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The drivers of deforestation and forest degradation in the Himalayan region: A literature review

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Executive summary

This literature review of the drivers of deforestation and forest degradation (D&D) in the Himalaya is based on recent reports and papers, especially those with a strong empirical basis. They are of varying methodological quality and geographical scope. They range from studies with a strong empirical basis derived from an examination of satellite data and/or multiple regression analyses of statistically representative data, as well as key informant interviews and secondary data, to those with a weaker empirical basis and which rely much more on key informant interviews and secondary data. This review gives greater emphasis to sources with a strong empirical basis and where the geographical zone or eco-region covered is more clearly defined. In several studies, the analysis was not clearly disaggregated according to eco-region or geographical zone so it was not always apparent, for example, when the analysis referred to Himalayan temperate forest (as compared to subtropical forest areas); in others, the basis on which the drivers had been ranked was unclear, and/or the indirect drivers of D&D were not clearly separated.

Notwithstanding these caveats, it can be observed that forest degradation has been a more important issue in terms of its carbon emissions and area than deforestation in most Himalayan countries or regions. Deforestation has often been associated with military conflict and the presence of insurgent groups, such as in Afghanistan, Pakistan, and Myanmar. The Tibet Autonomous Region, China also underwent rapid deforestation, driven by development policies and poor governance, during the last quarter of the twentieth century. Northern Myanmar is the only Himalayan region in which commercial agriculture has been a major driver of deforestation.

This review identifies several dominant narratives about D&D drivers, mainly around the process of forest degradation:

- Policy failure and weak governance constitute the dominant overall narrative, except for in Bhutan, and have been particularly prevalent in Pakistan, Afghanistan, and northern Myanmar. Policy failure has also contributed to the ineffectiveness of collective action to counteract the drivers of D&D, as shown in the literature from Nepal and northern India.

[1] Forest Trends; [2] International Centre for Integrated Mountain Development; [3] Food and Agriculture Organization

- Some studies highlight what has been termed the 'theory of Himalayan environmental degradation' in which the main underlying cause is population pressure resulting in subsistence and shifting agriculture, livestock grazing and fodder demand, and fuelwood and subsistence timber extraction as the main direct D&D drivers. This narrative is especially reported for Nepal and northern India, and helps explain the lower levels of forest degradation in high-altitude areas.
- The emerging role of climate change, and the associated increased importance of fire following drought conditions, although this is hard to substantiate from the literature; increasingly uncertain rainfall due to climate change may also be contributing to agricultural de-intensification and abandonment in some areas.
- The increasing importance of hydropower projects and mining as drivers of deforestation, especially in Myanmar and Bhutan.

These narratives interact in many areas, for example, population pressure and policy failure, and governance failure and international demand. This can result in multilevel interactions of direct and indirect drivers, making it a demanding area of research. This review has a number of research methodology implications:

- Both quantitative and qualitative research are vital.
- As regards quantitative research, the main starting point for analysing D&D drivers must be spatial analysis using remote-sensing data. In the case of forest degradation drivers, ground observation is an essential complement to spatial analysis.
- A second key quantitative research tool is multiple regression analysis, especially with a view to establishing an empirical basis for the indirect drivers. This tool has however been quite sparsely used, probably since it can be quite challenging, for example, the interrelationships between explanatory variables (or multicollinearity) can complicate causative analysis.
- As regards qualitative analysis, the main priority is higher-level policy and governance analysis, or what is sometimes called 'political economy analysis'.

Keywords: deforestation, forest degradation, REDD+, policy gaps, theory of Himalayan environmental degradation, climate change

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Abbreviations and acronyms

CTA	Central Tibetan Administration
D&D	Deforestation and forest degradation
EIA	Environmental impact assessment
FAO	Food and Agriculture Organization of the United Nations
FRA	Forest Resource Assessment
FUG	Forest user group (Nepal)
ICIMOD	International Centre for Integrated Mountain Development
LUC	Land use certificate (Myanmar)
NDC	Nationally determined contribution
NGO	Nongovernmental organisation
NTFP	Nontimber forest product
REDD+	Reducing emissions from deforestation and forest degradation
SFM	Sustainable forest management
TAR	Tibet Autonomous Region, China
UNFCCC	United Nations Framework Convention on Climate Change
VP	Van panchayat (India)

Contents

SECTION I

Introduction

The main objective of this literature review, conducted for the (Himalayan) Regional REDD+ Initiative[1] coordinated by the International Centre for Integrated Mountain Development (ICIMOD), is to obtain a more systematic understanding of D&D drivers in the Himalayan region, partly as a basis for identifying the policy implications for emerging REDD+ programmes in the ICIMOD partner countries, as well as to assess research methodology implications.

Understanding the D&D drivers is essential for developing certain climate change mitigation policies and measures, such as those included in national Reducing Emissions from Deforestation and Forest Degradation (REDD+) programmes.[2] The United Nations Framework Convention on Climate Change (UNFCCC) negotiation process has encouraged tropical or developing countries to identify land use, land use change, and forestry activities that address D&D drivers, and to assess their potential contribution to the mitigation of climate change (Angelsen et al. 2012).

