragana-Lonicera.*
76	High altitude isolated vegetation	Alpine steppe level, between 5000-5500 m, up to 6000 m, isolated (padded) vegetation	**Characteristic species:** *Potentilla biflora var. lahulensis, Androsace sessiliflora, A. muscoidea, Arenaria polytrichoides, Thylacospermum rupifragum, Saxifraga hypostoma, S. pulvinaria, S. staintonii, S. andersoni, S. georgei* **Other non-padded species:** *Rhododendron nivale, Picrorhiza scrophulariaefolia, Aster flaccidus, Nepeta pharica, Aster linkiangensis, Oreosolen wattii*

			At 5400 m - Dense meadow with at least 80 species At 5800 m – isolated patch with more than 30 species At 6000 m – vegetation with more than 10 species
77	Xerophilic valley formations	Faces north to south, windy, intense evaporation, xerophilic vegetation	**Kali Gandaki Valley:** extensive xerophilic vegetation on the upper region, low number of species; Characteristic species: *Sophora moorcroftiana, Lonicera hypoleuca, Oxytropis mollis, Berberis mucrifolia, Ephedra gerardiana*; Vegetaton on halomorphic soil: *Salsola kali, Triglochin palustre, Triglochin maritimus* **Karnali Valley (West of Jumla):** main valley with steppe with grass and succulent plants; Species on the river slopes: *Aristida ascensionis, Euphorbia royleana, Agave Mexicana, Opuntia vulgaris, Sarcostemma sp., Kalanchoe spathulata* **Trisuli Valley (from the Syabrubesi to the Tibetan boarder):** Similar vegetation to Karnali Valley but less succulent species; Common species: *Euphorbia royleana* **Bheri Valley:** North-South course downstream from Tibrikot, a few xerophilic and succulent species include *Boucerosia umbellate, Selaginella bryopteris, Euphorbia royleana, Dipcadi hysudricum, Urginea indica* **Marsyandi Valley:** Downstream from Thonje, unique vegetation on the slopes; Grasses grow on the gravel that include *Aristida ravennae, Pennisetum flaccidum* and a species of *Leptodermis. Chamaeropes* palm between 1400 to 1900 m, which mixes with *Pinus excelsa* at the upper limit.

Based on Dobremez and his colleague's extensive fieldwork across Nepal, seven ecological maps of scale 1:250,000 covering entire country were produced between 1972 and 1985 (MoFSC 2002). These ecological maps applied the iso-potential zoning approach coined by P. Ozenda in 1963 and then used for medium to small-scale ecological mapping. The iso-potential ecological zone signifies a relatively homogenous area in terms of the ecological factors, including physical (abiotic), biological (biotic) and human factors and their interactions to manifest a unique natural environment. Hence, the iso-potential area is characterized by the homogeneity of ecological factors and their interactions, and the concept is considered more comprehensive than 'biotope' or 'ecosystem' (Dobremez 1976).

In 2003, ICIMOD digitized these manually drawn ecological maps into the geospatial map by generalizing the maps based on elevation, vegetation and the base map (Figure 1) (ICIMOD 2003). The generalized ecology map identified 62 ecology types comprising 60 vegetation types, one water body, and Nival zone. The 60 vegetation types were classified based on the bioclimatic zone (14 vegetation types), physiographic zone (4 forest types), dominant plant genus using common names comprising one genus only (11) or two (11) or three genus (9) forest types, mixed forest formation (5 forest types) and scrubs/shrubs/steppe/grass (6) vegetation types.

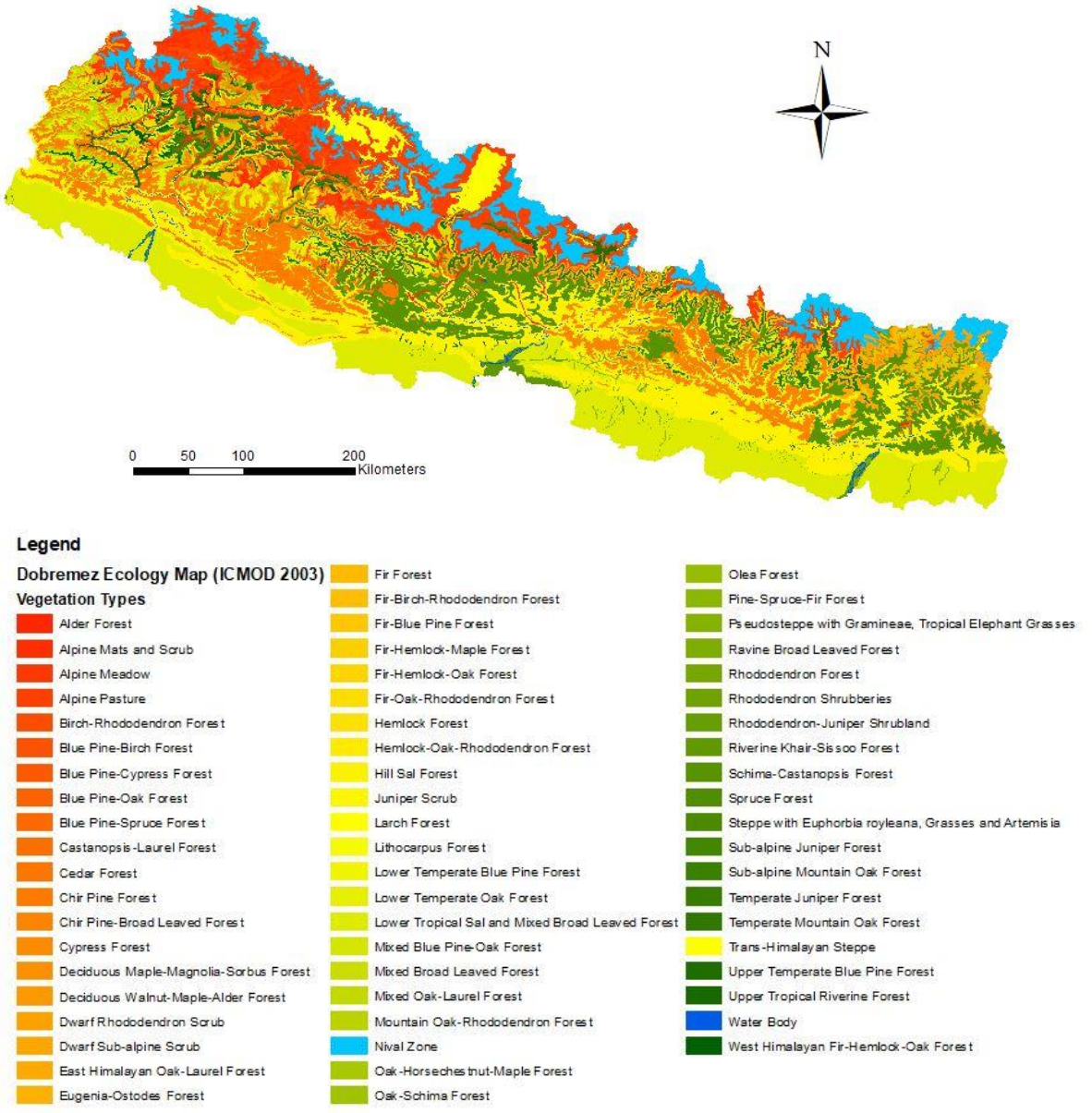

Figure 1: Dobremez Ecology Map of Nepal digitized by ICIMOD (2003)

Biodiversity Profile Project (BPP 1996) classified Nepal's ecosystem types based on the above seven ecology maps. According to the report, these maps were digitized in 1995 and identified 198 vegetation communities across Nepal. However, Tree Improvement and Silviculture Component (TISC 2002) inconsistently reported the number of vegetation types classified in these maps. Without the access to the BPP's digitized map delineating 198 vegetation types

from the Dobremez's seven ecology maps, we could not reconcile the total number of vegetation types in these reports.

2.3 Jackson (1994)

Jackson (1994) describes 24 vegetation types in Nepal. His classification is based largely on Stainton (1972) and Dobremez (1976). He classifies vegetation types according to their distribution in six bioclimatic zones, i.e. tropical, subtropical, lower temperate, upper temperate, subalpine, and alpine. Table 6 lists Jackson's (1994) vegetation types, with their distribution and species association.

Table 6: Vegetation types in Nepal as described by Jackson (1994)

SN	Vegetation type	Distribution	Species association
Tropical zone (up to 1000 m)			
1	*Shorea robusta* forest	Terai plains and the hills	*Shorea robusta, Terminalia alata, Adina cordifolia, Anogissus latifolia, Lgerstroemia parviflora, Dillenia pentagyna, Syzygium cumini, Semicarpus anacardium*
2	*Acacia catechu-Dalbergia sissoo* forest	On newly deposited alluvium along streams and rivers	*Acacia catechu, Dalbergia sissoo*
3	Other riverain forest	Small strips of forest in moist localities near streams	*Michelia champaca, Litsea species, Phoebe lanceolata, Actinodaphne angustifolia, Cinnamomum species* (east), *Syzyzium cumini* (west) [Stainton's Tropical Evergreen Forest]; *Bombax ceiba, Holoptelea integrifolia, Trewia nudiflora* [Stainton's Tropical Deciduous Riverain Forest]
4	Grassland	Usually on poorly drained clays; e.g. Rapti valley (CNP), Shuklaphanta	*Saccharum spontaneum, Phragmites karka, Arundo donax, Eulaliopsis binata*
5	*Terminalia-Anogeissus* deciduous hill forest	Southern slopes in the foothills in the west up to 1200m, south slopes in the large river valleys elsewhere	*Terminalia alata, Anogeissus latifolia, Ehretia laevis, Flacourtia indica, Lannea coromandelica, Shorea robusta*
Subtropical zone (1000-2000m in the west, 1000-1700m in the east)			
6	*Pinus roxburghii* forest	*On all aspects in the west; southern aspects and dry lower slopes of large river valleys in centre and east*	*Pinus roxburghii* (generally pure), but also with *Olea ferruginea, Pistacia species* (west), *Schima wallichii, Shorea robusta*
7	*Schima-Castanopsis* forest	On moister sites (e.g. north face and area of heavy rainfall) in central and eastern Nepal	*Schima wallichii, Castanopsis indica* (below 1200m), *C. tribuloides* (above 1200m)
8	*Alnus nepalensis* forest	In wet areas along streams and ravines, newly exposed soils,	*Alnus nepalensis* (generally pure), *Lyonia ovalifolia*

		abandoned cultivation	
9	Riverain forest with *Toona* and *Albizia* species	Along streams, corresponding to Stainton's Subtropical Semi-evergreen Forest	*Toona ciliata, Albizia species, Pandanus nepalensis*
Lower temperate zone (2000-2700m in the west, 1700-2400m in the east)			
10	Forest of *Quercus leucotrichophora* and *Q. lanata*	1750-2400m, on all aspects in the west and south slopes and sides of large river valleys in the centre and east	*Quercus leucotrichophora* (west), *Q. lanata* (east)
11	*Quercus floribunda* forest	2100-2850m, on wet sites	*Quercus floribunda, Aesculus indica, Acer species*
12	*Quercus lamellosa* forest	1900-2600m, Replaces *Q. lanata* forest in areas of high rainfall, such as south of the Annapurna massif, confined to north and west aspects	*Quercus lamellosa*, with Lauraceae of the temperate mixed broadleaved forest
13	Lower temperate mixed broadleaved forest, with abundant Lauraceae	1500-2100m, north and west aspects and in high rainfall areas	*Machilus species, Neolitsea cuipila, Cinnamomum tamala, Listea species, Michelia kosopa, Quercus lamellosa*
14	*Pinus wallichiana* forest (lower type)	1800-4000m, lower type on dry, south-facing slopes	*Pinus wallichiana*
Upper temperate zone (2700-3100 in the west, 2400-2800m in the east)			
15	*Quercus semecarpifolia* forest	2400-3000m (centre and east), extends up to 3700m in the west, more prevalent on south aspect	*Quercus semecarpifolia, Rhododendron arboretum, Ilex dipyrena*
16	Upper temperate mixed broadleaved forest	2400-3150m, mainly on north and west slopes east of the Kali Gandaki	*Acer species, Rhododendron arboretum*, Lauraceae (*Litsea, Lindera, Neolitsea*), *Tsuga dumosa*
17	*Rhododendron* forest	Very moist places, especially in the far east	*Rhodedendron arboretum, R. barbatum, R. grande, R. falconeri*
18	Upper temperate coniferous forest	Stainton's *Picea smithiana* and *Abies pindrow* forests are also included in this type.	*Pinus wallichiana* (generally pure), but with *Abies pindrow, Picea smithiana, Cedrus deodara* in moister areas in the west, *Juniperus indica* in dry Mustang region, *Tsuga Dumosa, Taxus baccata, Acer species* in centre and east
Subalpine forest (3000-4200m in the west, around 3000m in the east)			
19	*Abies spectabilis* forest	3000-3500m (centre), up to treeline (west)	*Abies spectabilis*, with *Quercus semecarpifolia* in the west, *Rhododendron species, Acer*

			species, *Larix griffithiana, L. himalaica* in the centre and east
20	*Betula utilis* forest	3300m to treeline	*Betula utilis* (generally pure), but with *Rhododendron species, Acer species* in the understory; *Abies spectabilis, Quercus semecarpifolia* in the west and Humla-Jumla area
21	*Rhododendron* forest	In wet sites in the east	*Rhododendron campanulatum, R. thomsonii, R. campbellianum*
22	*Juniperus indica* steppe	North of the Himalaya	*Juniperus indica*, with shrubby understory
23	Caragana steppe	In Mustang region	Caragana species
Alpine zone (between tree line and the region of perpetual snow)			
24	Alpine vegetation		Shruby Rhododendrons and junipers, *Hippophae rhamnoides, Cotoneaster microphyllus*

2.4 Biodiversity Profiles Project (1996)

The Biodiversity Profiles Project (BPP)'s classification of Nepal's ecosystems is primarily based on the ecological maps prepared by Dobremez and his colleagues between the late 1960s and 1985. BPP reported 136 ecosystem types in the original ecological maps and reduced them to 118 ecosystem types by merging the similar ecosystem types (BPP 1996). Among the 118 ecosystem types, 112 represent vegetation types at different physiography, bioclimate and biogeographic regions (Table 7). The rest six types (presented in the last rows of Table 9) represent non-vegetation ecosystems, such as water bodies, glaciers, and cultivated areas. Although the ecological maps had identified vegetation types across Nepal, BPP used the term 'ecosystem type' instead of 'vegetation type'. By definition, ecosystem and vegetation are significantly different terms and are not appropriate to use interchangeably.

For the ecosystem classification, BPP (1996) used four physiographic zones (viz. the Highlands, Midhills, Siwaliks, and Terai), six bioclimatic divisions (viz. alpine, sub-alpine, montane, collinean, sub-tropical, and tropical, with upper and lower sub-levels for alpine and sub-alpine levels), and three biogeographic regions (viz. western, central, and eastern regions) in Nepal.

Table 7: Ecosystem types in Nepal as described by BPP (1996)

SN	Code	Name of ecosystem	Altitude (m)
Highlands physiographic zone			
Alpine level			
Upper alpine level			
1	2101	Alpine meadows with Graminae and Cyperaceae	4000-4800
2	2102	Xerophytic mat patches and scarcely vegetated rocks and screes	

3	2103	Mesophytic mat patches and scarcely vegetated rocks and screes	
4	2104	Mesophytic and hydrophytic mat patches and scarcely vegetated rocks and screes	
5	2105	Alpine meadows on the southern side of the Himalaya	
6	2106	Dry alpine vegetation on the northern side of the Himalaya	
7	2107	High altitude discontinuous vegetation cushion plants	
8	2108	Meadows: mat patches	
9	2109	Scarcely vegetated rocks and screes of upper alpine level	
10	2110	Meadows *et lande communes aux deux soux etages*	
Lower alpine level			
11	2201	Rhododendron mesohygrophytic scrublands, *Juniperus…*, meadows	3800-4300
12	2202	Rhododendron mesohygrophytic scrublands (*R. anthopogan, R. nivale*…)	
13	2203	Juniper mesohygrophytic scrublands (*J. indica, J. recurva, J squamata*)	
14	2204	Xerophytic closed alpine mat and scrub	
15	2205	Mesophytic closed alpine mat and scrub	
16	2206	Shrublands with patches of abundant *Rhododendron anthopogon, R. nivale…*	
Sub-alpine level			
Upper sub-alpine level Western biogeographical region			
17	3101	Mesophytic closed sub-alpine mat and scrub (*R. anthopogon*…)	3300-3800
18	3102	Rhododendron-Birch forest (*Betula utilis, R. campanulatum*)	3300-3700
19	3103	Birch-Blue pine open forest	
Upper sub-alpine level Central Nepalese biogeographical region			
20	3110	North Himalayan alpine vegetation	
Upper sub-alpine level Eastern Nepalese biogeographical region			
21	3120	*Betula utilis* forest with Rhododendron… and *Abies spectabilis*	3200-3900
22	3121	Rhododendron shrublands	3300-3900
23	3122	Rhododendron-Juniper shrublands	3600-3900
Lower sub-alpine level West Nepalese biogeographical region			
24	3201	Mesophytic Fir forest with oak and rhododendron	2900-3400
25	3202	Hygrophytic Fir-Hemlock-Oak forest	2800-3300
26	3203	Fir forest (*Abies spectabilis*)	
Lower sub-alpine level Eastern Nepalese biogeographical region			
27	3220	*Abies spectabilis* forest with rhododendron	2900-3600
28	3221	*Larix griffithiana* forest	2900-3600
29	3222	*Larix griffithiana, L. potanini* forest	
30	3223	*Larix potanini* forest	
Steppic formations			
North-West Nepalese biogeographic region			
31	8001	High altitude cushion plant formation	
32	8002	*Caragana versicolor, Lonicera spinosa* steppe	
33	8003	*Caragana gerardiana, Lonicera spinosa* xerophile steppe	
34	8004	*Caragana bresispina, Artemisia* steppe	