A robust and empirically-based understanding of the drivers of D&D is needed for three main reasons:

- To identify REDD+ policies and interventions: An analysis of the drivers of D&D is the bedrock of any REDD+ programme or project;
- To help define the forest reference level[3]: This should be based on a quantitative, historical analysis of context-specific drivers, and associated changes in forest carbon stocks (Hosonuma et al. 2012); and
- For REDD+ adaptive management: D&D drivers are constantly changing (for example, due to market forces, climate change, and other drivers) and therefore need to be carefully monitored over time so that REDD+ programmes and projects can adapt and continue to reduce emissions cost-effectively (Salvini et al. 2014).

The structure of this review paper is as follows: first, some key definitions and classifications are discussed in section 2. Section 3 briefly presents the criteria for inclusion of a study in this review. In section 4, recent empirical data on D&D drivers are summarised for each Himalayan country and subregion covered. This is followed by a synthesis discussion in section 5, and finally, the paper's conclusions.

[1] The Regional REDD+ Initiative is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, and jointly implemented by ICIMOD and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The objective of the Initiative is to improve the conditions for the implementation of REDD+ measures that would mitigate climate change, and which are socially and environmentally sound, in the Himalayan countries Bhutan and Nepal, and in the Himalayan regions of India and Myanmar.

[2] It should be noted that REDD+ programmes can include various other actions apart from those of tackling D&D, fostering forest conservation, sustainable management of forests, and enhancement of forest carbon stocks, including through forest restoration, are other actions that can qualify for international REDD+ payments provided there has been appropriate measurement, reporting and verification.

[3] A 'forest reference level' refers to a benchmark or baseline level of carbon emissions against which any changes in emission levels, due to a REDD+ programme or project, need to be measured.

SECTION II

Definitions and classifications

'Himalayan region' is interpreted as meaning the mountainous and hilly areas of Himalayan countries (Nepal, Bhutan) and regions (for example, northern Myanmar, northwestern Pakistan). Within the two Himalayan countries, the analysis is of temperate (the temperate zone may be broadly classified as over 2000 metres above sea level) or montane forests as far as it is possible to delineate them; for example, in the case of Nepal, the Churia and Siwalik hills are included, but the lowland Terai region is excluded.

Before addressing the definitions of 'deforestation' and 'forest degradation' it is important to consider what is meant by 'forest'. As defined in the FAO Forest Resource Assessment (FRA), conducted every five years, it is an area of at least 0.5 hectares (ha), with a crown cover of over 10% and trees at least five metres (m) tall (FAO 2015b). The UNFCCC definition of forest used for REDD+ is slightly different since it uses ranges: an area of 0.05–1 ha, trees of 2–5 m, and a crown cover of 10%–30% (UNFCCC 2006). There can also be differences in the definition of 'intact' and 'open/degraded' forest. In the FAO (2015b) definition, an 'intact' forest has more than 40% canopy cover, and 'degraded' or 'open' forest 10%–40%. But in a study of deforestation in Myanmar, an expert group decided that an 'intact' forest needed at least 80% canopy cover and if 10%–80%, was 'degraded' forest (Bhagwat et al. 2017). There are also definitions of varying levels of forest density – in general, 'dense' or 'very dense' forest is defined as over 70% canopy cover, and 'medium dense' or 'moderately dense' forest is 40%–70%.

'Deforestation' can be defined as the permanent conversion of 'forest' land to another land use, usually involving the removal of all trees (Hosonuma et al. 2012; Houghton 2012). The UNFCCC definition of deforestation is a 'measurable sustained decrease in crown cover to less than 10–30 per cent.' Very few sources differentiate the rate of deforestation in Himalayan (temperate) forests from other forest types in countries with Himalayan forests. One paper (Brandt et al. 2017), however, presents average annual deforestation rates for Himalayan temperate forests outside protected areas in five countries for the period 2000–2014 (Table 1). These range from 0.5% in Bhutan to 1.7% in Myanmar, with an overall annual average deforestation rate of 1.2%. Brand et al (2017) do not, however, describe exactly how these estimates were derived except to say that they were based on data and maps from high-resolution Landsat imagery published by Hansen et al. (2013).[4]

Notwithstanding the data presented in Table 1, any deforestation data needs to be interpreted very carefully according to the definitions used; these definitions are very often not made explicit. One major issue is whether forest clearance due to shifting

TABLE 1 AVERAGE ANNUAL DEFORESTATION RATES IN HIMALAYAN TEMPERATE FORESTS OUTSIDE PROTECTED AREAS, 2000–2014

Country	Annual deforestation rate (2000–2014)
Bhutan	0.5%
China	1.3%
India	1.4%
Myanmar	1.7%
Nepal	0.6%
Overall	1.2%

Source: Brandt et al. (2017)

[4] In the Hansen et al (2013) study, 'forest' was identified and defined by pixels that were at least half covered by trees over five metres in height.

cultivation is included under deforestation or forest degradation, since the assumption is that the forest will at least partially regrow. Therefore, shifting cultivation, as well as damage caused by fire and insects, and logging is classified under forest degradation rather than deforestation in the five-yearly *Global Forest Resources Assessment* (*FRA*) of the Food and Agriculture Organization of the United Nations (FAO 2015b). However, some datasets include shifting cultivation under deforestation, which complicates inter-country comparisons (Houghton 2012).[5]

Shifting cultivation for subsistence agriculture can be regarded as the most important direct driver of D&D in tropical countries since it has made the biggest net contribution to forest-based greenhouse gas emissions, about 30% (Houghton 2012), followed in importance by permanent agricultural crop conversion; draining and burning of peatland for oil palm production (only in Asia); forest conversion for pasture and grazing; logging for timber; and fuelwood extraction. The treatment of shifting cultivation therefore makes a huge difference when discussing the relative importance of deforestation – if shifting cultivation were included in it, deforestation would be considered responsible for about 90% of net greenhouse gas emissions from forest land, but only 60% if it were counted under forest degradation (Houghton 2012).

'Forest degradation' can be defined as a change to a lower density of biomass or a thinning of the canopy cover.[6] From satellite imagery, it is possible to identify when a forest changes from being in the category 'dense forest' (usually defined as having a canopy cover of over 50%) to 'medium dense forest' (canopy cover of 30%–50%), or from 'medium dense' to 'open' (or 'degraded') forest (10%–30% canopy cover). Or it can be measured as a change from 'intact' to 'degraded' forest. As shown below in the analysis of forest degradation in Myanmar, this is very dependent on how the terms 'dense', 'intact', and 'degraded' are defined, which again complicates cross-country comparisons. It is therefore important to check definitions when making cross-country comparisons. There is also the issue of whether countries are consistent in their reporting, even when seeking to conform to a common definition such as in the *FRA* (Houghton 2012).

The 'direct drivers' of D&D can be defined as human activities that directly cause the loss or deterioration of forest cover (Geist and Lambin 2002). Several key distinctions or classifications between D&D drivers need to be made:

- First, between being responsible for deforestation or forest degradation; this is not always easy since some drivers are common to both, such as logging and fires, and shifting cultivation could be classified under either, as already discussed. Table 2 presents a classification of direct drivers (Hosonuma et al. 2012).
- Second, between anthropogenic causes and 'natural causes', since it is only efforts to tackle the former that qualify for international REDD+ payments. 'Natural causes' can include fire, landslides, riverine floods, and other causes. Fires can be difficult to classify – 'accidental' fire can be considered as a 'natural' driver that is increasingly linked to climate change, but again, it can be difficult to distinguish between deliberate/wilful fires and nondeliberate/accidental fires.
- Third, between direct or proximate drivers of D&D and indirect drivers, also called underlying causes. Direct drivers are normally the consequence of a complex and interacting set of underlying causes, composed of a mixture of social, political, economic, and technological factors (Geist and Lambin 2002). But some direct drivers, such as road construction, building of other infrastructure, and mining, simultaneously act as indirect drivers since they attract or stimulate further D&D.

TABLE 2 DIRECT DRIVERS OF DEFORESTATION AND FOREST DEGRADATION

Direct drivers of deforestation	Direct drivers of forest degradation
Commercial agriculture: for crops, tree plantations, pasture	Timber/logging: including illegal logging and subsistence use
Subsistence agriculture by smallholders: permanent and shifting cultivation	Fuelwood and charcoal: domestic and commercial
Mining	Livestock grazing: large-scale and small-scale
Infrastructure-building: roads, hydropower, railways, pipelines	Fire (uncontrolled)
Urban expansion: including of settlements	

Source: Hosonuma et al. (2012)

[5] Areas under shifting cultivation and those left fallow can be difficult to distinguish. The FAO includes the cropping portion of shifting cultivation under 'arable and permanent crops' and excludes fallow areas if they are older than five years, but it is difficult for countries to report these distinctions consistently. The length of the fallow period is another factor when considering whether shifting cultivation should be classified under deforestation or forest degradation (Houghton 2012).

[6] Some studies, such as the analysis of drivers of D&D in Bhutan, use the change in canopy cover as a proxy for forest degradation (WMD 2017).

SECTION III

Sources and criteria for inclusion

There have been many studies of D&D in the Himalayan region, including a large body of literature from the last quarter of the twentieth century (for example, Blaikie and Sadeque 2000; Ives 1987). It is therefore necessary to be somewhat selective for this review. The main criteria for including a source in this paper are:

- The degree of geographical focus on hill and mountain areas of the Himalaya;
- **Timing or date:** Only recent studies (mainly since 2010) have been included, given the very dynamic nature of D&D drivers,[7] and that the main interest is in current and projected trends;
- **Methodology:** Studies that are empirical or quantitative, and involve analysis of primary data have been prioritised over papers that are based mainly on qualitative analysis and secondary data. A rigorous analysis of drivers ideally requires a combination of satellite data (although this is less effective for analysing forest degradation), statistical or econometric analysis of household survey or census data, and field surveys or forest inventories (Houghton 2012). More qualitative analysis, for example, from stakeholder consultations, can then be overlaid on this empirical basis.