35	8005	*Caragana pygmaea, Lonicera spinosa* xerophile steppe	
36	8006	*Myricaria-Hippophae-Salix* riverine thickets	
37	8007	*Sophora moorcroftiana, Oxytropis mollis* steppe	
Midhills physiographic zone			
Montane level			
Montane West Nepalese biogeographic region			
38	4001	Mesophytic monatne Oak-Rhododendron forest	2450-2900
39	4002	Mixed Blue Pine-Oak forest	2500-3000
40	4003	Mixed hygrophytic Oak-Hemlock-Fir forest	2400-2900
41	4004	Open and dry monatne Blue Pine forest	
42	4005	Blue Pine-Spruce forest	
43	4006	Juniper forest (*Juniperus indica*)	
44	4007	Rhododendron-Hemlock-Oak forest	
45	4008	Hemlock forest (*Tsuga dumosa*)	
46	4009	Mountain Oak forest (*Quercus semecarpifolia*)	
47	4010	Blue Pine-Spruce-Fir forest	
48	4011	Spruce mountain forest (*Picea smithiana*)	
Montane Eastern Nepalese biogeographic region			
49	4020	*Lithocarpus pachyphylla* forest	2400-2900
50	4021	*Rhododendron cinnamonmeum* forest	2400-2900
51	4022	Deciduous mixed broad-leaved forest	2400-2900
52	4023	Mixed broadleaved forest, *Rhododendron-Acer_Symplocus-Lauraceae*	2400-2900
53	4024	*Daphniphyllum himalayense* forest with a few *Rhododendron grande*	2100-2900
Collinean level			
Collinean West Nepalese biogeographic region			
54	5000	Blue Pine-Cypress forest	2300-2700
55	5001	Cypress forest with dwarf Barberry	1850-2400
56	5002	Collinean Oak forest (*Quercus leucotrichophora, Q. lanata*)	2000-2500
57	5003	Mixed Blue Pine-Oak forest	1800-2500
58	5004	Mixed Oaks-Laurels forest with shrubs	1500-2500
59	5005	Mixed hygrophytic broad-leaved forest with oaks	
60	5006	Cedar forest (*Cedrus deodara*)	
61	5007	Open Blue Pine forest (*Pinus wallichiana*)	
62	5008	Collinean Oak-mixed broadleaved forest (*Q. lanata*)	
63	5009	*Aesculus, Juglans* riverine forest	
64	5010	Deciduous broadleaved forest (*Alnus, Juglans, Acer*)	
Collinean Central Nepalese biogeographic region			
65	5011	Hygrophytic *Quercus lamellosa* forest	
Collinean Eastern Nepalese biogeographic region			
66	5012	Hygrophytic forest with *Quercus lamellosa*	1800-2400
67	5013	Hygrophytic forest with *Castanopsis tribuloides*	

68	5014	Mesohygrophytic forest with *Quercus glauca*	
69	5015	Mesohygrophytic forest with *Quercus lanata, Pinus excelsa*	
Sub-tropical level			
Sub-tropical Eastern Nepalese biogeographic region			
70	6001	*Eugenia tetragona, Ostodes paniculata* forest	900-1700
Upper sub-tropical West Nepalese biogeographic region			
71	6101	Mixed Chir Pine-Oak forest (*Pinus roxburghii, Q. leucotrichophora*)	1400-1900
72	6102	*Quercus glauca, Alnus nepalensis, Betula alnoides* riverine forest	1400-1800
73	6103	Open *Olea cuspidata* forest	
74	6105	Sub-tropical mixed broadleaved forest	
75	6106	*Quercus incana, Schima wallichii* forest	
Upper sub-tropical Central Nepalese biogeographic region			
76	6109	Hygrophytic *Schima wallichii, Castanopsis tribuloides* forest	
Upper sub-tropical Eastern Nepalese biogeographic region			
77	6110	*Castanopsis tribuloides* forest with *Schima walichii,* …	1400-1900
78	6120	*Castanopsis hystrix* forest with *C. tribuloides* …	1400-1900
79	6121	*Alnus nepalensis* forest	1200-2400
Upper and lower sub-tropical West Nepalese biogeographic region			
80	6201	Chir Pine forest with grasses and *Engelhardria*	900-1900
81	6202	Mixed Chir Pine-Broadleaved forest	900-1400
82	6203	*Alnus nepalensis* riverine forest	800-2000
83	6204	*Euphorbia royleana* steppe in inner valleys	
84	6207	Grasses-*Artemisia* steppe	
Upper and lower sub-tropical Central Nepalese biogeographic region			
85	6109	Hygrophytic *Schima wallichii, Castanopsis tribuloides* forest	
Upper and lower sub-tropical Eastern Nepalese biogeographic region			
86	6220	*Schima wallichii, Castanopsis indica* hygrophile forest	900-1400
87	6221	*Schima wallichii, Pinus roxburghii* mesohygrophile forest	
88	6222	*Pinus roxburghii* xerophile forest with *Phyllanthus emblica*	
89	6223	*Schima wallichii, Lagerstromia parviflora* hygrophile forest	
Siwaliks physiographic zone			
Sub-tropical level			
Upper sub-tropical Western Nepalese biogeographic region			
90	6104	Upper Siwalik Chir Pine-Oak forest	
Upper and lower sub-tropical Western Nepalese biogeographic region			
91	6205	Siwaliks Chir Pine forest	
92	6206	*Alnus nitida* riverine forest	
Tropical level			
Upper tropical West Nepalese biogeographic region			
93	7101	Tropical hill Sal forest in large valleys	450-1000
94	7102	Tropical riverine forest (*Albizia lebbek, toona ciliata*, …)	450-1000
95	7103	Sal forest in inner valleys (*Shorea robusta, Terminalia tomentosa*)	600-1000
96	7104	Mesophytic tropical forest on southern slopes of the Siwaliks	350-900

97	7105	Hygrophytic tropical forest on northern slopes of the Siwaliks	350-900
98	7106	Siwalik tropical deciduous forest	
Upper tropical East Nepalese biogeographic region			
99	7120	Tropical hill Sal forest	350-900
100	7122	Dense forest with *Shorea robusta, Lagerstromia parviflora*, …	
101	7123	Dense forest with *Terminalia tomentosa, T. belerica*, …	
Lower tropical level West Nepalese biogeographic region			
102	7204	Dun valleys Sal forest	
Terai physiographic zone			
Tropical level			
Upper tropical Eastern Nepalese biogeographic region			
103	7121	Tropical riverine forest	
104	7124	Sal forest (*Shorea robusta*)	
Upper tropical Western Nepalese biogeographic region			
105	7201	Tarai tropical Sal forest (*Shorea robusta, Terminalia tomentosa*, …)	
106	7202	Khair-Sissoo riverine forest	150-350
107	7203	*Samalia malabarica, Trewia nudiflora* riverine forest	
108	7205	Bhabaar light Sal forest	75-300
109	7206	Pseudo steppe with Graminae, Tropical elephant grasses	
Lower tropical Eastern Nepalese biogeographic region			
110	7220	Tarai tropical Sal forest	
111	7221	Tropical mixed wet forest	
112	7222	Tropical dense forest with *Terminalia sp.*	
Other ecosystems (in all zones)			
113	1000	Glaciers, snow, rock (Highlands, Nival level)	>4800
114	9900	Water bodies (Highlands, Midhills, Terai)	
115	9003	Pokhara cultivated areas (Midhills)	
116	9001	Dun cultivated areas (Siwaliks)	
117	9000	Cultivated areas (Terai)	
118	9002	Terai cultivated areas (Terai)	

2.5 TISC (2002)

The Tree Improvement and Silviculture Component (TISC) of the Natural Resource Management Sector Assistance Programme (NARMSAP) implemented by the then Department of Forest prepared the iso-potential vegetation map of Nepal based on the ecological maps prepared by Dobremez and his colleagues (1969-1985) and Nepal's ecosystem classification by BPP. International Union for Conservation of Nature (IUCN) assessed them and recommended 59 vegetation types in Nepal. TISC further reduced them to 36 classes to simplify the mapping of the climax and near-climax vegetation into homogenous ecological areas representing the iso-potential area for a particular vegetation type (TISC 2002).

TISC classifies Nepal's vegetation according to six main life zones, with sub-zones for some of them (Table 8) (TISC 2002). It also considers four biogeographic regions as identified by Dobremez (1976), i.e. Eastern Nepalese biogeographic region, Central Nepalese biogeographic region with a sub-region on the northern side, Western Nepalese biogeographic region with a sub-region on the northern side, and Trans-Himalayan biogeographic region, while describing vegetation types.

Table 8: Life zones in Nepal as described by TISC (2002)

Zone	Average altitude (m)	Description/Key species
1. Nival	**>5000**	**Above snowline (5000m in E, C but 4800 in W, and 5500 in Trans- Himalaya). A zone of permanent snow.**
2. Alpine	**4000-5000**	**Between treeline (3700-4200m) and snowline (4800-5000m, 5500 in Transhimalaya). A zone of alpine grasslands and rangelands, associated with *Juniperus* thickets, Rhododendron bushes and cushion formations; exhibits much variation between N and S slopes and longitudes.**
2.1 Upper Alpine	4500-5000	Open meadows of grasses (Gramineae) and sedges (Cyperaceae) and alpine scrub vegetation on the south of main Himalaya; steppic vegetation of cushion plants and rosettes on Transhimalayan region
2.2 Lower Alpine	4000-4500	Juniperus thickets, Rhododendron bushes
3. Subalpine	**3000-4000**	**Between Abies spectabilis zone (about 3000m) and treeline (3700-4200m). A zone of *Abies, Betula and Rhododendrons*.**
3.1 Upper Subalpine	3500-4000	*Betula utilis*, pure or associated with Rhododendrons
3.2 Lower Subalpine	3000-3500	*Abies spectabilis*, pure or associated with *Tsuga dumosa, Quercus semecarpifolia, Rhododendrons*
4. Temperate	**2000-3000**	**Over 40% of Nepal's vegetation types; a zone of *Quercus* and Conifer forests, associated with *Acer* and *Rhododendrons*.**
4.1 Upper Temperate (Cool Temperate)	2500-3000	*Quercus semecarpifolia*, pure or associated with *Rhododendron arboreum, Acer species, Lithocarpus spicata* (east), *Pinus wallichiana, Picea smithiana, Tsuga dumosa* (west), *Rhododendrons; Lithocarpus pachyphylla* forest
4.2 Lower Temperate (Warm Temperate)	2000-2500	Mixed *Quercus* species forests, e.g. *Q. incana, Q. lanata* (main), N-aspect: *Q. floribunda* (W), *Q. glauca, Q. lamellosa* (E,C); *Pinus wallichiana* forest
5. Subtropical	**1000-2000**	**Zone of *Pinus roxburghii* in west and *Castanopsis-Schima* in Centre/East; *Pinus roxburghii*-mixed broadleaved forest (C)**
6. Tropical	**<1000**	**Tarai, Bhavar, Dun valleys, and low lying river terraces (Tars), e.g. Tumlingtar, Batar, Salyantar, Palungtar etc.; *Shorea***

		***robusta* and savannah dominated.**
6.1 Upper Tropical	300-1000	Churia hills and their foothills, dun valleys; zone of *Hill Shorea robusta*, with *Terminalia, Anogeissus, Lagerstoemia, Adina*
6.2 Lower Tropical	<300	Tarai and Bhabar zones; *Shorea robusta, with Duabanga grandiflora, Terminalia chebula, T. belerica, Dillenia pentagyana* etc.; tropical savannah

The 36 climax or near-climax vegetation types were classified in the five bioclimatic zones including Alpine (3), Sub-alpine (7), Temperate (17), Subtropical (4), Upper Tropical (1), Lower Tropical (1), and Trans-Himalayan zones (3). The TISC's vegetation types, altitudinal range, and species association are summarized in Table 9.

Table 9: Vegetation types in Nepal as described by TISC (2002)

SN	Vegetation type	Distribution	Species association
Alpine Zone			
1	Upper Alpine Meadows	4500-5000m, High Himalayan and Trans-Himalayan regions	Grasses like *Carex species, Calamogrotis species, Agrotis micantha, Festuca leptogunum*, Sedges (*Cyperaceae*); *Primula species, Rheum nobile, Kobresia hookeri, K. pygmaea, Chrysosplenium species, Potentilla peduncularis, Bistorta vaccinifolia, Poa pogophylla, Arenaria kansuensis* (east), xerophytic, mesophytic patchy vegetation (west); cushion plants (e.g. Caragana) in Trans-Himalaya
2	Dry Alpine Scrubs	Down to 3000m in some places	Dwarf and prostrate junipers: *Juniperus indica, J. recurve, J. squamata*, with *Ephedra gerardiana, Cassiope fastigiate, Potentilla fruticose, Berberis species, sedum species*
3	Moist Alpine Scrub	Mainly in the east	Dwarf Rhododendrons (*Rhododendron anthopogan, R. nivale, R. setosum, R. hypenanthum*) at higher elevations, and shrubby Rhododendrons (*R. campanulatum, R. wallichii, R. campylocarpum, R. thomsonii, R. wightii, R. fulgens*) at lower elevations
Sub-alpine Zone			
4	Fir-Blue Pine Forest	Side valleys of the Kaligandaki	*Abies species, Pinus wallichiana*
5	Birch-Rhododendron Forest	typical of this zone, on north, shady slopes and ravines	*Betula utilis, Abies spectabilis, Sorbus macrophylla, Acer species, Rhododendron campalunatum, R. campylocarpum, R. cinnabarinum, R. hodgsonii*; with *Juniperus species* in dry valleys
6	Fir Forest	3300-3500m, widespread between	*Abies spectabilis, with Rhododendron arboretum, R. barbatum, R. hodgsonii, R. campanulatum* (east);

		the Kaligandaki and Sunkoshi valley	*Quercus semecarpifolia* (Humla-Jumla area)
7	Larch Forest	On morainic debris with loose rocks and boulders	*Larix himalaica* (central – Manaslu and Langtang areas), *Larix griffithiana* (eastern – Simbua khola and Thapabu khola near Khambachen), with *Abies species, Pinus wallichiana, Betula utilis*
8	Fir-Oak-Rhododendron Forest	Confined in lower alpine zone of Bajhang and Doti	*Abies species, Quercus species, Rhododendron species*
9	Fir-Hemlock-Oak Forest	2800-3400m, humid western Midhills	*Abies spectabilis,* with *Tsuga dumosa* (north), *Quercus semecarpifolia* (south), *Taxux wallichiana*
10	Sub-alpine Mountain Oak Forest	3400-3700m on southern aspect	*Quercus semecarpifolia*
Temperate Zone			
11	Upper Temperate Blue Pine Forest	2500-3000m, south and south-western aspects	*Pinus wallichiana* (Syn.: *P. excelsa, P. chylla, P. griffithii*), with *Abies spectabilis, Betula utilis* (upper range)
12	Temperate Juniper Forest	Dhorpatan area	Generally pure forest of *Juniperus species*, but with a few *Abies, Betula and Quercus* trees on fringes
13	Spruce Forest	2000-3000m, shady slopes west of the Trisuli; e.g. west of Rara and Chankheli ridge in Mugu	*Picea smithiana, Pinus wallichiana, Abies pindrow*
14	West Himalayan Fir-Hemlock-Oak Forest	2100-3000m, west of the Karnali	*Abies pindrow,* with *Picea smithiana* (Karnali region), *Tsuga dumosa, Quercus semecarpifolia* (Seti region)
15	Temperate Mountain Oak Forest	Above 2500m, widespread in the west	*Quercus semecarpifolia,* with *Tsuga dumosa, Rhododendron species, Acer species* (humid slopes), Laurels (*Neolitsea umbrosa, Lindera pulcherrima, Dodecadenia grandiflora)* [centre and east], *Pinus wallichiana* (dry sites, e.g. Dhorpatan area)
16	*Lithocarpus* Forest	2600-3000m, in Tamur valley and ridges in Sikkim border	*Lithocarpus pachyphylla,* with *Quercus lamellosa, Q. lineata, Ilex dipyrena, Michelia doltsopa, Magnolia campbellii*
17	*Rhododendron* Forest	Milke-Jaljale ridge	*Rhododendron arboreum,* with *R. barbatum, R. campanulatum*
18	Mountain Oak-Rhododendron Forest	2500-2900m, all aspects in far west	*Quercus semecarpifolia, Rhododendron arboreum*
19	Deciduous Maple-Magnolia-Sorbus Forest	2500-3000m, Arun and Tamur valleys	*Magnolia campbellii, Acer campbellii,* with *Rhododendron barbatum, Symplocos pyrifolia* in the second layer
20	Mixed Rhododendron-Maple Forest	2600-3000m, widespread in Arun and Tamur valleys	*Rhododendron arboreum, Acer campbellii, A. sterculiaceum, A. pectinatum,* with *Symplocos species, Ilex species, Taxus wallichiana, Tsuga*

			dumosa (corresponding to Stainton's upper temperate mixed broadleaved forest)
21	Cedar Forest	2000-3000m, in Karnali region (e.g. in the Tila river valley)	*Cedrus deodara, Cupressus torulosa, Olea ferruginia, Pinus wallichiana*
22	Cypress Forest	2000-2500m, in dry, steep, high wind areas, in the west	*Cupressus torulosa, Abies spectabilis, Betula utilis, Juniperus indica, Pinus wallichiana*
23	Mixed Blue Pine-Oak Forest	2000-2500m, as a result of human disturbances in oak forest	*Pinus wallichiana, Quercus lanata, Q. dilatata, Castanopsis tribuloides*
24	Lower Temperate Oak Forest	2000-2500m, widespread in the west	*Quercus incana, Q. lanuginosa, Q. glauca,* with *Rhododendron arboreum, Lyonia ovalifolia, Myrica esculenta, Cornus capitata*
25	Deciduous Walnut-Maple-Alder Forest	2100-2900m, along streams and ravines in the west	*Aesculus, Juglans, Acer, Populus, Betula, Corylus, Ulmus species,* with *Abies pindrow, Tsuga dumosa, Quercus dilatata*
26	East Himalayan Oak-Laurel Forest	High rainfall areas, e.g. Arun and Tamur valleys, Annapurna-Dhaulagiri region	*Quercus lamellosa, Q. glauca, Q. oxydon (Q. lineata), Litsea elongata, Machilus duthei, M. odoratissima, Dodecadenia grandiflora, Neolitsea umbrosa, Lindera pulcherrima, Symplocos species, Daphniphyllum himalayense, Mahonia napaulensis*
27	Olea Forest	1500-2000m, in the upper Bheri valley	*Olea cuspidate, O. glandulifera,* with *Capparis spinosa, Pistachia integerrima, Punica granatum, Cedrus deodara*
Sub-tropical Zone			
28	Chir Pine Forest	1000-2000m, on all aspects in the west, and south aspect in centre and east	Generally pure forest of *Pinus roxburghii,* with *Quercus species* in the upper limit and *Shorea robusta* in the lower limit, *Engelhardia spicata, Toona ciliata* in damp ravines and gullies
29	Chir Pine-Broadleaved Forest	1000-2000m, widespread in west than east	*Pinus roxburghii, Quercus incana, Q. lanata, Rhododendron arboreum, Lyonia ovalifolia, Engelhardia spicata, Erythrina stricta, Schima wallichii*
30	*Schima-Castanopsis* Forest	1000-2000m	*Schima wallichii, with Castanopsis indica* (1000-1500m), *C. tribuloides* (1500-2000m, abundant in Arun and Tamur valleys), *C. hystrix* (east). Alder (*Alnus species*) Forest occurs in *Schima-Castanopsis* belt.
31	*Eugenia-Ostodes* Forest	Far east up to Tamur valley	*Eugenia tetragona, Ostodes paniculata*
Upper Tropical Zone			
32	Hill Sal Forest	300-1000m	*Shorea robusta*, with *Terminalia, Anogeissus, Lagerstroemia, Adina species*
Lower Tropical Zone			