[7] It should be noted that past D&D drivers may be an unreliable guide to future drivers; for example, as climate change gets stronger, fire and pests are likely to increase in importance.

SECTION IV

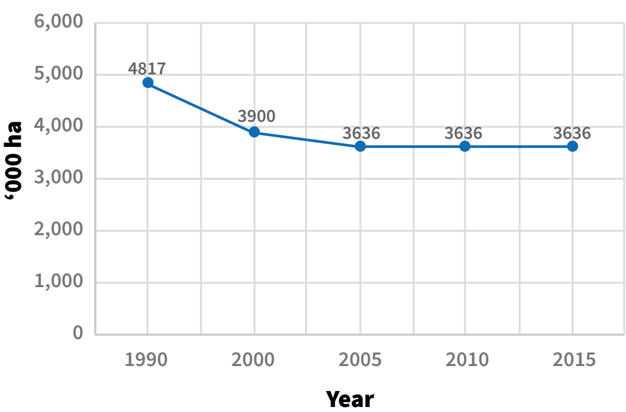
Country and regional analyses

4.1 Nepal

Nepal can be divided into three main physical regions – ‘mountains’, covering 19% of the land area; ‘hills’, covering about 64%; and the lowland Terai region, covering 17% (Paudel et al. 2013). The forest cover in Nepal as a whole was about 25% in 2015 (FAO 2015b). There was a sharp decline in forest cover in Nepal between 1990 and 2005, but it has remained constant since 2005 due to various policy and reforestation measures, including community forestry in the hill and mountain areas (Figure 1).

There have been several papers over the last decade on the causes of D&D in Nepal; many of them, such as Acharya et al. (2011), Chaudhary et al. (2016), Rimal et al. (2014), and Paudel et al. (2013), have been mainly based on a qualitative analysis and/or a literature review of secondary data. The analysis of D&D drivers in these papers tends to lack contextual specificity (for example, not clearly separating lowland and hill or mountain areas), and/or does not differentiate clearly between deforestation and forest degradation. For example, there is considerable discussion in Chaudhary et al. (2016) of deforestation caused by policies, unclear or insecure tenure, and political instability,[8] but the main impacts of these factors have been in the Terai. An example of the need for careful regional differentiation is the effects on forest cover of the Maoist-led conflict of 1996–2006: while it had a big impact on the Terai, forest, community forestry in the hills was much less affected (except where the military cleared forests to eliminate suspected Maoist hiding places), partly due to the political sympathies of the Maoists with forest user groups (FUGs) (Bhattarai et al. 2009).

FIGURE 1 **FOREST COVER IN NEPAL, 1990–2015**



Source: FAO (2015b)

In general, the lists of prioritised (direct) drivers in these sources include fire, unsustainable/illegal fuelwood and timber harvesting, infrastructure development (such as hydropower projects and transmission lines), overgrazing, and occasionally mining, urbanisation and natural disasters. For higher mountain areas, fire and overgrazing are most often mentioned.

Altitude, subsistence agriculture, road-building, and population pressures are strongly interlinked factors for D&D in Nepal. From satellite data, Bhattarai et al. (2009) found decreasing rates of D&D as the altitude increased, and accessibility and population pressure declined. At the same time this study found agriculture (including grazing and fodder collection), together with

[8] Historically, political instability has been an important driver of deforestation in Nepal. There was widespread deforestation following the Private Forests (Nationalization) Act, 1957, during the prodemocracy revolution of 1989–1990, and during the Maoist-led conflict of 1996–2006 (Bhattarai et al. 2009).

human settlement or population, as the main driver of D&D in the hilly and mountain areas: this may appear contradictory, but the reason is that a much larger area of forest is needed at higher altitudes to support a given agricultural area. According to research data cited in Acharya et al. (2011), in high-altitude Nepal, up to 50 ha of forest and grazing land are needed to maintain a hectare of paddy land, whereas in the midhills only 3.5 ha are needed. Bhattarai et al. (2009) also point out that although fewer people live at higher altitudes, they devote most of their time to collecting forest products. Therefore, even at higher altitudes, the people's high dependence on forest products (or the lack of alternative livelihoods) are the main indirect drivers of D&D.

They found that farming was the main driver of deforestation in the mountainous, higher altitude areas of the Central Development Region in both 1975–1990 and 1990–2000. During the period 1975–2000, the statistically significant factors influencing deforestation in the hilly areas (1,200–2,399 metres above mean sea level [masl]) were population, livestock, farming and distance from roads. In higher altitude areas (2,400–4,999 masl), the main drivers were farmland and overflowing or deviating rivers associated with annual snow melt and monsoonal activity.[9]

The role of subsistence agriculture or household needs in D&D is unsurprising given that forests are the main source of energy, animal feed, and construction materials for most people living in the hills and mountains of Nepal. Many who lack farmland resort to logging or the collection of nontimber forest products (NTFPs) in order to survive. There is also a downward spiral or linkage between forest degradation and deforestation: When forests become degraded, they result in declining farm production leading to further agricultural expansion into forest areas to maintain food and income levels (Bhattarai et al. 2009).

It is generally agreed that forest degradation is more important than deforestation in the hill and mountain areas of Nepal (Paudel et al. 2013). The strong correlation between decreasing forest cover and increasing shrubland (rather than farmland or other land uses) supports this view. Forest degradation in temperate forest areas was the focus of a paper by Baland et al. (2011). It is based on statistical analysis of World Bank 'standard measurement surveys' (that is, household surveys) in 1995–96 and 2002–2003, which provided data on household composition, income, and fuelwood consumption.[10] A limitation of this study was that the data was not clearly disaggregated by ecological region and may have been influenced by data from the lowland Terai area.

One of the statistical findings was that fuelwood consumption per capita increased with income when the growth of income was due to increased farm assets (land and livestock): a 100% rise in income resulted in a 37% rise in fuelwood collection. However, if the growth in household income was due to education or nonfarm assets, per capita fuelwood consumption fell slightly (6%). This again supports the conclusion that the main drivers of forest degradation are farming and population pressure. Another source of the demand for fuelwood, mainly along trekking routes, is tea lodges and hotels (Chaudhary et al. 2016).

Although with a weaker empirical basis, Rimal et al. (2014) presented some rather different findings from those of Bhattarai et al. (2009) and Baland et al. (2011). Based mainly on the views of rural people and key informants, they proposed that fire was the most important driver of both D&D in hill/mountain areas. This study also found that unsustainable wood product harvesting was a major anthropogenic driver of forest degradation in the hills, and that overgrazing and overharvesting of NTFPs were key drivers of degradation in higher altitude areas.

Rimal et al. (2014) also proposed that deforestation was driven by a combination of infrastructure development, resettlement, urban expansion, and agriculture in the lower-altitude hilly areas (specifically the Siwalik hills), and that these drivers became progressively less important as the altitude increased. This study also noted from case studies that some agricultural tracts in hill/mountain areas were being 'de-intensified' or even abandoned due to challenges faced by rainfed agriculture (such as erratic rainfall patterns) and were reverting to secondary forest regrowth or bush. It is therefore possible that subsistence agriculture as a D&D driver could be weakening over time in some areas, but this is a tenuous proposition as the case studies may be unrepresentative.

Various studies have tried to assess the impact of community forestry or, conversely, of the lack of collective action on D&D rates and drivers. The development of community forestry and FUGs in Nepal since 1978 is generally associated with an increase in forest area; for example, a study of 15 hill districts over a 14-year period revealed a 21% increase in biomass due to a combination of community forestry, forest restoration, and plantations (LFP 2010). A study of established FUGs found that setting up a FUG could be expected to reduce fuelwood collection by 10%–15% (Edmonds 2002). But more recent analysis seems to cast doubt on the positive environmental impacts of community forestry: Rimal et al. (2014) reported that forested areas in the midhills had declined over the last

[9] The loss of forests due to riverine flows has also been identified by other sources, such as Quincey et al. (2006), from satellite imagery.
[10] This paper also analysed forest degradation in the Indian Himalaya.

three decades, and noted the 'speculation' that much of this was due to unregulated roads built by village development committees.

Other studies (for example, Malla 2001) have highlighted problems pertaining to elite capture, governance, and gender equity among FUGs. Paudel et al. (2013) point to regulatory and policy problems that have reduced the incentives for sustainable forest management (SFM) by FUGs, especially the transaction costs imposed by the discretionary power of forest authorities and restrictions on timber trading that have reduced the forest stumpage value. Together with the poor management of state forests, this has caused a scarcity of timber that has stimulated illegal logging and trade.

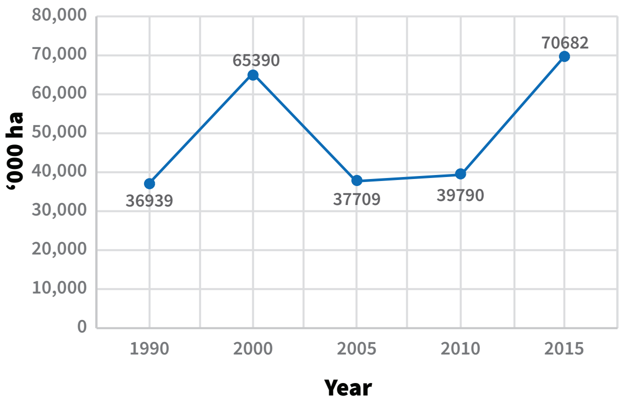
An increasingly important driver of deforestation is hydropower projects, which received a boost when the 2013 National Energy Strategy of Nepal waived the requirement for environmental impact assessments (EIAs) for such projects, another example of how policy failure has helped drive D&D. One common direct driver that is notably absent or of low significance in Nepal compared to some other countries in the region is commercial agriculture. This is because Nepal does not export agricultural commodities to any significant degree (Paudel et al. 2013).