33	Lower Tropical Sal and Mixed Broadleaved Forest		
33.1	Lower Tropical Sal Forest		*Shorea robusta*, with *Careya arborea, Ehretia laevis, Semecarpus anacardium, Dillenia pentagyna, D. indica, Butea frondosa*
33.2	Mixed Broadleaved Forest		
33.2.1	Terminalia Forest	Below 1000m, along narrow river valleys and foothills of Siwaliks	*Terminalia tomentosa, T. belerica, T. chebula, T. myriocarpa*
33.2.2	Tropical Evergreen Forest	Along water courses and wet gullies	*Michelia champaca, Eugenia jambolana, Albizia species, Cedrela toona, Artocarpus fraxinifolius*, with palms, bamboos, canes, tree ferns, cycads
33.2.3	Tropical Deciduous Riverain Forest	Consolidated river terraces	*Salmalia malabaricum, Holoptelea integrifolia, Schleichera trijuga, Ehretia laevis, Trewia nudiflora, Garuga pinnata, Shorea robusta*
33.2.4	Riverain Khair-Sissoo Forest	70-500m, along water courses	*Acacia catechu, Dalbergia sissoo*
33.2.5	Savannah/Grasslands	Below 300m	The dominant grassland species found in the Tarai and Dun valleys are described as follows: a) *Typha elephantica* (permanently waterlogged sites) b) *Phragmitis karka-Saccharum spontaneum-S. arundinaceum* (seasonally inundated, heavily grazed sites) c) *Phragmitis karka* (seasonal and permanent marsh) d) *Phragmitis karka-Saccharum spontaneum* (seasonal and permanent marsh) e) *Saccharum spontaneum* (flood plain, alluvial soil, often inundated) *f) Imperata cylindrica* g) *Narenga porphyrocoma* (old river terraces, wetter sites) h) *Themeda arundinaceae* (well-developed soils, forest edges)
34	Trans-Himalayan Upper Caragana Steppe	Above 3500m	*Caragana versicolor, Lonicera spinosa*
35	Trans-Himalayan Lower Caragana Steppe		*Caragana gerardiana, Artemisia species, Berberis species, Lonicera myrtilloides, Potentilla fructicosa*
36	Trans-Himalayan High Alpine Vegetation	Above 4500m	*Androsace tapete, Allardia glabra, Eriophyton wallichianum, Rhododendron nivale, Androsace muscoides, Picrorhiza scrophulariifolia, Oresolon watti*

The spatial extent and distribution of the above vegetation types are illustrated in the TISC's (2002) vegetation map (Figure 2). However, the map showing 36 vegetation types and permanent snow (Nival zone) does not show the 'Deciduous Walnut-Maple-Alder Forest' described in the report, whereas it shows the 'Oak-Horse Chestnut-Maple Forest', which has not been described elsewhere in the report.

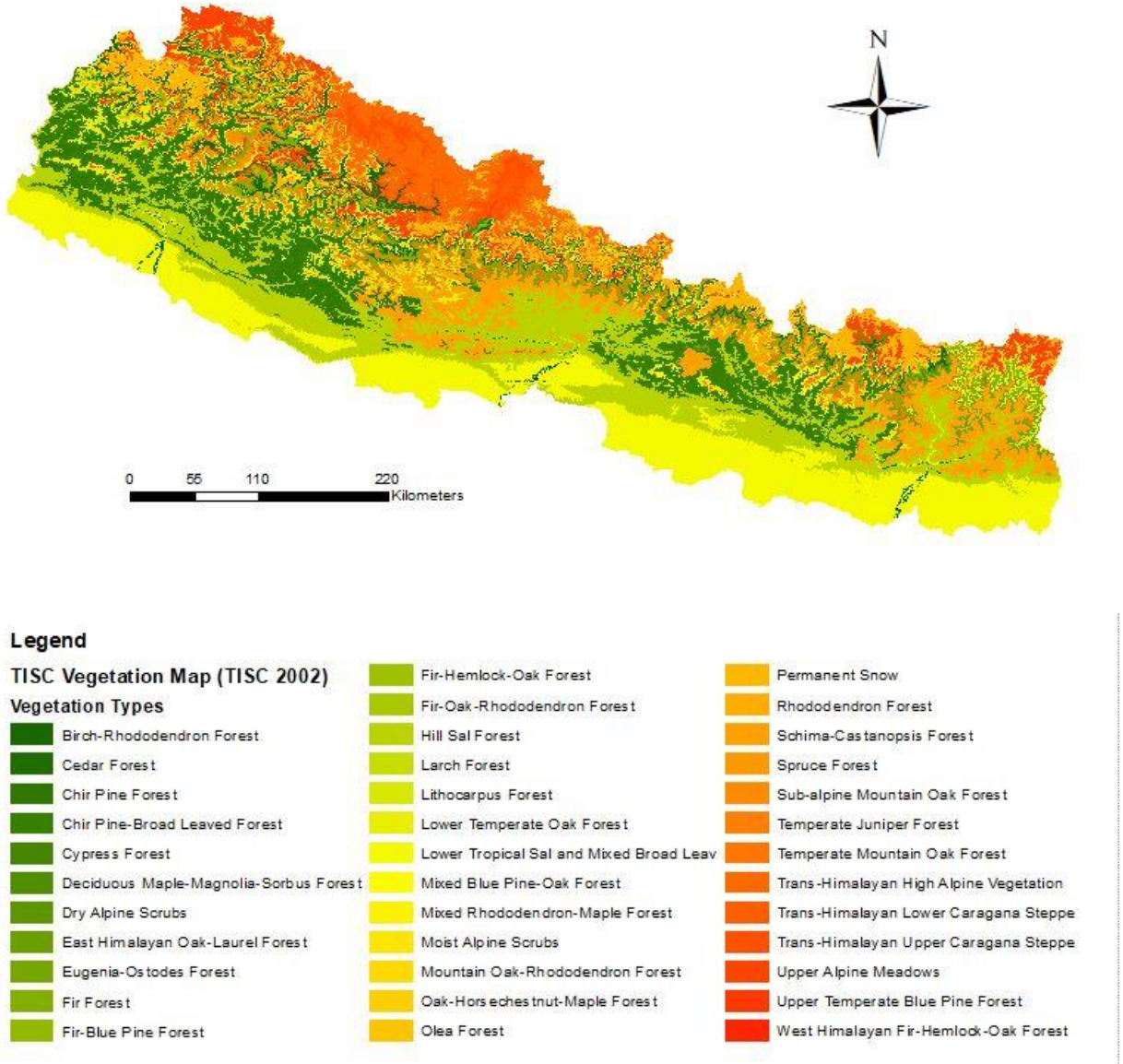

Figure 2: Iso-potential vegetation map of Nepal (TISC 2002)

2.6 DFRS (2014, 2015)

The Forest Resource Assessment (FRA) Nepal Project under the Department of Forest Research and Survey (DFRS) carried out the third nationwide forest inventory between 2010 and 2014.

Using the information collected during the inventory (forest type data from 907 plots) as training data, FRA/DFRS also carried out a forest mapping applying machine learning Classification and Regression Tree (CART) process with Landsat 8 image. The standard guidelines prepared for that mapping classify Nepal's forests into 25 types in the five physiographic regions, namely Terai, Churia, Mid Hills, High Hills, and High Himal (Table 10) (DFRS 2014).

Table 10: Forest types in Nepal as described by DFRS (2014)

SN	Forest Types (Level 3)	Definitions
Terai physiographic region		
1	*Shorea robusta* (Sal) forest	Forest where the basal area of *Shorea robusta* is >60% of the total basal area
2	Terai Mixed Hardwood (TMH) forest	Forest of mixed species at an altitude <1000m (*Shorea robusta, Terminalia, Eugenia, Trewia, Lagerstroemia, Adina, and Cedrela species* etc.) where the basal area of *Shorea robusta* is <33% of the total basal area.
3	*Acacia catechu-Dalbergia Sissoo* forest	Forest of mixed species (*Acacia catechu/Darbergia sissoo*) found on the floodplains and the riverbanks; it can be natural or plantation.
4	Sal mixed with Terai Mixed Hardwood (STMH) forest	Mixed forest in the Terai, where the basal area of Sal (*Shorea robusta*) is between 33 and 60% of the total basal area.
Churia [*Chure*] physiographic region		
5	*Shorea robusta* (Sal) forest	Forest where the basal area of *Shorea robusta* is >60% of the total basal area
6	Terai Mixed Hardwood (TMH) forest	Forest of mixed species at an altitude <1000m (*Shorea robusta, Terminalia, Eugenia, Trewia, Lagerstroemia, Adina, and Cedrela species* etc.) where the basal area of *Shorea robusta* is <33% of the total basal area.
7	Lower Mixed Hardwood (LMH) forest	Forest of mixed species in the Churia region between 1000 and 2000m.
8	Chir Pine forest	Forest in which *Pinus roxburghii* is dominant; it can be natural or plantation.
9	*Acacia catechu-Dalbergia Sissoo* forest	Forest of mixed species (*Acacia catechu/Darbergia sissoo*) found on the floodplains and the riverbanks; it can be natural or plantation.
10	Sal mixed with Terai Mixed Hardwood (STMH) forest	Mixed forest in which the basal area of Sal (*Shorea robusta*) is between 33 and 60% of the total basal area.
11	Sal mixed with Chir Pine forest	Mixed forest in the Churia region, where neither Sal (Shorea robusta) nor Chir Pine (Pinus roxburghii) occupies more than 60% of the total basal area.
Mid Hills physiographic region		
12	Upper Mixed Hardwood (UMH) forest	Forest of mixed hardwood species in the Mid Hills above 2000m.
13	Chir Pine forest	Forest in which *Pinus roxburghii* is dominant, i.e., its basal area is >60% of the total; it can be natural or plantation.

14	*Schima-Castanopsis* forest	Forest dominated by *Schima wallichii* and *Castanopsis indica*, i.e., both combinedly having >60% of the total basal area.
15	*Shorea robusta* (Hill Sal) forest	Forest in the Mid Hills where the basal area of *Shorea robusta* is >60% of the total basal area.
High Hills physiographic region		
16	Upper Mixed Hardwood (UMH) forest	Forest of mixed hardwood species in the High Hills above 2000m.
17	*Rhododendron* forest	Forest predominated by *Rhododendron species* at altitude above 2400m.
18	Blue Pine forest	Forest in which *Pinus wallichiana* is dominant, i.e., its basal area is >60% of the total; it is distributed in areas between 1800 and 4000m with abundance on south-facing slopes at the lower altitudes.
19	*Quercus semecarpifolia* forest	Forest dominated by *Quercus semecarpifolia*, found between 2400 and 3000m in Central and Eastern Nepal.
20	*Abies spectabilis* forest	Forest dominated by Abies spectabilis, often associated with *Quercus semecarpifolia, Betula utilis, Rhododendron species, and Larix griffithiana*, found between 3000 and 3500m.
21	*Betula utilis* forest	Forest dominated by *Betula utilis*, found between 3300m and tree line. It is often pure, but also associated with *Rhododendron* and *Acer species*, and also with *Abies spectabilis* and *Quercus semecarpifolia* in the western Nepal.
22	*Juniperus* forest	Forest predominantly covered by *Juniperus species*.
23	Upper Mixed Conifer (Spruce, Deodar, Larch, *Abies pindrow*) forest	Forest of mixed species like Spruce, Deodar, Larch, *Abies pindrow* etc.
High Himal physiographic region		
24	*Rhododendron* bush (Dwarf *Rhododendron*)	Bush of *Rhododendron species.*
25	*Betula utilis* forest	Forest of *Betula utilis* along with other species found in alpine and subalpine regions.

Although the guidelines describe 25 forest types across five physiographic regions as presented in Table 10, 17 forest types are identified after excluding the forest types listed more than once in different physiographic regions. However, DFRS further consolidated forest types into the following 15 types and generated a forest type map of Nepal (Figure 3) by integrating object-based image analysis with machine learning algorithm (DFRS 2015).

1) Terai Mixed Hardwood Forest
2) Upper Mixed Hardwood Forest
3) Lower Mixed Hardwood Forest
4) *Shorea robusta* (Sal) Forest
5) Chir Pine (*Pinus roxburghii*) Forest
6) Quercus Species Forest
7) Blue Pine (*Pinus wallichiana*) Forest
8) *Abies spectabilis* and *Abies pindrow* Forest

9) *Acacia catechu-Dalbergia sissoo* Forest
10) *Betula utilis* Forest
11) *Cedrus deodara* Forest
12) *Picea smithiana* Forest
13) *Cupressus torulosa* Forest
14) *Tsuga Dumosa* Forest
15) *Juglans wallichiana* Forest

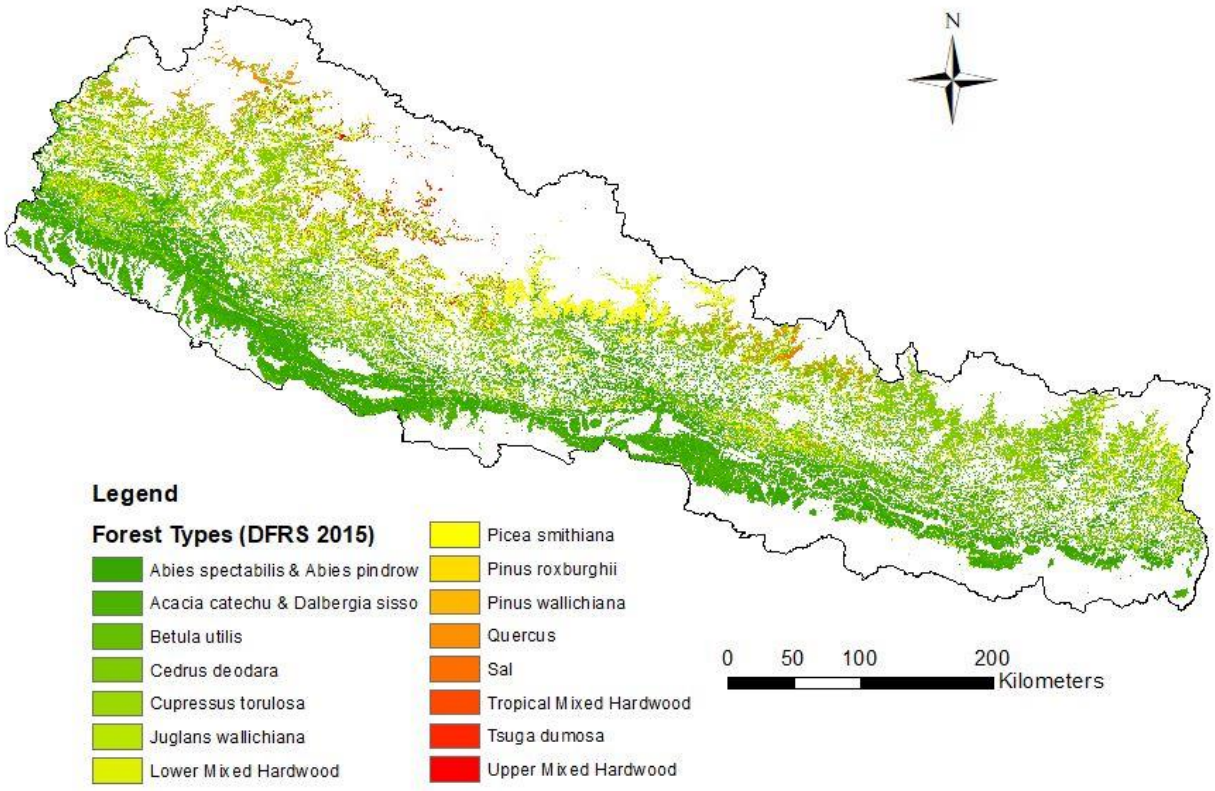

Figure 3: Forest type map of Nepal (DFRS 2015)

Further, the analysis of the FRA's plot-level data (N=1436, excluding outliers) gives 45 forest types as presented in Table 11. All of them might have not been mapped because of the insufficiency of training data for many forest types.

Table 11: Forest types in Nepal identified through the analysis of FRA data

SN	Forest Type	No. of signature	Min altitude	Max altitude
1	*Shorea robusta* Forest	285	91	1353
2	*Dalbergia sissoo* forest	5	98	1068
3	Tropical Mixed Broadleaved Forest	359	119	1229
4	Tropical Deciduous Riverine Forest	21	126	1266

5	*Tectona grandis* Forest	1	140	140
6	*Terminalia* Forest	21	167	1096
7	Tropical Evergreen Riverine Forest	4	184	326
8	*Anogeissus latifolius* Forest	9	190	974
9	*Senegalia catechu* Forest	6	319	921
10	*Pinus roxburghii*-Mixed Broadleaved Forest	19	536	2065
11	*Castanopsis-Schima* forest	26	540	2099
12	*Pinus roxburghii-Shorea robusta* Forest	19	563	1443
13	*Schima wallichii* forest	27	591	1965
14	*Pinus roxburghii* Forest	82	684	2133
15	Subtropical Mixed Broadleaved Forest	73	864	2019
16	*Alnus nepalensis* Forest	44	880	2498
17	*Olea* Forest	1	1213	1213
18	*Castanopsis* forest	8	1340	1906
19	*Quercus lanata* Forest	19	1394	2810
20	*Alnus nitida* Forest	2	1667	1867
21	Lower Temperate Mixed Broadleaved Forest	83	1762	2587
22	*Quercus incana* Forest	6	1815	2084
23	*Pinus wallichiana*-Mixed Broadleaved Forest	6	1854	2112
24	*Pinus wallichiana* Forest	28	1859	3788
25	*Daphniphyllum himalayense* Forest	6	1893	1985
26	*Rhododendron arboreum* Forest	35	1953	3434
27	*Quercus semecarpifolia* Forest	51	2013	3730
28	*Quercus-Rhododendron* Forest	23	2107	2725
29	*Pinus patula* Forest	1	2162	2162
30	*Cedrus deodara* Forest	5	2401	2670
31	Upper Temperate Mixed Broadleaved Forest	39	2428	3176
32	*Quercus floribunda* Forest	9	2482	3146
33	Upper Temperate Broadleaved-Conifer Mixed Forest	28	2491	3180
34	*Cupressus torulosa* Forest	2	2589	3291
35	*Tsuga dumosa* Forest	12	2627	3163
36	*Abies* Forest	19	2754	3604
37	*Picea smithiana* Forest	5	2781	3024
38	*Juglans regia* Forest	1	2804	2804
39	Upper Temperate Mixed Conifer Forest	5	2854	3231
40	*Rhododendron* scrub	4	3036	3795
41	Subalpine Broadleaved-Conifer Mixed Forest	15	3102	3704
42	*Betula utilis* Forest	9	3148	3765
43	Subalpine Mixed Broadleaved Forest	6	3164	3884
44	*Rhododendron barbatum* Forest	6	3165	4052
45	*Juniperus recurva* Forest	1	3820	3820

2.7 Miehe et al. (2015)

Miehe et al. (2015) classify Nepal's vegetation by analysing the vegetation types in the broader Himalayan context through the ecological observations and photo documentation for about four decades (p.395) and also reviewing the past studies, including Schweinfurth (1957), Stainton (1972), Dobremez et al. (1970-1985), TISC (2002), Shrestha et al. (2002), and Lilleso et al. (2005).