Finally, single-event disasters can significantly affect forest cover, for example, the 2015 earthquake resulted is an estimated 2.2% loss of forest cover in six districts of Nepal according to Chaudhary et al. 2016.

4.2 India

Forest cover in India as a whole fluctuated between 1990 and 2005, but has increased significantly since 2005 (Figure 2) so that by 2015, forest cover was 24% of the country's land area. Forest Survey of India data shows that of the five main Himalayan states, Mizoram was the only one with a significant rate of deforestation

FIGURE 2 **FOREST COVER IN INDIA, 1990–2015**



Source: FAO (2015b)

(0.65% per annum between 2009 and 2017), while in Himachal Pradesh, forest area increased over this period (FSI 2017) (Table 3).

An indicator of forest degradation is provided by the proportion of open forest area to the total forest area; it was about two-thirds in Mizoram, a third in Himachal Pradesh, a quarter in Uttarakhand, and over a fifth in Arunachal Pradesh and Sikkim. These proportions have not worsened noticeably since 2009 except in Uttarakhand. This data, as well as various other studies discussed below, indicates that forest degradation is the main problem in the Indian Himalaya.

According to Baland et al. (2011), the main drivers of forest degradation in remote, upland areas of Himachal Pradesh and Uttarakhand have been unsustainable fuelwood and fodder collection. This was based on a statistical analysis of household surveys conducted in 2002–2003 and detailed on-the-ground data collected from randomly selected 'transects' on forest quality, structure, species composition, and management practices, such as the lopping percentage (how much of the tree trunk was lopped for fuelwood and fodder). The transects revealed that the main direct drivers of

TABLE 3 **CHANGES IN FOREST AREA AND PROPORTION OF OPEN FOREST IN FIVE INDIAN STATES, 2009–2017**

	Forest area, 2009 (sq. km)	Forest area, 2017 (sq. km)	Annual change in area, 2009–2017 (%)	Open forest as a share of forest area, 2009 (%)	Open forest as a share of forest area, 2017 (%)
Arunachal Pradesh	67,484	66,694	-0.15	22.3	22.9
Himachal Pradesh	14,668	15,100	0.37	34.4	35.0
Mizoram	19,183	18,186	-0.65	67.2	67.1
Sikkim	3,359	3,344	-0.06	20.8	20.6
Uttarakhand	24,495	24,295	-0.10	22.7	26.5

Source: FSI (2017)

forest degradation in these more remote areas were the demand for fuelwood (about nine times higher than timber for house/shed construction), grazing, and fires. Meanwhile, most agricultural expansion took place in the nonforested commons, and was therefore not a major driver of deforestation.

It was also found that the demand for fuelwood was inelastic to per capita income; thus per capita fuelwood consumption was not higher for wealthier households. Unlike in Nepal, fuelwood consumption did not vary according to the cause (farm growth, off-farm income, or education) of the increase in household income. Baland et al. (2011) therefore concluded that population growth was the main indirect driver of forest degradation. Evidence that in some areas the demand for fuelwood is still high comes from a survey of 400 households in Uttarakhand (Germain et al. 2017), which revealed that forests are not meeting basic fuel and fodder needs. Another factor is altitude (or temperature): per capita consumption of fuelwood at altitudes of over 2,000 masl can be 2–3 times higher than per capita consumption at altitudes under 500 masl. On the other hand, it has been observed that Uttarakhand has been undergoing a process of depopulation in some areas, which complicates the analysis.

Another finding of Baland et al. (2011) was that lopping rates and fuelwood collection were significantly higher in villages without van panchayats (VPs). This confirmed a widely-held hypothesis – also previously reported by Somanathan et al. (2009) – that community forestry (or VP-managed forests) was more effective and efficient than state forests as regards to forest management and conservation.[11] It was therefore concluded that the lack of collective action was another important indirect driver of forest degradation. Since villagers practised sustainable management practices on their private land, this lack of collective action was not due to a lack of knowledge, and there were many examples of collective action in other areas, such as agricultural credit and by women's groups. Uttarakhand in particular has a large number of forest committees operating under the VPs. The explanation of Baland et al. (2011) was that, due to a low opportunity cost of labour, spending more time collecting fuelwood and fodder had little impact on the household economy, and therefore the incentive for collective action was relatively low.

However, the impact of collective action or the VPs on forest degradation is more nuanced than this. Partly to counter forest degradation, the government of India doubled the number of VPs managing forest areas (from 6,000 to 12,089) between 2002 and 2013, but there was a difference between newer and older VPs: the newer VPs generally had poorer quality forest, and therefore less incentive for SFM (Baland et al. 2011).