Vegetation classification by Miehe et al. (2015) uses four physical and biological attributes, including altitudinal belts, climatic zones, humidity types, and plant life forms and related formations, and also describes the intensity of human impacts on the vegetation.

(A) Altitudinal belts:

They consider the following seven altitudinal belts:

1) Lowland: Tarai region
2) Hill: Outer foothills and lower mountain slopes up to 1000m
3) Submontane: intermediate between hill and montane between 1000-1200 and 2000m
4) Montane: Between 2000 and 4000m (2000-2500m: lower cloud forest belt, 2500-3000m: middle cloud forest belt, 3000-treeline: upper cloud forest belt, subalpine: ecotone between montane forests and dwarf scrub formations)
5) Alpine: above the upper limit of trees and taller shrubs on humid slopes
6) Subnival: Transitional belt between the alpine and nival belt; relevant to humid areas
7) Nival: the highest altitudinal belt with plants only in sheltered habitats

(B) Climatic zones:

Miehe et al. (2015) classify Nepal into five climatic zones for vegetation classification as below:

1) Tropical: Tarai, Bhabar, Siwaliks, and Duns, i.e. below 1000m, where frost is absent
2) Subtropical: Most parts of midlands between 1000 and 2000m
3) Temperate: most parts of the southern slopes of the Himalayas and the valley floors of the Inner Valleys between 2000 and 3000m
4) Cool: Higher slopes of the southern slope of the Himalayas and the Inner Valleys between 3000 and 4000m, with its upper limit at the treeline ecotone
5) Cold: Between 4000 and 5000m, roughly corresponding to the alpine belt

(C) Humidity types:

They consider the following eight humidity types for classifying Nepal’s vegetation.

1) Perhumid: 12 humid months with continuously wet conditions

2) Euhumid: 12 humid months, but less precipitation; dry air conditions can occur around midday.
3) Subhumid: 11 humid months, and a short but distinct dry season
4) Semi-humid: 7-10 humid months with a pronounced dry season
5) Semi-arid: 4-6 humid months, with seasonality more pronounced than semi-humid
6) Subarid: 2-3 humid months
7) Euarid: 1 humid month or less, with annual precipitation ranging from 50 to 150mm
8) Perarid: deserts, with only episodic precipitation (not present in Nepal)

(D) Plant life forms and vegetation formations:

Miehe et al. (2015) consider the plant life forms as one of the important attributes for identifying or naming the vegetation type. While a vegetation unit generally consists of different life forms, they name it after the tallest-growing, most conspicuous life form, using a threshold of 10% crown cover. For example, if trees' crown cover is 10% or more, the vegetation is named after tree formation, if less, it goes to shrub formation, then to herbaceous formation. The following seven plant life formations have been considered:

1) Tree formations: single-stemmed woody phanerophytes, taller than 3m
2) Shrubby formations: woody formations dominated by caespitose (multi-branched from the base) phanerophytes, sub-divided into scrub (taller than 0.5m) and dwarf scrub (shorter than 0.5m)
3) Herbaceous formations: Vegetation unit where woody plants make up less than 10% of the cover, sub-divided into grasslands (dominated by graminoids) and forb communities (non-graminoid herbs, graminoids with less than 10% cover)
4) Alpine mats: humid-alpine zonal formation dominated by cyperaceae
5) Cushion communities: hemicryptophytic cushion plants in the upper alpine belt
6) Chasmophytic vegetation: plants rooting in rock fissures
7) Epilithic vegetation: plants adnate on rocks, with roots or rhizoids (e.g. moss, lichen on rocks)

The classification of vegetation formations according to cover density and growth heights are given in Table 12.

Table 12: Classification of vegetation formations by Miehe et al. (2015)

SN	Plant life form	Cover (%) / Height	Sub-formation	Formation
1	Tree	100-75	Dense forest	Forest
		75-50	Light forest	
		50-25	Dense woodland	Woodland
		25-10	Sparse woodland	
2	Shrub	100-75	Dense thicket	Thicket

		75-50	Light thicket	
		50-25	Open shrubland	Shrubland
		25-10	Sparse shrubland	
		<10	Desertic shrubland	
3	Grass (according to density)	100-75	Dense grassland	Grassland
		75-25	Open grassland	
	Grass (according to growth heights)	Caespitose grasses taller than 1m	Tall grassland	
		Dominance of medium-sized grasses, 0.3-1.0m	Grassland	
		Bunch grasses shorter than 30cm	Short grassland	
4	Alpine mat (according to density)	100-75	Closed	Mat
		<75	Open	
	Alpine mat (according to growth heights)	25cm	Tall mat	
		5-25cm	(medium-sized) mat	
		<5cm	Dwarf mat	

(E) Human impact intensity:

Miehe et al. (2015) use a scale of 0 to 6 for assessing severity of human impacts on vegetation as follows:

1) **Impact class 0:** No evidence of human impact or anthropogenic disturbance on vegetation
2) **Impact class 1:** Weakly disturbed vegetation, having little structural change; e.g. selective felling (<10%), presence of trails (<10% cover)
3) **Impact class 2:** Evidently disturbed vegetation, e.g. 25% crown cover removed
4) **Impact class 3:** Strongly disturbed vegetation, e.g. up to 50% of the crown cover lost
5) **Impact class 4:** Widely replaced vegetation, e.g. <25 % of original crown cover left
6) **Impact class 5:** Replaced and degraded vegetation, e.g. vegetation structure has changed from forests to treeless pastures
7) **Impact class 6:** Destroyed, e.g. lacks any perennial plants and has open soils, screes or bedrock

Vegetation classification

Miehe et al. (2015) classify Nepal's vegetation into 53 types, which includes all kinds of vegetation formations, i.e. forest, shrublands, and grasslands. Table 13 lists those vegetation types with their brief descriptions on environmental gradients, topography, biogeography and climatic conditions.

Table 13: Vegetation types in Nepal as described by Miehe et al. (2015)

SN	Vegetation type	Species association	Altitude, climate,	Topography, micro-climate,	Remarks

			humidity, biogeography	aspect	
The vegetation types of the southern slopes of the Himalaya					
The tropical belt					
1	*Shorea robusta* forest	*Shorea robusta, Terminalia alata, T. bellirica, Dilenia pentagyna, Adina cordifolia, Lagerstroemia parviflora, Mallotus philippensis, Bauhinia vahlii, B. variegata, Semecarpus anacardium*	Up to 1200m, tropical, semi-humid, E/C/W	Lowland to hill, sandy to silty colluvial soils	Drought deciduous, broadleaved, Tall, open forest, 25-35m tall
2	*Terminalia* and *Anogeissus* forest	*Terminalia tomentosa, T. chebula, T. bellirica, T. myriocarpa, Anogeissus latifolia, Glochidion velutinum, Croton oblongifolius, Garuga pinnata, Ehretia laevis, Sapium insigne, Syzigium cumini, Lagerstroemia parviflora, Dilenia pentagyna, Engelhardia spicata, Bauhinia variegata, Flacourtia indica, Lannea coromandelica*	Up to 1200m, tropical, semi-humid, E/C/W but common in west	Duns, Siwaliks, lower midhills, shallow and rocky soils on south aspect (*Anogeissus*) or clay (*Terminalia*)	Drought deciduous, broadleaved, 10-15m tall, locally consisting entirely of *Terminalia tomentosa* or *Anogeissus latifolia*
3	Riverine grassland	*Saccharum spontaneum, Narenga porphyrocoma, Themeda arundinaceae, imperata cylindrica, Phragmites karka, Arundo donax*	60-400m, tropical, semi-humid	Floodplains and lower terraces of the great rivers of the Duns, Bhabar and Tarai; clay, loams, sands	Tall grassland
4	*Dalbergia sissoo-Acacia catechu* riverine forest	*Dalbergia sissoo, Acacia catechu, Tamarix dioica, Zizyphus species, Murraya koenigii, Callicarpa macrophylla*	Up to 1200m, tropical, semi-humid, E/C/W	Young gravel terraces along the great rivers, *Acacia* also on south-facing hill slopes	Drought deciduous, broadleaved, Pioneer succession, closed canopy, 12-15m tall
5	*Bombax* riverine forest	*Bombax ceiba, Grewia disperma, Celtis tetranda, Croton roxburghii, Holarrhena pubescens, Adina cordifolia*	Up to 1400m, tropical, semi-humid	Older, stable river terraces in Duns, Bhabar, Tarai, succeeding *Acacia-Dalbergia* forest	Drought deciduous, broadleaved, 30m tall
The subtropical belt					
6	*Schima-Castanopsis* forest	*Schima wallichii, Castanopsis indica, C. tribuloides, Engelhardia species, Magnolia velutina, M. champaca, M. hodgsonii, Betula alnoides, Exbucklandia populnea*	1000-2000m, subtropical, subhumid to semi-humid, C/E	Hill, all aspects	Evergreen, broadleaved
7	*Quercus*	*Quercus lanata, Rhododendron*	1500-2400m,	Dry, south-	Evergreen,

	lanata forest	*arboreum, Ilex dipyrena, Symplocos paniculata, Lindera pulcherrima, Rhus wallichii, Lyonia ovalifolia, Carpinus viminea*	Subtropical, submontane, subhumid to semi-arid	facing, wind-exposed sites	broadleaved, Climax, Multi-storeyed, 15-25m tall
8	*Pinus roxburghii* forest	*Pinus roxburghii* (generally pure), but with *woodfordia fruticosa, pyracantha crenulata, Caryopteris foetida, Rhododendron arboreum, Lyonia ovalifolia*	500 to 1500-1800m (west), 800-2000m (east) Subtropical, submontane, subhumid to semi-arid, E/C/W	All exposures, but south or east exposures in high rainfall area	Evergreen, conifer, Single storeyed, max 40m tall, rarely exceeding 70% crown cover, fire climax
9	*Toona ciliata-Albizia julibrissin* riverine forest	*Toona ciliata, Albizia julibrissin, pandanus nepalensis, cyathea spinosa, Podocarpus nerifolius, Magnolia hodgsonii, Saurauia napaulensis*	600-1700m, tropical to subtropical, hill to submontane, euhumid, E/C	Permanently moist; boulders, sand and gravels of mudflows, along streams of side valleys	Deciduous to evergreen, broadleaved, edaphic climax
10	*Alnus nepalensis* riverine forest	*Alnus nepalensis* (tree layer), Urticaceae Acanthaceae, Lianas	1000-2450m, subtropical, semi-humid to euhumid, submontane, E/C/W	Along streams and moist mudflow accumulations	Deciduous, broadleaved, pioneer, evenaged, 30m tall, edaphic climax
11	*Euphorbia royleana* grasslands	Grasses like *Andropogon species, Themeda species, Cymbopogon species, Chrysopogon species, Arundinella species, Carex myosurus, Miscanthus nepalensis*, with trees and shrubs like *Euphorbia royleana, Erythrina arborescens, Butea minor, Desmodium species*	800-2800m, subtropical, semi-humid, hill to montane, E/C/W	Steep south-facing slopes exposed to up-valley winds	Tussock grassland, frequently fired
12	Thickets and pastures	Exotic weeds (*Eupatorium, Ageratum, Lantana*), tropical grasses (*Cynodon dactylon, Chrysopogon aciculatus, Setaria pallidefusca*), ferns (*Pteridium aquilinum, Pteris quadriaurita*), tall forbs (*Artemisia species, Anaphalis species*), *Callicarpa macrophylla, Woodfordia fruticosa, Vitex nebundo, Rubus ellipticus, Berberis aristata ….*	Below 1000-2500m, subtropical, semi-humid to euhumid, hill to submontane, E/C/W	Southern exposure	Communal grazing land around settlements, result of overgrazing and exploitation
The cloud forest belt					
13	*Quercus lamellosa* forest	*Quercus lamellosa, Q. glauca, Q. oxydon, Q. acutissima, Lithocarpus elegans, Castanopsis tribuloides, Betula*	1600-2800m, temperate, euhumid to subhumid,	Mostly on shady humid slopes	Evergreen, broadleaved, multi-storeyed, species rich,

		alnoides, Acer campbellii, Magnolia doltsopa	montane, E/C		epiphyte-burdened, climax, up to 60m tall
14	*Lithocarpus pachyphylla* forest	*Lithocarpus pachyphylla, Quercus lamellosa, Q. lineata, Magnolia campbellii, M. doltsopa, Betula alnoides, Schefflera rhododendrifolia, Acer caesium, Daphniphyllum himalayense, Litsea elongata, Neolitsea foliosa, Symplocos lucida, Ilex dipyrena, Rhododendron falconeri, R. grande*	2400-2900m, temperate, euhumid, montane, E	Only in the south-facing sites on the Singalila Danda (Sikkim border)	Evergreen, broadleaved, epiphyte-burdened, climax, 25-30m tall
15	*Quercus floribunda* forest	*Quercus floribunda* (Syn.: *Q. dilatata), Acer species, Juglans regia, Aesculus indica, Machilus duthiei, Symplocos species, Neolitsea pallens, Lindera pulcherrima, Dodecadenia grandiflora, Rhododendron arboreum*	1900-2400m (west), 2100-2900m (towards east), subtropical to temperate, subhumid to semi-humid, submontane to montane	Damp, shady slopes	With cold-deciduous trees, broadleaved, multi-storeyed, climax, 30m tall
16	*Quercus semecarpifolia* forest	*Quercus semecarpifolia, Tsuga Dumosa, Magnolia campbellii, Acer species, Taxus wallichiana, Rhododendron arboreum, Lyonia ovalifolia,* Lauraceae, Aquifoliaceae, Celastraceae, Symplocaceae, Ericaceae, Araliaceae, Rosaceae	2200-3000m (general), 2700-3500m (drier sites), temperate, subhumid to semi-humid, montane, E/C/W	Moderate rain shadow, mostly on southern exposure	Evergreen, broadleaved, multi-storeyed, epiphyte-burdened, species rich, climax, 40m tall
17	*Tsuga dumosa* forest	Tsuga dumosa, Quercus semecarpifolia, Acer species, Magnolia campbellii, Sorbus cuspidate, Taxus baccata, Rhododendron barbatum, R. falconeri	2100-3000m, temperate, euhumid to subhumid, montane	Semi-humid southern exposure, and northern exposure in the inner valleys, on well-drained ridges	Evergreen, mixed broadleaved with *Tsuga*, epiphyte-burdened, climax
18	*Rhododendron arboreum* forest	*Rhododendron arboreum*, with sparse shrubs like *Viburnum erubescens, Piptanthus nepalensis, Berberis aristata, Cotoneaster acuminatus, Daphne bholua, Sarcococca hookeriana….*	1200-4000m, temperate, sub-humid to semi-arid, montane, E/C/W	Mostly on southern exposure	Evergreen, broadleaved, single-storeyed, monospecific, 8-15m tall single-stemmed, gnarled trees
19	*Rhododendron hodgsonii* forest	*Rhododendron hodgsonii, R. grande, R. falconeri*	3000-4000m, cool, euhumid, upper montane	All exposures, permanently wet, level or gently sloping ground	Evergreen, broadleaved, low to dwarf, gnarled, single-storeyed, climax

20	*Abies spectabilis* forest	*Abies spectabilis (*Syn.: *A. webbiana), Betula utilis, Rhododendron campanunatum, R. barbaratum, R. arboreum, Lyonia villosa, Sorbus cuspidata, S. foliolosa, S. microphylla, Juniperus recurve, Prunus rufa, Acer species, Ribes species, Hydrangea heteromalla*	3000-4200m, cool, euhumid to subhumid, upper montane, E/C/W	All exposures, but shady slopes in rain shadow	Evergreen, conifer, abundant epiphytes, climax, 40m tall
21	*Abies densa* forest	*Abies densa, Betula utilis, Pyrus pashia, Prunus rufa, Sorbus species,* bamboo *(Yushania microphylla)*	3000-4350m (general), down to 2900m (inner valleys), cool, euhumid to subhumid, upper montane, E	Moderate rain shadow,	Evergreen, conifer, climax, 50m tall
22	*Juniperus recurva* forest	*Juniperus recurva* (Syn.: *J. wallichiana, J. squamata*) (almost pure at canopy), *Sorbus foliolosa, S. ursina, Betula utilis, Prunus rufa, Rhododendron campalunatum*	3000-4300m, cool, euhumid to subhumid, upper montane and treeline ecotone	South-facing slopes, mostly on shallow soils, rock cliffs	Evergreen, conifer, climax on sunny slopes, 30m tall
23	*Juniperus recurva* thickets	Shrubby form of *Juniperus recurva* (generally pure), but at margins: *Berberis concinna, Rhododendron lepidotum, Rosa sericea*	3600-4200m, cold, subhumid to semi-humid, treeline ecotone	Southerly cliffs and shallow steep slopes	Evergreen, conifer, climax, 2m tall
24	*Rhododendron* thickets	*Rhododendron wallichii, R. fulgens, R. campylocarpum, Sorbus microphylla*	3800-4400m, cold, euhumid to semi-humid, treeline ecotone, E/C/W	North-facing slopes	Gnarled, climax, 3-4m tall to dwarf shrubs
25	*Bamboo* thickets	*Yushania, Arundinaria, Fargesia, Drepanostachyum, Himalayacalamus species*	2800-3600m, temperate to cool, euhumid to subhumid, montane	On disturbed site by landslide, logging and fire,	In Nepal, only in Thakkhola above Chim
26	Tall forb communities of cattle resting places	*Rumex nepalensis, Microula species, Cynoglossum glochidiatum, Urtica dioica, Scopolia straminifolia, Arctium lappa, Sambucus adnata*	2000-4300m, cool, euhumid to semi-humid, montane	On manure heaps and eutrophic, seasonal grazing settlements	1-3m tall
The alpine belt					
27	*Rhododendron* dwarf thickets	*Rhododendron anthopogen, R. nivale, R. setosum*	3450-3800 (W), 3800-5100 (E/C), cold, semi-humid to subhumid	Shady slopes	Rich in bryophytes, climax, up to 50cm tall
28	*Kobresia nepalensis* mats	*Kobresia nepalensis, Bistorta macrophylla, Saussurea species, Primula species, Pedicularis species, Potentilla microphylla,*	4000-5000m (somewhere down to 3600m), cold, semi-humid	Southern exposure	Climax/ anthropogenic plagioclimax, up to 20cm tall, with 50-

		Festuca species, Poa species, Elymus species	to semi-arid		90% cover
29	Crustose lichen covers of rock walls	*Sporastatia testudinea, Aspicilia species, Rhizocarpon geographicum*	6000m (Khumbu Himal), 7450m (Mt. Makalu)	Stable rock surface with sufficient fog precipitation	Climax, blackish cover of boulders and rock walls
The vegetation types of the inner valleys					
The subtropical belt					
30	*Olea ferruginea* woodlands	*Olea ferrunginea, Pistacia chinensis, Punica granatum, Acer pentapomicum, Celtis australis, Cotinus coggygria, Ficus palmata*	1000-2000m, subtropical, semi-humid, submontane, W	Dry river gorges – valley bottoms, lower slopes, shallow soils	2-8m tall
The temperate belt					
31	*Cedrus deodara* forest	*Cedrus deodara,* with *Pinus gerardiana* (west)*, P. roxburghii, Quercus baloot* (lower range), *Pinus wallichiana, Quercus floribunda, Aesculus indica, Picea smithiana, Abies pindrow, Taxus wallichiana* (upper range), *Rhododendron arboreum, Lyonia ovalifolia, Ilex dipyrena* (humid border)	1800-3000m, temperate, semi-humid to semi-arid, submontane to montane, W	Dry rocky slopes in rain-shadowed inner valleys, Bheri valley between Tibrikot and Tarakot, Sinja and Tila khola, Jumla	Evergreen, conifer, 50-60m tall, edaphic climax of dry, southern scree slopes
32	*Aesculus-Acer* forest	*Aesculus, Juglans, Acer caesium, Acer cappadocicum, Ulmus wallichiana, Morus serrata, Carpinus viminea, C. faginea, Populus ciliate, Taxus wallichiana*	1800-3100, temperate, subhumid, montane, W	Shady slopes and along streams, Jumla area	Deciduous, broadleaved, multi-storeyed, edaphic mesoclimatic climax, 30m tall
33	*Pinus wallichiana* forest	*Pinus wallichiana* (Syn.: *P. excelsa, P. griffithii*), with *Abies pindrow, Picea smithiana* (lower range), *A. spectabilis, Betula utilis* (upper range)	1600-3600m, subhumid to semi-arid, montane	Mostly on sunny slopes, on abandoned fields, e.g. around Rara lake	Evergreen, conifer, single-storeyed, monospecific, light, up to 50m tall
34	*Picea smithiana* forest	*Picea smithiana (*Syn.*: P. morinda), Abies pindrow, Aesculus species, Juglans regia, Quercus semecarpifolia, Pinus wallichiana, Juniperus indica, Populus ciliate, Acer species, Sorbus cuspidate, Taxus wallichiana*	2100-3600m, temperate to cool, subarid to semi-arid, montane, W	Shady slopes, Trisuli valley as eastern limit	Evergreen, conifer, up to 60m tall
35	*Abies pindrow* forest	*Abies pindrow, Pinus wallichiana, Taxus wallichiana, Aesculus indica, Juglans regia, Populus ciliata, Acer species, Betula utilis, Prunus cornuta, Sorbus species*	2000-3000m, temperate to cool, subhumid to semi-humid, montane, W	Steep shady slopes in Humla-Jumla area and Dolpa	Evergreen, conifer, climax, up to 45m tall
36	*Betula utilis* forest	*Betula utilis, Sorbus microphylla, Prunus rufa;* shrubs: *Salix*	3600-4200m, cool-temperate,	North aspect (moderate rain-	Cold deciduous, broadleaved, low

		karelinii, Rhododendron campanulatum, R. fulgens	semi-humid to semi-arid, upper montane	shadow) and south (south of the Himalayas)	to dwarf, gnarled, single-storeyed, climax, 8-12m tall
37	*Cupressus torulosa* forest	*Cupressus torulosa*, with understory of *Juniperus indica, Pinus wallichiana, Picea smithiana*	2500-3200m, temperate, semi-arid to subarid, montane	All exposures but mostly on south-facing rocky cliffs (Dolpa, Suligad valley, Phoksundo)	Evergreen, conifer, climax near drought line, edaphic climax in humid part, up to 50m tall,
38	*Juniperus indica* forest	*Juniperus indica (*Syn.: *J. wallichiana, Sabina wallichiana);* in humid sites*: Sorbus species, Picea smithiana, Pinus wallichiana, Rhododendron arboreum;* in drought line ecotone*: Cupressus torulosa*	3000-4500m, temperate, semi-arid to subarid, upper montane, E/C/W	Mostly on sunny slopes near drought line, in inner valleys (Dolpa, Thakkhola, Manangbhot)	Evergreen, conifer, gnarled and stunted in drought line and upper treeline, climax, up to 15m tall
39	*Larix* forest	Larix himalaica (Shiar khola, Langtang, upper Trisuli), Larix griffithiana (Rolwaling eastward)	3000m to treeline ecotone, cool, euhumid to subhumid, E/C	Moraines and landslides in inner valleys (upper Shiar khola, Manaslu and Ghunsa, Kanchenjunga)	Pioneer, up to 20m tall
40	*Hippophae* riverine woodlands	*Hippophae salicifolia*	2000-3400m, temperate to cool, subarid to semi-humid, montane	Alluvial gravel flats in rain shadow of inner valleys (e.g. Thakkhola near Larjung)	Pioneer, 8-12m tall in maturity
41	*Caragana sukiensis* thickets	*Caragana sukiensis* (Syn.: *C. nepalensis, C. hoplites*); if less dense: *Leptodermis kumaonensis, Viburnum cotinifolium, Rhododendron lepidotum, R. arboreum, Lyonia ovalifolia, Juniperus recurva*	2400-3700m, temperate to cool, subhumid to semi-humid, montane, C/W	Southern exposures of the inner valley (largest stand in upper Langtang valley)	Impenetrable thorny thickets, 1.5-3m tall
42	*Rhododendron lepidotum* shrublands	*Rhododendron lepidotum, Cotoneaster microphylla, Aster albescens, Potentilla fruticosa, Berberis concinna*	2500-4850m, temperate, subhumid to semi-humid, montane, E/C/W	South-facing slopes, in south of the Himalayas and inner valleys	Even-sized shrubs, 1m (generally), but 0.2 to 3m tall
43	*Rosa-Berberis-Cotoneaster* shrublands	*Rosa species, Berberis species, Prinsepia utilis, Daphne bholua, Biburnum species, Elsholtzia fruticose, Cotoneaster microphyllus, Danthonea cumminsii, Deyeuxia pulchella*	2000 to 3500-4050m, temperate to cool, subhumid to semi-arid, montane	Sunny slopes in the south and east slopes of the Himalayas	Shrubland pasture, anthropogenic replacement, 0.5-1.5m (generally) but up to 3m
The alpine belt					
44	*Juniperus squamata* dwarf	*Juniperus squamata,* with *Berberis concinna, B. mucrifolia, Potentilla fruticose, Lonicera*	3550-4000m (northwest) and 4000-5200m	South-facing, rocky slopes with shallow	Climax, up to 1.5m tall

	shrublands	*asperifolia, Ephedra gerardiana, Rosa sericea*	(inner valleys), cold, semi-humid to semi-arid, alpine	soils	
45	*Kobresia pygmaea* dwarf mats	*Kobresia pygmaea, Bistorta mactrophylla, Potentilla microphylla*	4000-5960m, cold, semi-humid to semi-arid, high alpine	Upper catchment of inner valleys and rolling hills between 4700-5100m	Mats, anthropogenic plagioclimax in the grazing area
46	High alpine cushion communities and highest plant records	Caryophyllaceae, Rosaceae, crustose and fruticose lichens, dwarf shrubs (*Potentilla fruticosa, Rhododendron nivale*); medicinal plants: *Delphinium brunonianum, Saussurea gossypiphora, Ophiocordyceps sinensis*	5000-5960m, cold, semi-humid to subarid, subnival	Gentle slopes with water saturated substrates	
47	*Hippophae tibetana* riverine dwarf thickets	Hippophae tibetana, with tall forms on disturbed sites (Rumex species, Rheum species, Artemisia wallichiana, A. roxburghiana)	3500-5000m, cold, subhumid to semi-arid, upper montane to lower alpine	Gravel flats of glacial basins throughout inner valleys	Dense thickets, pioneer, 15-50cm tall
48	Pioneer plant successions in glacial forelands	Algae, mosses (*Bryum species*), lichens (*Gyalidea scutellaris, Stereocaulon species*), dwarf shrubs (*Myricaria species, Oxyria digyna*)	5000-6000m, cold, subhumid to semi-humid, alpine	Recently exposed fluvio-glacial sands, gravels and boulders	Formed after ice melting
The vegetation types of the Arid Zone					
49	*Caragana gerardiana* open dwarf shrublands	*Caragana gerardiana, Cotoneaster tibeticus, Krascheninnikovia ceratoides, Lonicera spinosa, L. hypoleuca, Artemisia gmelinii, Rosa sericea, Berberis species*	2600-3900m, temperate, semi-arid to subarid, montane	Gravel terraces in rain shadow areas (Karnali, Barbung Khola, Thakkhola, Arun)	Thorny cushions, 0.5 - 1.2m tall
50	*Caragana versicolor* open dwarf shrublands	*Caragana versicolor, Krascheninnikovia ceratoides, Lonicera spinosa, Berberis species, Potentilla fruticose, Artemisia gmelinii*	4400-5000m, cold, semi-arid to subarid, subalpine to alpine	Sandy and silt rich soils on gently rolling slopes in rain-shadow, upper Kaligandaki catchment	Thorny cushions, climax, 0.3 – 0.8m tall
51	Alpine steppe	*Carex montis, C. moorcroftii, Saussurea leontodontoides, Arenaria bryophylla, Androsace tapete, Incarvillea younghusbandii, Potentilla bifurca, Dracocephalum heterophyllum, Heteropappus semiprostratus, Stipa purpurea, Callianthemum pimpinelloides, Oxytropis microphylla*	Above 4600m, cold, subarid, alpine	Shallow, south-facing, strongly wind-exposed sites (watershed of Kore-La between upper Mustangbhot and Yarlung Zhangbo valley	Short grass steppe with feature grasses, sedges and cushion plants, negligible area in Nepal

				of South Tibet)	
52	Salt meadows	*Carex orbicularis, Blysmus compressus, Eleocharis species, Juncus thomsonii, Trichophorum pumilum, Kobresia schoenoides, Deschampsia caespitosa, Primula tibetica, Pedicularis longiflora, Glaux maritima, Triglochin maritima*	2500-4300m, temperate, semi-arid to euarid, montane	Around springs or along streams with stagnant water, in arid valley bottoms of the inner valley (Manangbhot, Thakkhola, and Limi of Humla)	Dense, short grassland with herbs of salty water surplus, 10-15cm tall, small areas between 20 and 2000m^2, azonal climax of arid Central Asia
53	Plant communities of wastelands	Tall forbs (*Hyoscyamus niger, Vincetoxicum hirundinaria, Mirabilis himalaica, Urtica dioica, Arctium lappa*), rosettes of ruderal plants (*Plantago depressa, Erodium stephanianum*….)	2500-4200m, temperate, semi-arid to euarid, montane	Wastelands around settlements with trampling and eutrophication from livestock	Ruderal vegetation

Note: E/C/W = East/Centre/West

3. International Vegetation classification (IVC)

The International Vegetation Classification (IVC), which is based on the ecological vegetation (EcoVeg) classification approach, applies an eight-level hierarchy to all terrestrial vegetation including natural and cultural vegetation. It provides a broad to fine (local) scale vegetation classification based on the vegetation's physiognomy, biogeographic and floristic characteristics (Faber-Langendoen et al., 2016). The hierarchy includes three upper (formation) levels, three middle (physiognomic-biogeographic-floristic) levels and two lower (floristic) levels for natural vegetation. Each class is clearly defined by providing specific criteria and description to facilitate a consistent framework application (Faber-Langendoen et al. 2014) (Table 14).

Table 14: Eight hierarchy levels of the International Vegetation Classification (IVC) (Source: Faber-Langendoen et al. 2014)

Natural hierarchy	Definition	Example names	
		Scientific	**Colloquial**
	Upper levels		
L1: Formation class	A broad combination of dominant general growth forms adapted to basic moisture, temperature, and/or substrate or aquatic conditions.	Mesomorphic Shrub and Herb Vegetation	Shrub and Herb Vegetation
L2: Formation subclass	A combination of general dominant and diagnostic growth forms that reflect global mega- or macroclimatic factors driven primarily by latitude and continental position or that reflect aquatic conditions overriding substrate	Temperate and Boreal Shrub and Herb Vegetation	Temperate and Boreal Grassland and Shrubland
L3: Formation	A combination of dominant and diagnostic growth forms that reflect global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates and hydrologic condition	Temperate Shrub and Herb Vegetation	Temperate Grassland and Shrubland
	Middle levels		
L4: Division	A combination of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbances	Andropogon-Stipa-Bouteloua Grassland and Shrubland	Great Plains Grassland and Shrubland

L5: Macrogroup	A moderate set of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes	Andropogon gerardii-Schizachyrium scoparium-Sorghastrum nutans Grassland and Shrubland	Great Plains Tallgrass Prairie
L6: Group	A relatively narrow set of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes	Andropogon gerardii-Heterostipa spartea-Muhlebergia richardsonis Grassland	Northern Great Plains Tallgrass Prairie
	Lower levels		
L7: Alliance	A Characteristic range of species composition, habitat condition, physiognomy, and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation. Alliances reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes	Andropogon gerardii-Sporobolus heterolepsis Grassland	Northern Mesic Big Tallgrass Prairie
L8: Association	A characteristic range of species composition, diagnostic species occurrences, habitat conditions, and physiognomy. Associations reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes	Andropogon gerardii-Heterostipa spartea-Sporobolus heterolepsis Grassland	Northern Mesic Big Bluestem Prairie

For the upper (formation) levels, the EcoVeg approach has identified six classes, 13 subclasses and 37 formations for natural global vegetation (Faber-Langendoen et al. 2016) (Table 15).

Table 15: Formation level units, Level 1 to Level 3 based on EcoVeg's global vegetation classification

Level 1 Formation Class	Level 2 Formation Subclass	Level 3 - Formation
1. Forest and Woodland (Mesomorphic Tree Vegetation)	1.A Tropical Forest and Woodland	1.A.1. Tropical Dry Forest & Woodland
		1.A.2. Tropical Lowland Humid Forest
		1.A.3. Tropical Montane Humid Forest
		1.A.4. Tropical Flooded & Swamp forest*
		1.A.5. Mangrove*

	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland
		1.B.2. Cool Temperate Forest & Woodland
		1.B.3. Temperate Flooded & Swamp Forest*
		1.B.4. Boreal Forest & Woodland
		1.B.5. Boreal Flooded & Swamp Forest*
2. Shrub & Herb Vegetation [Mesomorphic Shrub & Herb Vegetation]	2.A. Tropical Grassland, Savanna & Shrubland	2.A.1. Tropical Lowland Grassland, Savanna & Shrubland
		2.A.2. Tropical Montane Grassland & Shrubland
		2.A.3. Tropical Scrub & Herb Coastal Vegetation
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland
		2.B.2. Temperate Grassland & Shrubland
		2.B.3. Boreal Grassland & Shrubland
		2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation
	2.C. Shrub & Herb Wetland	2.C.1. Tropical Bog & Fen *
		2.C.2. Temperate to Polar Bog & Fen*
		2.C.3. Tropical Freshwater Marsh, Wet Meadow & Shrubland*
		2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland*
		2.C.5. Salt Marsh*
3. Desert & Semi-Desert [Xeromorphic Woodland, Scrub & Herb Vegetation]	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.1. Tropical Thorn Woodland
		3.A.2. Warm Desert & Semi-Desert Scrub & Grassland
	3.B. Cool Semi-Desert Scrub & Grassland	3.B.1. Cool Semi-Desert Scrub & Grassland
4. Polar & High Montane Scrub, Grassland & Barrens [Cryomorphic Grassland & Barrens] [Cryomorphic Scrub, Herb & Cryptogam Vegetation]	4.A. Tropical High Montane Scrub & Grassland	4.A.1. Tropical High Montane Scrub & Grassland
	4.B. Temperate to Polar Alpine & Tundra Vegetation	4.B.1. Temperate & Boreal Alpine Dwarf-shrub & Grassland
		4.B.2. Polar Tundra & Barrens
5. Aquatic Vegetation [Hydromorphic Vegetation]	5.A. Saltwater Aquatic Vegetation	5.A.1. Floating & Suspended Macroalgae Saltwater Vegetation*
		5.A.2. Benthic Macroalgae Saltwater Vegetation*
		5.A.3. Benthic Vascular Saltwater Vegetation*
		5.A.4. Benthic Lichen Saltwater Vegetation*
	5.B. Freshwater Aquatic	5.B.1. Tropical Freshwater Aquatic Vegetation*

	Vegetation	5.B.2. Temperate to Polar Freshwater Aquatic Vegetation*
6. Open Rock Vegetation [Cryptogam - Open Mesomorphic Vegetation]	6.A. Tropical Open Rock Vegetation	6.A.1. Tropical Cliff, Scree & Other Rock Vegetation
	6.B. Temperate and Boreal Open Rock Vegetation	6.B.1. Temperate and Boreal Cliff, Scree and Other Rock Vegetation

NB: * represents wetland formation

4. Implications of the past vegetation classification and IVC for EFTMP

The systematic classification of Nepal's vegetation started with J. D. A. Stainton's ecological survey between 1962 and 1969 (Stainton 1972). Since then, several attempts have been made to classify Nepal's vegetation. Dobremez and his colleagues carried out a comprehensive vegetation survey between 1969 and 1974 to classify and map Nepal's vegetation (Dobremez 1976). Jackson (1994), BPP (1996) and TISC (2002) reclassified the country's vegetation on their own way but based largely on the previous works by Stainton (1972) and Dobremez (1976). Latest in the 2010s, DFRS (2015) and Miehe et al. (2015) also reclassified Nepal's vegetation differently than the previous ones.

Inconsistencies among the different assessments can be observed in terms of coverage of vegetation formations, number of vegetation types, methods used, nomenclature of vegetation types etc. These are briefly discussed below, with their implications for the EFTMP.