A more recent source (Nagahama et al. 2016) has observed that the managerial autonomy of VPs has declined over time as the Forest Department increased its control over the levels of timber and NTFP harvest and sale. This resulted in increased intracommunity clashes of interest and reduced the regulatory power and influence of the VP. It also led to increased illegal logging and other forms of encroachment. Weak transparency and accountability, elite capture, and a lack of gender inclusiveness were also found to be prevalent among VPs. Therefore, as in Nepal, policy gaps and weak governance have contributed to less effective collective action.

A recent literature review of the drivers of forest degradation in Uttarakhand (Ranjan 2018) also sheds light on the role of collective action. It describes a complex relationship between population pressure, ineffective VP management, the changing composition of tree species with pine replacing oak in degraded forests, and fire, the main direct driver. Oak trees are better able to meet household needs than pine. Although pine forest is naturally more resistant to fire than oak, a study of forest fires between 1998 and 2012 found that 46% of fires were in pine-dominated forest and 34% in oak-dominated forest (Verma 2017). Ranjan (2018) concluded that SFM regimes are only possible with lower population pressures; above a certain population pressure, it is difficult to meet household fuelwood and fodder within an SFM regime. But even with SFM practices, oak forests will continue to degrade due to droughts and higher temperatures associated with global warming.

A recent analysis of D&D drivers in Mizoram, based on a household survey[12] (of land use, fuelwood consumption, and other factors) and discussions with key informants (Forest Department staff and village council members), found that shifting cultivation was the main direct driver of forest degradation,[13] with 70% of the population involved in it. The main indirect drivers were population pressure, unemployment,

[11] According to Somanathan et al. (2009), the cost of state forest management in Uttarakhand was seven times higher than under a VP regime, and with no significant difference in forest degradation.
[12] The survey was conducted in six villages of Mamit district located at an altitude range of 479–1,265 masl. It therefore covered a relatively low-altitude area compared to some of the other Himalayan regions studied.
[13] The study seemed to focus on forest degradation as the main problem, but there was no explicit differentiation between the drivers of forest degradation and deforestation.

and road connectivity (Rawat et al. 2017). The *State of Forest Report 2017* also reported that shifting cultivation was the main cause of forest loss, together with 'developmental activities',[14] in the states of Mizoram and Arunachal Pradesh (FSI 2017).

The normal pattern of shifting cultivation is that – after forest clearance and the extraction of valuable forest products – the land is cultivated for 4–5 years (mainly with rice, turmeric, oil palm, orange, banana, ginger, and vegetables) and then abandoned, which then often reverts to pioneer *Euphorbiaceous* scrub. This system responds to the high demand for forest products, especially fuelwood (82% of households in Mizoram relied on it for heating), fodder, and timber for housing.

The policy response to shifting cultivation has itself become a key D&D driver in northeastern India, including in Mizoram and Arunachal Pradesh (Pant et al. 2018). One key effect of government programmes trying to replace shifting cultivation with permanent agriculture has been the erosion of traditional or customary institutions and norms, such as benefit-sharing frameworks, resulting in elite capture and the breakdown of quite sustainable natural resource management systems. In effect, policy gaps have given rise to a lack of cooperation and convergence among various institutions and departments (Pant et al. 2018).

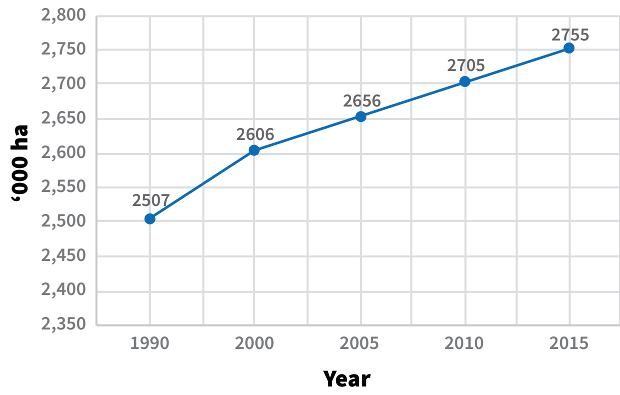
In more intact forest, the collection of NTFPs and illegal hunting were important factors; the time spent collecting medicinal plants and other NTFPs for sale in nearby urban markets has increased over time in response to their increasing scarcity and value (Rawat et al. 2017).

4.3 Bhutan

The drivers of D&D in Bhutan were comprehensively reported by WMD (2017).[15] This study is based on land use change maps derived from satellite imagery, government statistics, and key informant or stakeholder consultations. Bhutan has the strongest environmental policies of the countries in the Himalayan region; just over half the country is under protected areas. The forest area has increased from 2.61 million ha in 2000 to 2.7 million ha in 2015 (Figure 3), partly due to extensive regrowth of deforested areas (Gilani et al. 2014), so that by 2015, the forest cover was 71% (FAO 2015b).