(A) Coverage of vegetation formations

DFRS (2015) covers only forest and woodland formation in its classification. Stainton (1972) covers part of mesomorphic shrub and herb vegetation (excludes grassland and savanna) in addition to the forest and woodland formation. Dobremez (1976), BPP (1996) and Miehe et al. (2015) are the most comprehensive assessments in terms of coverage of vegetation formations. They cover all terrestrial vegetation formations in Nepal, including forest and woodland, mesomorphic shrub and herb vegetation, desert and semi-desert vegetation, and open rock vegetation formation as defined by IVC (Faber-Langendoen et al. 2014). Jackson (1994) and TISC (2002) also cover all major vegetation formations into a small number of vegetation types. However, none of the classifications strictly adhere to any standard vegetation classification system.

(B) Number of vegetation types

BPP (1996) proposes the highest number of vegetation types (112), which were derived from the 198 ecology types mapped by Dobremez and his colleagues between 1969 and 1985. Dobremez (1976), Miehe et al. (2015), TISC (2002), Jackson (1994), and DFRS (2015) report 77, 53, 36, 24 and 15 vegetation/forest types, respectively. All the assessments have considered species composition/association as the major basis of vegetation classification; the differences in the number of vegetation types are mainly attributed to the scale - fine or coarse - of differentiation between types.

(C) Data and methods

Among the different vegetation assessments, some applied more targeted efforts for the classification of Nepal's vegetation (e.g., Stainton 1972, Dobremez 1976, BPP 1996, and TISC

2002), whereas others did so as part of broader objectives of their works (e.g., Jackson 1994, FRTC 2015, Miehe et al. 2015). Similarly, while some used an extensive field survey for data collection (Stainton 1972, Dobremez 1976, Miehe et al. 2015), others were based largely on secondary data and information (Jackson 1994, BPP 1996, TISC 2002, DFRS 2015).

While Stainton (1972), Jackson (1994), and Miehe et al. (2015) identified and described Nepal's vegetation types and their distribution without delineating them spatially, Dobremez and his colleagues (1970-1985) manually produced iso-potential vegetation maps for seven regions showing the spatial distribution of various vegetation types in the same environmental and climatic regimes. TISC (2002) also produced iso-potential vegetation map based on the work by Dobremez and his colleagues. DFRS (2015) is the only assessment that produced a vegetation (forest) type map based on existing vegetation. However, its accuracy and comprehensiveness are limited because the data collection was not intended for vegetation classification and mapping.

EFTMP aims to reclassify and map Nepal's vegetation based on the actual vegetation occurrence so that it can be monitored periodically. It intends to delineate vegetation types using a geospatial approach, i.e. analysis of satellite images using signatures from the field data. Therefore, it plans to collect plot data in such a way that sufficient training data set for each vegetation type are available for satellite image classification.

(D) Field survey methodology

Stainton (1972) and Dobremez (1976) carried out extensive field surveys across the country along the randomly selected horizontal and vertical transects to capture all vegetation types and their environments. They applied an ecological observation approach to identify and define each vegetation unit in its entirety and the accompanied environment. While Stainton (1972) carried out field observations by himself over the period of eight years (effectively two and a half years), Dobremez (1976) used a multidisciplinary team, comprising ecologists and botanists, for field observations over five years (effectively two years).

We note the following lessons learnt from the review of Nepal's forest or vegetation type classifications regarding field survey:

a) In Nepal, vegetation types and structures vary significantly along the altitudinal gradient (North-South), while the east-west direction presents fewer variations. Therefore, ecological observation/field data collection will be aligned along the North-South transects distributed from east to west to identify and describe all vegetation types.
b) Unlike Stainton (1972) and Dobremez (1976), who spent a long period of time to complete the field survey, EFTMP has planned to engage five field teams (each

comprising a forester, a botanist and a local resource person) to complete the field survey in one and a quarter years. Therefore, systematic transects/sample points have been allocated to ensure consistency and accuracy of data. Also, a Standard Operating Procedure (SOP) has been prepared to maintain consistency in methods of data collection by all field crews.

c) The past assessments show certain biodiversity hotspots and pocket areas of some vegetation types that the systematic transects may not cover. Therefore, some purposive transects or observation plots are needed to survey these isolated areas. The Arun, Tamur, Kaligandaki, Trisuli and Karnali valleys are the vital vegetation hotspots for classifying forest/vegetation types of Nepal. In addition, Table 16 lists some vegetation types that are confined to specific areas.

Table 16: Some vegetation types with specific areas of their distribution

SN	Vegetation type	Specific locations
1	*Terminalia* forest	East Rapti valley, Bheri valley (Stainton 1972)
2	*Lithocarpus pachyphylla* forest	South-facing slope of Singalila Danda (near Sikkim border) (Stainton 1972, Miehe et al. 2015)
3	*Picea smitihiana* forest	Upper Budhigandaki and Trisuli valleys, west of Rara lake and Chankheli ridge (Mugu) (Stainton 1972, TISC 2002, Miehe et al. 2015)
4	*Larix griffithiana* forest	Simbua khola (near Sikkim border), Ghunsa, Kanchenjunga (Stainton 1972, Miehe et al. 2015)
5	*Larix himalaica* forest	Upper Shiar khola (Budhigandaki valley), Langtang valley (near Rasuwa Garhi) (Stainton 1972, Miehe et al. 2015)
6	*Alnus nitida* forest	Mugu Karnali (Stainton 1972)
7	*Juniperus indica* forest	Dhorpatan, Thakkhola, Dolpa (Stainton 1972, TISC 2002, Miehe et al. 2015)
8	*Rhododendron* forest	Milke-Jaljale ridge (TISC 2002)
9	*Cedrus deodara* forest	Bheri valley between Tibrikot and Tarakot, Sinja and Tila valleys (Jumla) (TISC 2002, Miehe et al. 2015)
10	*Olea* forest	Upper Bheri valley (TISC 2002)
11	*Aesculus-Acer* forest	Jumla area (Miehe et al. 2015)
12	*Cupressus torulosa* forest	Suligad valley, Dolpa (Miehe et al. 2015)
13	*Hippophae salicifolia* forest	Thakkhola near Larjung (Miehe et al. 2015)
14	*Caragana sukiensis* shrublands	Upper Langtang valley (Miehe et al. 2015)

5. Classification of Nepal's Vegetation

5.1 Vegetation classification approach

EFTMP aims to reclassify and map Nepal's vegetation types covering all types of vegetation formations applying the IVC's EcoVeg approach (refer to Section 3) for ensuring consistency with the global vegetation classification. Applying the local knowledge of physiognomy, biogeographic and floristic characteristics of Nepal's vegetation, the vegetation formation levels applicable to Nepal's natural vegetation are identified from the global list in Table 17.

Table 17: Formation levels 1 to 3 applicable to Nepal based on EcoVeg's vegetation classification

Level 1 Formation Class	Level 2 Formation Subclass	Level 3 - Formation
1. Forest and Woodland (Mesomorphic Tree Vegetation)	1.A Tropical Forest and Woodland	1.A.1. Tropical Dry Forest & Woodland
		1.A.2. Tropical Lowland Humid Forest
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland
		1.B.2. Cool Temperate Forest & Woodland
2. Shrub & Herb Vegetation [Mesomorphic Shrub & Herb Vegetation]	2.A. Tropical Grassland, Savanna & Shrubland	2.A.1. Tropical Lowland Grassland, Savanna & Shrubland
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.2. Temperate Grassland & Shrubland
		2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation
	2.C. Shrub & Herb Wetland	2.C.1. Tropical Bog & Fen *
		2.C.2. Temperate to Polar Bog & Fen*
		2.C.3. Tropical Freshwater Marsh, Wet Meadow & Shrubland*
		2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland*
3. Desert & Semi-Desert [Xeromorphic Woodland, Scrub & Herb Vegetation]	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland
	3.B. Cool Semi-Desert Scrub & Grassland	3.B.1. Cool Semi-Desert Scrub & Grassland
		4.B.1. Temperate & Boreal Alpine Dwarf-shrub & Grassland
4. Polar & High Montane Scrub, Grassland & Barrens [Cryomorphic Grassland & Barrens [Cryomorphic Scrub, Herb & Cryptogam Vegetation]	4.B. Temperate to Polar Alpine & Tundra Vegetation	4.B.2. Polar Tundra & Barrens

5. Aquatic Vegetation [Hydromorphic Vegetation]	5.B. Freshwater Aquatic Vegetation	5.B.1. Tropical Freshwater Aquatic Vegetation*
		5.B.2. Temperate to Polar Freshwater Aquatic Vegetation*
6. Open Rock Vegetation [Cryptogam - Open Mesomorphic Vegetation]	6.B. Temperate and Boreal Open Rock Vegetation	6.B.1. Temperate and Boreal Cliff, Scree and Other Rock Vegetation

For the classification of vegetation types, EFTMP focuses on 'association' (L8 level of the hierarchy of the EcoVeg approach to vegetation classification) by examining the dominant or diagnostic species, physiognomy and biogeoclimatic condition. The vegetation association underpins the fine-scale vegetation classification encompassing the natural and cultural vegetations and enables retrospectively developing the remaining hierarchy levels including 'division' (L4), 'macrogroup' (L5), 'group' (L6) and 'alliance' (L7).

5.2 Nomenclature of vegetation types

There are inconsistencies in naming vegetation types between different classifications or within the same classification (e.g., using common names or botanical names, species order in two/three-species mixed forest etc.). Hence, EFTMP requires to standardize the forest/vegetation classification by applying a consistent approach in terms of vegetation formation, species dominance, species naming, and the use of classifiers as described below.

(i) Naming of vegetation formations

Various names for vegetation formation have been used in the past assessments; for example, forest, wood, woodland, shrubland, dwarf shrubland, scrub, thicket, dwarf thicket, steppe, savannah, grassland, meadow, mat, and cushion community. EFTMP will follow the EcoVeg approach while naming the vegetation formations as follows:

i) forest/woodland (for forest, wood, woodland),
ii) shrubland/scrub (for scrub, shrubland, dwarf shrubland, thicket, dwarf thicket, steppe), and
iii) grassland/savanna (for savannah, grassland, meadow, mat).
iv) other (appropriate names for rock and scree vegetations)

(ii) Determining species dominance

The past assessments have named a vegetation type based primarily on the dominance of species in a vegetation unit [for all vegetation formations, i.e. forest (trees), shrubland, and grassland]. However, except DFRS (2014, 2015), all of them have determined species dominance based on the qualitative judgement. For EFTMP, the plot data will be quantitatively analysed to determine the floristic composition and growth form. Hence, adapting to DFRS (2014), the following rules will apply to assess species dominance and name a forest type accordingly.

- A forest with >/=60% dominance of basal area of a species will be named after that species; e.g. *Shorea robusta* Forest.
- A forest with two or more species having <60% but >/=33% dominance of basal area will be named after all those species following alphabetical orders; e.g. *Dalbergia sissoo-Senegalia catechu* Forest, *Acer-Aesculus-Juglans* Forest.
- A forest with only one species having <60% but >/=30% dominance of basal area will be named to show that species mixed with others; e.g. *Shorea robusta*-Tarai Mixed Broadleaved Forest.

In the case of shrublands/scrubs and grasslands, the percentage of crown cover will be considered for determining species dominance.

(iii) Naming of species-specific forests

Different assessments have used varying naming protocols for species-specific forests, as one can see in the previous tables. For EFTMP, the full botanical name of a species will be used in naming a species-specific forest type, e.g. *Pinus roxburghii* Forest, *Quercus incana-Quercus lanuginosa* Forest, *Dalbergia sissoo-Senegalia catechu* Forest. However, if more than one species of a genus constitutes the forest type, the name contains genus only, e.g. Q*uercus* forest, *Acer-Aesculus-Juglans* forest. Common English names and Nepali names will also be provided while reporting. Alphabetical order will be followed for a mix of two or more species.

(iv) Use of classifiers

Different classifiers (bioclimatic, biogeographic, microclimatic, physiographic etc.) have been used previously for forest/vegetation classifications. The EFTMP will apply the following rules for using classifiers for forest/vegetation types.

- No classifier (e.g., Tarai, Chure or Middle Hills, tropical or sub-tropical, eastern, central or western etc.) will apply in a species-specific forest type; for example, '*Shorea robusta* forest' for that type found elsewhere.
- Bioclimatic [adapting to TISC's (2002) bioclimatic divisions] and morphological classifiers will apply in a mixed forest type, e.g. Tropical Mixed Broadleaved Forest, Warm Temperate Mixed Broadleaved Forest.
- A biogeographic classifier (western/central/eastern) will apply only if it requires differentiating two mixed types in the same bioclimatic range.
- The terms ‘broadleaved’ and ‘conifer’ will apply to denote hardwood and pine/needle-leaved forests, respectively.
- No classifier will apply for a natural stand or plantation.

Other classifiers, such as microclimatic (e.g. riverine), deciduous/evergreen etc., will apply if it requires differentiating mixed types through them.

5.3 Proposed vegetation types

Based on the review of the past assessments and consultation with experts, a new vegetation typology has been proposed based on species composition/association. It comprises a total of 69 vegetation types (forest and woodland - 54, scrub/shrubland - 6, grassland - 9) (Table 18). The vegetation type mapping will be initiated using this typology. Various attributes of forest and grassland types, given in their definitions, can be used for stratification for sampling and mapping. The vegetation types that might be missing from this list but identified later during mapping exercise or field survey will be added later. Also, two or more vegetation types may need to be merged during the mapping exercise.

Table 18: Proposed vegetation typology for the forest and grassland type mapping

SN	EFTMP Vegetation Type	Operational definition	Altitude range (m)	Symbol
Forest types (Nepalese names in brackets)				
1	*Tectona grandis* Forest [Teak Ban]	A plantation forest predominated by *Tectona grandis,* found in the tropical zone [such as Chiliya (Rupandehi) Tamagadhi (Bara), Sagarnath (Sarlahi) and Ratuwamai (Jhapa)]	Below 300	Te.gr
2	*Eucalyptus* Forest [Masala Ban]	A plantation forest predominated by *Eucalyptus species,* found in the tropical zone [such as Ratuwamai and Sagarnath area)	Below 300	Eu.sp
3	Tropical Mixed Broadleaved Forest [Usna Pradeshiya Misrit Chaudapate Ban]	A tropical mixed broadleaved forest having common species like *Shorea robusta, Terminalia species, Butea frondosa, Anogeissus latifolia, Adina cordifolia, Aegle marmelos, Lannea grandis, Duabanga grandiflora, Dilenia pentagyna, and Lagerstroemia parviflora*, but without predominance of a particular species (no single species having equal to or above 60% of the total basal area)	Below 1000	TMBF
4	Tropical Evergreen Riverine Forest [Usna Pradeshiya Nadi Tatiya Sadabahar Ban]	A tropical mixed evergreen forest having common species like *Michelia champaca, Eugenia jambolana, Phoebe lanceolata, Mangifera sylvatica, Diospyros species, Machillus villosa, Acer oblongum, Bassia buryraceae, Xylosma longifolium, Ormosia glauca,* with some deciduous trees like *Cedrela toona, Albizzia species, Acrocarpus fraxinifolius, Garuga pinnata and Duabanga sonneratioides,* found along water courses in the Tarai, Bhabar, Dun valleys and Churia hills. *Castanopsis tribuloides, C. indica, Quercus glauca* can occur above 2000 ft.	Below 1000	TERF
5	*Shorea robusta* Forest [Sal Ban]	A tropical deciduous broadleaved forest predominated by *Shorea robusta* (with its basal area equal to or above 60%).	Below 1200	Sh.ro
6	*Dalbergia sissoo-Senegalia catechu* Forest [Sisau-Khair Ban]	A tropical deciduous broadleaved forest co-dominated by *Acacia catechu* and *Dalbergia sissoo* (both combinedly having equal or over 60% of the total basal area), found in the riverine habitats, specifically on the relatively new floodplains along the large rivers	Below 1200	Ds-Sc
7	*Terminalia* Forest [Asna Ban]	A tropical to subtropical deciduous broadleaved forest pre-dominated by *Terminalia species*, i.e. *T. tomentosa, T. chebula, T. belerica, T. myriocarpa*) (with its basal area equal to or above 60%), common associates being *Eugenia jambolana,*	Below 1200	Term

		Lagerstroemia parviflora, Dillenia pentagyna, Adina cordifolia and Cedrela toona, common in the Churia and Duns.		
8	*Anogeissus latifolia* Forest [Banjhi Ban]	A tropical to subtropical deciduous broadleaved forest pre-dominated by *Anogeissus latifolia*		An.la
9	Tropical Deciduous Riverine Forest [Usna Pradeshiya Nadi Tatiya Patjhar Ban]	A tropical deciduous mixed broadleaved forest having common species like *Bombax ceiba, Holoptelea integrifolia, Schleichera trijuga, Ehretia laevis, Trewia nudiflora* and *Garuga pinnata*, found on the old river terraces.	Below 1400	TDRF
10	*Pinus roxburghii* Forest [Khote Salla Ban]	A subtropical evergreen conifer forest predominated by *Pinus roxburghii* (with its basal area equal to or above 60%), found mostly on the south-facing slopes.	500-2000	Pi.Ro
11	*Albizia julibrissin-Toona ciliata* Forest [Siris-Tooni Ban]	A tropical to subtropical, partly deciduous and dominantly evergreen broadleaved forest co-dominated by *Albizia jilibrissin* and *Toona ciliata* (both combinedly having equal to or above 60% of the total basal area), found in the riverine habitats in the eastern and central regions	600-1700	Al-To
12	Subtropical Mixed Broadleaved Forest	A subtropical evergreen broadleaved forest having common species like *Eugenia tetragona, E. ramosissima, Ostodes paniculata, Drimycarpus racemosus, Lithocarpus spicata, Acer thomsonii, A. oblungum, Machilus species, Castanopsis indica, C. tribuloides, Phoebe lanceolata, Cryptocarya amygdalina, Cinnamomum species, Turpinia nepalensis, Bassia butyraceae, Helicia erratica, Macaranga pustulata, Alnus nepalensis, Erythrina suberosa, Cedrela toona, Albizzia lebbek, A. chinensis, Schima wallichii, Leucosceptrum canum, Eurya acuminata, Talauma hodgsonii, Symplocos spicata, Laportea sinuata, Miliusa macrocarpa, Mahonia napaulensis, Caseria graveolens, Amoora decandra,* found east of the Tamur valley	900-1700	SMEF
13	*Castanopsis-Schima* Forest [Katus-Chilaune Ban] (also, *Castanopsis* Forest, *Schima* Forest separately if any)	A subtropical evergreen broadleaved forest co-dominated by *Castanopsis species* and *Schima wallichii* (both combinedly having equal to or above 60% of the total basal area). [Pure forests of Castanopsis or Schima will be considered if any of them predominates the forest]	1000-2000	Ca-Sc
14	*Pinus roxburghii-Shorea robusta* Forest [Khote Salla-Sal Ban]	A subtropical mixed broadleaved-conifer forest co-dominated by *Shorea robusta* (broadleaved) and *Pinus roxburghii* (conifer) (each having 33-60% of the total basal area), found specifically in the Churia region.		Pr-Sr
15	*Pinus roxburghii*-Mixed Broadleaved Forest [Khote Salla Misrit Chaudapate Ban]	A subtropical mixed broadleaved-conifer forest dominated by *Pinus roxburghii* (*Pinus roxburghii* having 33-60% of the total basal area), common associates being *Quercus incana, Q. lanata, Rhododendron arboreum, Lyonia ovalifolia* (in the west), *Schima wallichii* (in the central and eastern region), *Engelhardtia spicata* and *Erythrina stricta.*	1000-2000	Pr-MBF
16	*Olea* Forest [Jaitun Ban]	A subtropical evergreen broadleaved forest predominated by *Olea species* (with its basal area equal to or above 60%), found in the dry valley bottoms and lower slopes in the Bheri valley	1000-2100	Olea

17	*Alnus* Forest [Uttis Ban] (*Alnus nepalensis* forest, *Alnus nitida* forest, if the latter has large enough area to be delineated separately)	A subtropical deciduous broadleaved forest predominated by *Alnus species* (with its basal area equal to or above 60%), found along streams and moist mudflows (*Alnus nitida* in Mugu Karnali and *Alnus nepalensis* elsewhere)	1000-2450	Alnus
18	*Quercus incana* Forest [Banjh Ban]	A subtropical evergreen broadleaved forest predominated by *Quercus incana* (with its basal area equal to or above 60%), found specifically west of the Karnali river	1200-2400	Qu.in
19	*Rhododendron arboreum* Forest [Lali Gurans Ban]	A temperate evergreen broadleaved forest predominated by *Rhododendron arboreum* (with its basal area equal to or above 60%), commonly found as a single-storeyed, mono-specific, even-aged and closed forest, mostly on southern exposure.	1200-4000	Rh.ar
20	*Quercus lanata* Forest [Thulo Banjh Ban]	A subtropical evergreen broadleaved forest predominated by *Quercus lanata* (with its basal area above 60%), found in the central and eastern mountains	1500-2400	Qu.ln
21	*Quercus incana - Quercus lanata* Forest [Banjh Ban]	A mixed evergreen forest co-dominated by Quercus incana and Q. lanata (each having 33-60% of the total basal area)	1650-2400	Qi-Ql
22	*Pinus patula* Forest [Pate Salla Ban]	A plantation forest dominated by *Pinus patula*, found in the subtropical and temperate zones (specifically in Kavre Palanchok and Sindhupalchok districts)	1500-2500	Pi.pa
23	Warm Temperate Mixed Broadleaved Forest [Tallo Samshitoshna Misrit Chaudapate Ban]	A temperate mixed, mostly evergreen, broadleaved forest having common species like *Machilus duthiei, M. odoratissima, M. sericea, Phoebe lanceolata, P. pollida, Cinnamomum tamala, Actinodaphne reticulata, Lindera bifaria, L. neesiana, Litsea oblonga, L. citrata, Neolitsea umbrosa, N. lanuginosa , Michelia kisopa, Lithocarpus spicata, Quercus glauca, Castanopsis tribuloides, Betula alnoides, Alnus nepalensis, Dalbergia hircina, Albizzia mollis, Acer oblongum, Cedrela toona, Juglans regia, Ehretia macrophylla, Engelhardtia spicata, Schima wallichii, Michelia doltsopa, Cucklandia populnea, Carpinus viminea, Acer thomsonii.* **The second canopy consists of** *Lindera pulcherrima, Neolitsea umbrosa, Dodecadenia grandiflora, Eriobotrya elliptica, Sapium insigne, Daphnephyllum himalayense, Macaranga denticulata, M. pustulata, Myrsine semiserrata, Symplocos theaefolia, S, ramosissima, Prunus undulata, Rhododendron arboreum, Sarauja napaulensis* etc.	1500-2200	LTMB
24	*Quercus lamellosa* Forest [Thulo Phalant Ban]	A temperate evergreen broadleaved forest predominated by *Quercus lamellosa* (with its basal area above 60%), found in the eastern mountains	1600-2800	Qu.lm
25	*Pinus wallichiana* Forest [Gobre Salla Ban]	A temperate to subalpine evergreen conifer forest, predominated by *Pinus wallichiana* (with its basal area above 60%), found mostly on sunny slopes	1600-3600	Pi.wa
26	*Pinus wallichiana-Quercus Species*	A mixed broadleaved-conifer forest co-dominated by *Pinus wallichiana* and *Quercus species*.		Pw-Qs

	Forest [Gobre Salla-Khasru Ban]			
27	*Juglans regia* Forest [Okhar Ban]	A temperate deciduous broadleaved forest predominated by *Juglans regia* (with its basal area above 60%), found on moist sites, specifically in Jagadulla Municipality, Dolpa district	1800-2800	Ju.re
28	*Cedrus deodara* Forest [Devdar Ban]	A temperate evergreen conifer forest predominated by *Cedrus deodara* (with its basal area above 60%), found on rocky slopes of inner valleys in western mountains	1800-3000	Ce.de
29	*Acer-Aesculus* Forest [Phirphire-Pagre Ban]	A temperate deciduous broadleaved forest co-dominated by *Acer species* and *Aesculus indica* (both combinedly having equal to or above 60% of the total basal area), found on shady slopes along streams in the western mountains	1800-3100	Ac-Ae
30	*Quercus floribunda* Forest [Seto Khasru Ban]	A subalpine deciduous broadleaved forest predominated by *Quercus floribunda* (with its basal area above 60%), found on shady slopes	1900-2900	Qu.fl
31	*Hippophae salicifolia* Forest [Dale Chuk Ban]	A temperate to subalpine deciduous broadleaved forest predominated by *Hippophae salicifolia* (with its basal area above 60%), found mainly on river gravels of the rain-shadowed inner valleys	2000-3400	Hi.sa
32	*Pinus wallichiana-Abies species* Forest	A mixed conifer forest co-dominated by *Pinus wallichiana* and *Abies species*		Pw-As
33	*Abies pindrow* Forest	A temperate to subalpine evergreen conifer forest predominated by *Abies pindrow* (with its basal area above 60%), found in the western mountains	2000-3500	Ab.pi
34	*Abies-Quercus-Tsuga* Forest	A mixed broadleaved-conifer forest having *Abies species, Quercus species* and *Tsuga dumosa*.		Ab-Qu-Ts
35	*Abies-Quercus-Rhododendron* Forest	A mixed broadleaved-conifer forest having *Abies species, Quercus species* and *Rhododendron species*.		Ab-Qu-Rh
36	*Tsuga dumosa* Forest	A temperate evergreen conifer forest predominated by *Tsuga dumosa* (with its basal area above 60%), found generally on the southern slope in the west and northern slopes of the inner valleys in the eastern region	2100-3000	Ts.du
37	*Picea smithiana Forest*	A temperate evergreen conifer forest predominated by *Picea smithiana* (with its basal area above 60%), found on the shady slopes in the central and western mountains	2100-3600	Pi.sm
38	*Populus ciliata* Forest [Bhote Pipal Ban]	A temperate to subalpine deciduous broadleaved forest predominated by *Populus ciliata* (with its basal area above 60%), found in the riverine habitats of the inner valleys west of the Trishuli river	2100-3600	Po.ci
39	*Quercus semecarpifolia* Forest [Khasru Ban]	A temperate evergreen broadleaved forest predominated by *Quercus semecarpifolia* (with its basal area above 60%), found mostly on southern slopes	2200-3500	Qu.se
40	*Quercus semecarpifolia-Rhododendron species* Forest [Khasru-Gurans Ban]	A mixed forest co-dominated by *Quercus semecarpifolia* and *Rhododendron species*		Qs-Rs

41	*Lithocarpus pachyphylla* Forest [Arkhaulo Ban]	A temperate evergreen broadleaved forest predominated by *Lithocarpus pachyphylla* (with its basal area above 60%), found on the south-facing slope in the eastern mountains	2400-2900	Li.pa
42	*Acer-Magnolia* Forest	An upper temperate deciduous broadleaved forest co-dominated by *Acer species* and *Magnolia campbelli* (each having 33-60% of the total basal area), found on steep humid slopes in the eastern mountains	2500-3000	Ac-Ma
43	Cool Temperate Mixed Broadleaved Forest [Mathillo Samshitoshna Misrit Chaudapate Ban]	A mixed forest if not co-dominated by *Acer* and *Magnolia species* or *Acer* and *Rhododendron species* between 2500 and 3000 m.		UTMB
44	*Cupressus torulosa* Forest [Raj Salla Ban]	A temperate evergreen conifer forest predominated by *Cupressus torulosa* (with its basal area above 60%), found in western mountains	2500-3200	Cu.to
45	*Acer-Rhododendron* Forest [Phirphire-Gurans Ban]	An upper temperate mixed broadleaved forest co-dominated by *Acer species* and *Rhododendron arboreum* (each having 33-60% of the total basal area), found in the eastern region, specifically in the Arun and Tamor valleys	2600-3000	Ac-Rh
46	*Rhododendron hodgsonii* Forest	A subalpine evergreen broadleaved forest predominated by *Rhododendron hodgsonii* (with its basal area above 60%), found as a low to dwarf, gnarled, single-storeyed forest rich in bryophytes or lichen epiphytes on the wet slopes in the eastern region	3000-4000	Rh.ho
47	*Abies pindrow-Abies spectabilis* Forest	A mixed forest *co-dominated by Abies pindrow* and *Abies spectabilis.*		Ap-As
48	*Abies spectabilis* Forest	A subalpine evergreen conifer forest predominated by *Abies spectabilis* (with its basal area above 60%)	3000-4200	Ab.sp
49	*Juniperus recurva* Forest	A subalpine evergreen conifer forest predominated by *Juniperus recurva* (with its basal area above 60%), found on the south-facing rocky cliffs	3000-4300	Ju.re
50	*Abies densa* forest	A subalpine evergreen conifer forest predominated by *Abies densa* (with its basal area above 60%), found particularly in Tamor valley	3000-4350	Ab.de
51	*Larix* Forest (*Larix himalica* forest and *Larix griffithiana* forest, separately if possible)	A subalpine deciduous conifer forest predominated by *Larix species* (with its basal area above 60%), found on rocky slopes of deep valleys in the eastern mountains (*Larix himalica* in Shiar Khola, Langtang, upper Trisuli, and *Larix griffithiana* from Rolwaling to the southeastern inner valleys)	3000-4100	Larix
52	*Juniperus indica* Forest [Dhupi Ban]	A subalpine evergreen conifer forest predominated by *Juniperus indica* (with its basal area above 60%), found on the rocky slopes of inner valleys	3000-4500	Ju.in
53	*Betula-Rhododendron* Forest [Bhojpatra-Gurans Ban]	A mixed forest co-dominated by *Betula utilis* and *Rhododendron species*		Be-Rh
54	*Betula utilis* Forest [Bhojpatra Ban]	A subalpine deciduous broadleaved forest predominated by *Betula utilis* (with its basal area above 60%), found around tree	3600-4200	Be.ut

		line		
Shrubland (other wooded land) types				
55	*Caragana sukiensis* Scrub	A temperate to subalpine shrubby vegetation formation dominated by *Caragana sukiensis* (with its crown coverage above 60% of the total vegetation cover), found on southern exposures of the inner valleys west of Langtang (largest stand in the upper Langtang Valley)	2400-3700	Csuk
56	*Caragana gerardiana* Scrub	A temperate to subalpine spiny cushion vegetation formation dominated by *Caragana gerardiana* (with its crown coverage above 60% of the total vegetation cover), found on gravel terraces in the lower range of the Trans-Himalayan region	2600-3900	Cger
57	*Hippophae tibetana* Scrub	A subalpine to alpine shrubby vegetation dominated by *Hippophae tibetana* (with its crown coverage above 60% of the total vegetation cover), found in the riverine habitats of the Trans-Himalayan region	3500-5000	Htib
58	*Rhododendron* Scrub [Guransko Jhadi]	An alpine vegetation dominated by *Rhododendron species* in their shrubby and dwarf forms (with its crown coverage above 60% of the total vegetation cover), found on moist slopes	3700-4400	RS
59	*Juniperus* Scrub [Dhupiko Jhadi]	An alpine vegetation dominated by *Juniperus species* in their dwarf forms (with its crown coverage above 60% of the total vegetation cover), found on dry slopes	3700-5000	JS
60	*Caragana versicolor* Scrub	A subalpine to alpine spiny cushion vegetation formation dominated by *Caragana versicolor* (with its crown coverage above 60% of the total vegetation cover), found on the sandy and silt-rich mineral soils of gentle slopes in the upper range of the Trans-Himalayan region	4400-5000	Cver
Grassland types				
61	Tropical Savannah [Ushna Pradeshiya Ghanse Maidan]	A tropical grassland dominated by *Saccharum-Phragmatis* association, in which trees such as *Bombax ceiba, Albizia chinensis* and *Trewia nudiflora* are often present, found on the old, consolidated flood plains (For example, in parts of Koshi Tappu, Shuklaphanta, and Chitwan National Park)	Below 300	TS
62	Tropical Riverine Grassland [Ushna Pradeshiya Nadi Tatiya Ghanse Maidan]	A tropical tall dense grassland dominated by *Saccharum spontaneum, Narenga porphyrocoma* and *Themeda arundinacea,* found on the recent flood plains (seasonally flooded area) along the large rivers in the Tarai, Bhabar and Duns. *Phragmites karka, Narenga porphyrocoma* and *Arundo donax* prevail in year-round waterlogged sites.	Below 400	TRG
63	Tropical Hill Grasslands	Grasslands found in Churia hills (specific types to be identified through field survey)	400-1000	THG
64	Subtropical Grasslands	Grasslands found in sub-tropical region (specific types to be identified through field survey)	1000-2000	SG
65	Temperate Grasslands	Grasslands found in temperate region (specific types to be identified through field survey)	2000-3000	TG
66	Pioneer plant successions in	The recently exposed fluvo-glacial sands, gravels and boulders colonized by alpine vegetation, such as carpets of mosses	3520-4000	PPSG

	glacial forelands	(*Bryum* spp), Lichens (*Gyalidea scutellaris*, *Stereocaulon* spp), Rosettes of *Epilobium* spp, *Senecio albopurpureus*, carpets of *Stellaria decumbens,* and the creeping mat-forming dwarf shrubs of *Myricaria species* and *Oxyria digyna*		
67	*Kobresia nepalensis* Grasslands	An alpine land covered by *Kobresia nepalensis*, found on humid southern exposure, specifically in the eastern region	3600-5000	Ko.ne
68	Upper Alpine Grasslands	A high alpine herbaceous vegetation formation dominated by grass species like *Carex species, Calamogrostis species, Agrotis micantha* and *Festuca leptogonum*, found mostly on the south faces of the main Himalaya	4500-5000	UAM
69	*Kobresia pygmaea* Grasslands	A high alpine land covered by smooth mats of *Kobresia pygmaea* (the smallest of the High Asian Cyperaceae), forming a uniform lawn with up to 95% plant cover, found on the moraine slopes in the headwaters of the inner valleys and the rolling hills in the arid zone	4700-5100	Ko.py

Source: Stainton (1972), Dobremez (1976), Jackson (1994), TISC (2002), FRA/DFRS (2014), Miehe et al. (2019)

Note: 1. "Inner valley" are the valleys in the rain shadowed area that drain southwards, mostly between 2500 and 4500m. 2. Nepali names for all forest types will be given/confirmed once the field data are collected. 3. Formation types (e.g. forest/woodland, shrubland/scrub, grassland/savanna etc.) will be revised appropriately according to the EcoVeg classification approach based on field data.

The equivalences of the proposed EFTMP vegetation types and that presented by previous studies are given in Annex 1.

6. Conclusion

The review showed that Nepal's vegetation assessments and classifications have commenced in the early 1950s following the botanical explorations for collecting new species in the pristine Himalayan region. Stainton (1972) and Dobremez et al. (1969-1985) extensively conducted field visits along the various ecological transects and classified the vegetations on the physiographic regions. Miele et al. (2015) classified Nepal's vegetation based on the four decades of ecological observations and past studies. Other classifications such as Jackson et al. (1994), BPP (1996), TISC (2002) and DFRS (2014, 2015) were largely derived from Stainton (1972) and Dobremez's vegetation classification and mapping. However, these vegetation classifications have presented inconsistencies in vegetation formation, number of vegetation types and naming of the vegetation communities across the country. Therefore, EFTMP is commissioned to classify Nepal's vegetation based on the field surveys and assessing the vegetation formation, species composition, growth forms and floristic pattern in all physiographic and climatic regions.

The vegetation classification approaches, data collection methods used, and the naming of vegetation types by the past vegetation assessments have significant implications for Nepal's vegetation classification by EFTMP for field survey methodology and nomenclature of vegetation types. A total of 69 vegetation types, including 54 forest/woodland types, six shrubland/scrub types, and nine grassland/savanna types, have been proposed based on the analysis of the past studies and the secondary data. After completing the field survey and the plot data analysis, the proposed vegetation types will be revisited and updated, providing a full list of vegetation types of Nepal. Furthermore, the physiognomy, biogeography, and formations will be examined for the vegetation types and retrospectively identified the mid-level hierarchy of the IVC framework.

Some key departures from the past vegetation assessments have been proposed for EFTMP. First, it follows the IVC's EcoVeg approach to vegetation classification. Second, it collects data and information from an extensive field survey along the north-south transects, systematically distributed from east to west, and from the purposively selected transects/observation plots at some vegetation hotspots. Third, vegetation map will be based on the existing vegetation. Fourth, it applies a geospatial approach to vegetation classification and mapping, using the field plot data as training data set to classify satellite imagery applying machine learning algorithms. This wall-to-wall vegetation map enables monitoring and updating vegetation types over time and space.

References

Addicott, E., Neldner, V. J., and Ryan, T. (2021). Aligning quantitative vegetation classification and landscape scale mapping: updating the classification approach of the Regional Ecosystem classification system used in Queensland. Australian Journal of Botany. Special Issue, https://doi.org/10.1071/BT20108

Barnekow Lillesø, J-P., Shrestha, T. B., Dhakal, L. P., Nayaju, R. P., & Shrestha, R. (2005). The map of potential vegetation of Nepal: a forestry/agro-ecological/biodiversity classification system. Hørsholm: Center for Skov, Landskab og Planlægning/Københavns Universitet. Development and Environment, No. 2/2005

Biodiversity Profiles Project (BPP) (1996). An assessment of the Representation of the Terrestrial Ecosystems within the Protected Areas System of Nepal. Biodiversity Profiles Project Publication No. 15. Department of National Parks and Wildlife Conservation. Ministry of Forests and Soil Conservation. His Majesty's Government of Nepal. Kathmandu.

Byers, A. C., Byers, E. A., and Thapa, D., (2014). Conservation and Restoration of Alpine Ecosystems in the Upper Barun Valley, Makalu-Barun National Park, Nepal. The Mountain Institute Technical Report No. 2014.11, pages 100.

DFRS (2014). Standard Guidelines for Forest Cover and Forest Types Mapping (Technical Document No. 2). Forest Resource Assessment Nepal, Department of Forest Research and Survey, Kathmandu.

DFRS (2015). State of Nepal's Forests. Forest Resource Assessment (FRA) Nepal, Department of Forest Research and Survey (DFRS). Kathmandu, Nepal.

Dobremez, J. F. (1976). Le Ne´pal: E´cologie et Bioge´ographie [Ecology and Biogeography of Nepal]. Centre Nationale de la Recherche Scientifique, Paris, France.

DoEE (2017) National Vegetation Information System home page. Australian Government, Department of the Environment and Energy, Canberra. URL: http://www.environment.gov.au/land/native-vegetation/nati onal-vegetation-information-system.

Faber-Langendoen, D., Keeler-Wolf, T., Meidninger, D., Tart, D., Hoagland, B., Josse, C., Navarro, G., Ponomarenko, S., Saucier, J-P., Weakley, A., and Comer, P. (2014). EcoVeg: a new approach to vegetation description and classification. Ecological Monographs, 84(4), pp. 533-561.

Faber-Langendoen, D.; Keeler-Wolf, T.; Meidinger, D.; Josse, C.; Weakley, A.; Tart, D.; Navarro, G.; Hoagland, B.; Ponomarenko, S.; Fults, G.; Helmer, E. (2016). Classification and description of world formation types. Gen. Tech. Rep. RMRS-GTR-346. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 222 p.

Faber-Langendoen, D., Peet, R., Meidinger, D., and Keeler-Wolf, T. (2017). The EcoVeg approach in the Americas: U.S., Canadian and International Vegetation Classifications. Phytocoenologia, DOI: 10.1127/phyto/2017/0165

Faber-Langendoen, Don., Navarro, G., Willner, W., Keith, D. A., Liu, C., Guo, K., and Meidinger, D. (2020). Perspectives on Terrestrial Biomes: The International Vegetation Classification. In book: Reference Module in Earth Systems and Environmental Sciences, 10.1016/B978-0-12-409548-9.12417-0.

Gellie, NJH, Hunter, JT, Benson, JS, Kirkpatrick, JB, Cheal, DC, McCreery, K and Brocklehurst, P (2018). 'Overview of plot-based vegetation classification approaches within Australia' , *Phytocoenologia*, vol. 48, no. 2 , pp. 251-272 , doi: 10.1127/phyto/2017/0173.

H. G. Champion (1936). Preliminary survey of the forest types of India and Burma. Indian Forest Records (New series), *Sliviculture*, Vol I. Government of India Press, New Delhi.

Jackson J. K. (1994). Manual of Afforestation in Nepal (Volume 1, 2). Forest Research and Survey Centre, Kathmandu.

Miehe, G., Miehe, S., Böhner, J., Bäumler, R., Ghimire, S. K., Bhattarai, K., Chaudhary, R. P., Subedi, M., Jha, P. K. & Pendry, C. (2015). Vegetation Ecology (Chapter 16). In Miehe, G., Pendry, C. & Chaudhary, R. P. (Eds.), *Nepal: An introduction to the natural history, ecology and human environment of the Himalayas* (pp. 7-16). Edinburgh: Royal Botanic Garden Edinburgh.

Municha (1997). Classification of vegetation: Past, present and future. Journal of Vegetation Science, 8, pp. 751-760.

Nemani, R. and Running, S. W., (1996). Implementation of a hierarchical global vegetation classification in ecosystem function models. Journal of Vegetation Science, 7, pp 337-346.

Osmaston, A. E., (1927). Forest Flora for Kumaon. Government Press, Allahabad.

Sayre, R., P. Comer, J. Hak, C. Josse, J. Bow, H. Warner, M. Larwanou, E. Kelbessa, T. Bekele, H. Kehl, R. Amena, R. Andriamasimanana, T. Ba, L. Benson, T. Boucher, M. Brown, J. Cress, O. Dassering, B. Friesen, F. Gachathi, S. Houcine, M. Keita, E. Khamala, D. Marangu, F. Mokua, B. Morou, L. Mucina, S. Mugisha, E. Mwavu, M. Rutherford, P. Sanou, S. Syampungani, B. Tomor, A. Vall, J. Vande Weghe, E. Wangui, and L. Waruingi (2013). A New Map of Standardized Terrestrial Ecosystems of Africa. Washington, DC: Association of American Geographers. 24 pages.

Schweinfurth, U. (1957). Die horizontale und vertikale Verbreitung der Vegetation in Himalaya. Bonn. Cited in Stainton (1972).

Schwienfurth, U. (1992). Mapping Moutains: Vegetation in the Himalaya. GeoJournal, 27.1, pp 73-83

Shrestha, T. B. (2008). Classification of Nepalese Forests and Their Distribution in Protected Areas. The Initiation, Vol. 2(1).

Shrestha, T.B., Lillesø, J.P.B., Dhakal, L.P. and Shrestha, R. (2002). Forest and Vegetation Types of Nepal. Ministry of Forests and Soil Conservation, HMG/Nepal, Natural Resource Management Sector Assistance Programme (NARMSAP), Tree Improvement and Silviculture Component, Kathmandu, Nepal

Singers, J. D. and Rogers, G. M. (2014). A classification of New Zealand's terrestrial ecosystems. New Zealand Department of Conservation

Stainton, J. D. A. (1972). Forests of Nepal. John Murray. London.

TISC (2002). Forest and Vegetation Types of Nepal. Tree Improvement and Silviculture Component (TISC), Natural Resource Management Sector Assistance Programme, Ministry of Forest and Soil Conservation, pp 193.

Uddin, K., Shrestha, H. L., Murthy, M. S. R., Bajracharya, B., Shrestha, B., Gilani, H., Pradhan, S., Dangol, B. (2015). Development of 2010 national land cover database for Nepal. Journal of Environmental Management 148: 82-90. DOI: 10.1016/ j.jenvman.2014.07.047

Annex 1: The proposed EFTMP vegetation types and their equivalents in the past assessments

Proposed EFTMP types	Miehe et al. (2015)	TISC (2002)	Jackson (1994)	Dobremez (1976)	Stainton (1972)
Forest Types					
Tectona grandis Forest					
Eucalyptus Forest					
Tropical Mixed Broadleaved Forest		Lower Tropical Sal and Mixed Broadleaved Forest		*Shorea* and *Dillenia pentagyna* forest; *Shorea* and *Dillenia indica* forest; *Shorea robusta* and *Duabanga sonneratioides* forest; *Shorea* and *Terminalia tomentosa* forests (Chure slopes, Eastern facies, Western facies)	
Tropical Evergreen Riverine Forest		Tropical Evergreen Forest (Sub-type)	Other riverain forest		Tropical Evergreen Forest
Shorea robusta Forest	*Shorea robusta* forest	Lower Tropical Sal Forest (Sub-type); Hill Sal Forest	*Shorea robusta* forest	*Shorea robusta* Forest; *Shorea robusta* and *Cycas pectinata* forest; Riparian forest with *Shorea robusta* and *Mimosa rubicaulis*	Sal Forest
Dalbergia sissoo-Senegalia catechu Forest	*Dalbergia sissoo-Acacia catechu* riverine forest	Riverain Khair-Sissoo Forest (Sub-type)	*Acacia catechu-Dalbergia sissoo* forest	Riparian forest of *Dalbergia sissoo* and *Acacia catechu*	*Dalbergia sissoo-Acacia catechu* Forest
Terminalia Forest	*Terminalia* and *Anogeissus* forest	Terminalia Forest (Sub-type)	*Terminalia-Anogeissus* deciduous hill forest	*Shorea* and *Terminalia tomentosa* forests (Chure slopes, Eastern facies)	*Terminalia* Forest
Anogeissus latifolia Forest	*Terminalia* and *Anogeissus* forest		*Terminalia-Anogeissus* deciduous hill forest	*Shorea* and *Terminalia tomentosa* forest (Western facies)	Subtropical Deciduous Hill Foerst
Tropical Deciduous Riverine Forest	*Bombax* riverine forest	Tropical Deciduous Riverain Forest (Sub-type)	Other riverain forest		Tropical Deciduous Riverain Forest
Pinus roxburghii Forest	*Pinus roxburghii* forest	Chir Pine Forest	*Pinus roxburghii* forest	*Pinus roxburghii* xerophilic forest	*Pinus roxburghii* forest
Albizia julibrissin-Toona ciliata Forest	*Toona ciliata-Albizia julibrissin* riverine forest	Riverain forest with *Toona* and *Albizia* species	Riverain forest with *Toona* and *Albizia* species	Riparian forest of *Cedrela toona-Albizia mollis;* Hygrophilous forest of *Lagersroemia parviflora*	
Subtropical Mixed Broadleaved Forest		*Eugenia-Ostodes* Forest			Subtropical evergreen forest; Sub-tropical Semi-evergreen Hill Forest
Castanopsis-Schima Forest	*Schima-Castanopsis* forest	*Schima-Castanopsis* Forest	*Schima-Castanopsis* forest	Mesohygrophilic forest of *Schima wallichii-Castanopsis indica*	*Schima-Castanopsis* Forest;

				(Annapurna type, Central Nepal type, East Nepal type); *Castanopsis tribuloides* forest	Castanopsis tribuloides-C. hystrix forest
Pinus roxburghii-Shorea robusta Forest					
Pinus roxburghii-Mixed Broadleaved Forest		Chir Pine-Broadleaved Forest		Mesophilic forest of *Schima wallichii-Pinus roxburghii*	
Olea Forest	*Olea ferruginea* woodlands	Olea Forest		*Olea cuspidata* Steppe	
Alnus Forest	*Alnus nepalensis* riverine forest	Alder Forest (Sub-type)	*Alnus nepalensis* forest	*Alnus nepalensis* forest	*Alnus* woods
Quercus incana Forest		Lower Temperate Oak Forest	Forest of *Quercus leucotrichophora* and *Q. lanata*	*Quercus incana* Forest	*Quercus incana-Q. lanuginosa* Forest
Rhododendron arboreum Forest	*Rhododendron arboreum* forest	*Rhododendron* Forest	*Rhododendron* forest	*Rhododendron arboreum* and *Lyonia ovalifolia* forest; *Rhododendron* facies, *Rhododendron* forest; *Rhododendron* subalpine forest	*Rhododendron* Forest
Quercus lanata Forest	*Quercus lanata* forest	Lower Temperate Oak Forest	Forest of *Quercus leucotrichophora* and *Q. lanata*	*Quercus lanata* Forest	*Quercus incana-Q. lanuginosa* Forest
Quercus incana-Quercus lanata Forest		Lower Temperate Oak Forest	Forest of *Quercus leucotrichophora* and *Q. lanata*		*Quercus incana-Q. lanuginosa* Forest
Pinus patula Forest					
Warm Temperate Mixed Broadleaved Forest			Lower temperate mixed broadleaved forest, with abundant Lauraceae	*Quercus glauca* forest	Lower temperate mixed broadleaved forest
Quercus lamellosa Forest	*Quercus lamellosa* forest	East Himalayan Oak-Laurel Forest	*Quercus lamellosa* forest	*Quercus lamellosa* and Lauraceous forest; *Quercus lamellosa* and *Castanopsis hystrix* forest	*Quercus lamellosa* Forest
Pinus wallichiana Forest	*Pinus wallichiana* forest	Upper Temperate Blue Pine Forest	*Pinus wallichiana* forest (lower type)	*Pinus excelsa* forest; *Pinus excelsa* and *Juniperus indica* forest	*Pinus excelsa* forest
Pinus wallichiana-Quercus species Forest		Mixed Blue Pine-Oak Forest		*Quercus lanata-Pinus excelsa* forest	
Juglans regia		Deciduous Walnut-			*Aesculus-Juglans-*

Forest		Maple-Alder Forest			*Acer* forest
Cedrus deodara Forest	*Cedrus deodara* forest	Cedar Forest		*Cedrus deodara* forest	*Cedrus deodara* forest
Acer-Aesculus Forest	*Aesculus-Acer* forest	Deciduous Walnut-Maple-Alder Forest			*Aesculus-Juglans-Acer* forest
Quercus floribunda Forest	*Quercus floribunda* forest		*Quercus floribunda* forest	*Quercus glauca* forest	*Quercus dilatata* Forest
Hippophae salicifolia Forest	*Hippophae* riverine woodlands				*Hippophae* scrub
Pinus wallichiana-Abies species Forest		Fir-Blue Pine Forest			
Abies pindrow Forest	*Abies pindrow* forest	Fir Forest	Upper temperate coniferous forest	*Abies pindrow* forest	*Abies pindrow* forest
Abies-Quercus-Tsuga Forest		Fir-Hemlock-Oak Forest; West Himalayan Fir-Hemlock-Oak Forest			
Abies-Quercus-Rhododendron Forest		Fir-Oak-Rhododendron Forest		*Abies spectabilis* and *Quercus semecarpifolia* Forest	
Tsuga dumosa Forest	*Tsuga dumosa* forest		Upper temperate coniferous forest	*Tsuga dumosa* facies	*Tsuga Dumosa* forest
Picea smithiana Forest	*Picea smithiana* forest	Spruce Forest	Upper temperate coniferous forest	*Picea smithiana* and *Pinus excelsa* forest	*Picea smithiana* forest
Populus ciliata Forest				Riparian facies; *Populus ciliata* forest	*Populus ciliata* woods
Quercus semecarpifolia Forest	*Quercus semecarpifolia* forest	Temperate Mountain Oak Forest; Sub-alpine Mountain Oak Forest; Mountain Oak-Rhododendron Forest	*Quercus semecarpifolia* forest	*Quercus semecarpifolia* forests (West Nepal, Typical facies, Annapurna facies)	*Quercus semecarpifolia* forest
Lithocarpus pachyphylla Forest	*Lithocarpus pachyphylla* forest	*Lithocarpus* Forest		*Lithocarpus pachyphylla* forest	*Lithocarpus pachyphylla* forest
Acer-Magnolia Forest		Deciduous Maple-Magnolia-Sorbus Forest			Upper temperate mixed broadleaved forest
Cool Temperate Mixed Broadleaved Forest				*Daphniphyllum himalayense* forest	
Cupressus	*Cupressus*	Cypress Forest		*Cupressus torulosa*	*Cupressus*

torulosa Forest	*torulosa* forest			Steppe	*torulosa* forest
Acer-Rhododendron Forest		Mixed Rhododendron-Maple Forest	Upper temperate mixed broadleaved forest		
Rhododendron hodgsonii Forest	*Rhododendron hodgsonii* forest			*Rhododendron* subalpine forest	*Rhododendron* Forest
Abies pindrow-Abies spectabilis Forest					
Abies spectabilis Forest	*Abies spectabilis* forest	Fir Forest	*Abies spectabilis* forest	*Abies spectabilis* forest (Typical region)	*Abies spectabilis* forest
Juniperus recurva Forest	*Juniperus recurva* forest	Temperate Juniper Forest			
Abies densa forest	*Abies densa* forest				
Larix Forest	*Larix* forest	Larch Forest		*Larix potanini* forest; *Larix griffithiana* forest; *Larix potanini* and *L. griffithiana* forest; The Himalayan Larch forest; Xerophillic forest of *Larix potanini; Larix griffithiana* hygrophilous forest	*Larix* forest
Juniperus indica Forest	*Juniperus indica* forest	Temperate Juniper Forest	*Juniperus indica* steppe	*Pinus excelsa* and *Juniperus indica* forest; *Juniperus indica* forest; *Juniperus indica* Steppe	*Juniperus wallichiana* forest
Betula-Rhododendron Forest		Birch-Rhododendron Forest			
Betula utilis Forest	*Betula utilis* forest		*Betula utilis* forest	Xerophilic forest of *Betula utilis;* Mesophilic forest of *Betula utilis* (Typical facies)	*Betula utilis* Forest
Shrubland/scrub types					
Caragana sukiensis Scrub	*Caragana sukiensis* thickets			*Caragana nepalensis* Steppe	
Caragana gerardiana Scrub	*Caragana gerardiana* open dwarf shrublands	Trans-Himalayan Lower Caragana Steppe	Caragana steppe	*Caragana gerardiana* Steppe	
Hippophae tibetana Scrub	*Hippophae tibetana* riverine dwarf thickets				
Rhododendron Scrub	*Rhododendron* thickets; *Rhododendron* dwarf thickets; *Rhododendron lepidotum* shrublands	Moist Alpine Scrub	Alpine vegetation	*Rhododendron* heathland	Moist alpine scrub
Juniperus Scrub	*Juniperus recurva* thickets;	Dry Alpine Scrub	Alpine vegetation	Mesophilic Junipers heathland; *Juniperus*	Dry alpine scrub

	Juniperus squamata dwarf shrublands			*squamata* heathland	
Caragana versicolor Scrub	*Caragana versicolor* open dwarf shrublands	Trans-Himalayan Upper Caragana Steppe	Caragana steppe		
Grassland types					
Tropical Savannah		Savannah/Grasslands	Grassland	Large grass pseudo-steppe	
Tropical Riverine Grassland	Riverine grassland	Savannah/Grasslands	Grassland		
Tropical Hill Grasslands					
Subtropical Grasslands	*Euphorbia royleana* grasslands				
Temperate Grasslands					
Pioneer plant successions in glacial forelands	Pioneer plant successions in glacial forelands			Pioneer species group on scree; Pioneer species group on torrential gravels; Pioneer species group on moraines	
Kobresia nepalensis Grasslands	*Kobresia nepalensis* Mats				
Upper Alpine Grasslands		Upper Alpine Meadows		Meadows on the fine and homogenous soil; Vegetation on soil with heterogenous structure; Upper Alpine Vegetation; Alpine Meadows	
Kobresia pygmaea Grasslands	*Kobresia pygmaea* dwarf Mats				

Note: 1) Some vegetation types, such as *Rosa-Berberis-Cotoneaster* shrublands, Thickets and pastures, *Bamboo* thickets, Tall forb communities of cattle resting places, Alpine steppe, High alpine cushion communities and highest plant records, Salt meadows, Plant communities of wastelands, Crustose lichen covers of rock walls (Miehe et al. 2015), Trans-Himalayan High Alpine Vegetation (TISC 2002), and Mountain Heathland, Lower Alpine Meadow, Vegetation on Scree, Caragana brevispina Steppe, Caragana pygmaea and Lonicera spinosa Steppe, High Altitude isolated vegetation, and Xerophilic valley formations (Dobremez 1976) are excluded from the proposed vegetation typology. These will be included after the field survey if they are found significant for mapping.