This situation makes it essential to distinguish between gross and net deforestation when analysing D&D drivers; for example, according to satellite imagery,

FIGURE 3 **FOREST COVER IN BHUTAN, 1990–2015**



Source: FAO (2015b)

while 36,298 ha, or 57%, of gross deforestation over 2000–2015 was due to agriculture, 24,631 ha of farmland was converted back to forest, so that annual net deforestation due to agriculture was 778 ha. About 42% of gross deforestation took place at an altitude of 1,000–2,000 masl, and 28% of it in areas above 2,000 masl (WMD 2017).

Based on a spatial analysis and governmental statistical records over 2000–2015, the main drivers identified were 'State Reserve Forest Land allotment',[16] followed by hydropower (which provides over 99% of Bhutan's electricity), roads, agriculture, mining and quarrying, and power lines. The overlaps in this system of classification made it difficult to rank the importance of agriculture in particular. Roads constituted the most important indirect driver – 58% of deforestation and 32% of forest degradation was within 1 kilometre (km) of the nearest road.

This analysis was confirmed by stakeholder consultations which ranked current drivers of deforestation in the following order: roads, hydropower projects, transmissions lines, and the 'State Reserve Forest Land allotment'. Agriculture was not explicitly included. However, when asked about future drivers of deforestation, the order of ranking was: 'State Reserve Forest Land allotment'; roads and mining (equal scores), agriculture, including commercial agriculture; hydropower and power lines (equal scores). Hydropower, roads, mining, and power lines will continue to be important drivers in accordance with national economic development plans.

As regards forest degradation, gross degradation over 2000–2015 was 667,800 ha, but due to forest restoration and improvement, net degradation was over that

[14] The report also identified developmental activities as the main cause of forest loss in Sikkim, and, together with 'rotational felling', in Uttarakhand.
[15] Much of the data and analysis in this section are based on WMD (2017). No other reports of D&D drivers in Bhutan were identified.
[16] Confusingly, this includes allocation of land for agriculture, hydropower, and mining/quarrying, but excludes allocation for roads and transmissions lines (WMD 2017).

period was only 210,886 ha. About 17% of gross forest degradation was at 1,000–2,000 masl, 34% between 2,000 and 3,000 masl, and 31% above 3,000 masl. The main direct drivers of forest degradation, estimated from national statistics and spatial analysis, were as follows: timber/wood harvesting, including for communities in protected areas to meet their timber entitlements for construction; fire (especially in pine and oak forests); and localised livestock grazing (though in general the grazing density was insufficient to cause significant degradation). Stakeholder consultation workshops resulted in a very similar ranking order.

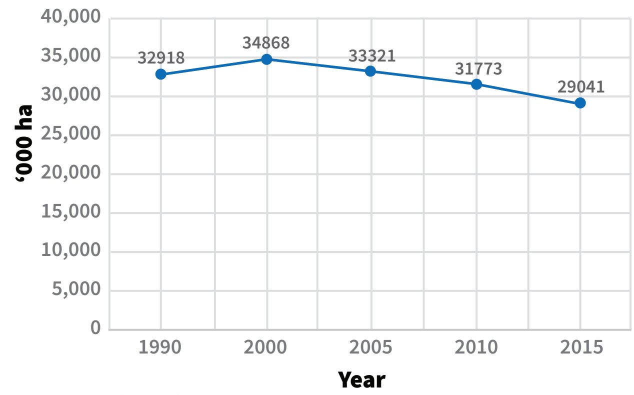
The main indirect drivers of D&D identified by key informants and a literature review (contained in WMD 2017) were: the weak scientific basis of decision-making for 'State Reserve Forest Land allotment'; hydropower project commitments; capacity constraints (this referred mainly to the capacity to implement policies, and included levels of human resources technical knowledge and management capacity); the unsustainable, rural subsidised timber allotment; and the failure to mainstream climate change in development planning. Given that 40% of gross degradation over 2000–2015 took place in protected areas, another indirect driver (although not prioritised by key informants) has been the poor management of protected areas.

In Bhutan, population pressure is not a driver; in fact, the inverse is the case since the demographic process favours forests. The annual rate of rural to urban migration of about 3.7% has resulted in declining fuelwood extraction and grazing densities, and the abandonment of some farming areas, which have reverted to juniper forest (WMD 2017). This is where it is vital to distinguish gross and net degradation: if only the former is considered, population would be regarded a key indirect driver as half the gross degradation was within 2 km of a human settlement. But in overall or 'net' terms, the declining population in forested areas is probably the main factor behind the net increase in the national forest area.

4.4 Myanmar

Myanmar is often referred to as one of the most forested countries in the world, but its national forest cover has declined from 51% in 2000 to 43% in 2015 (FAO 2015b). Figure 4 shows Myanmar's forested area from 1990 to 2015. Its rate of deforestation during 2010–2015 was 1.7% per annum, the third-highest in the world. Outside the Permanent Forest Estate, it was 2.4% (Kissinger 2017). But there is considerable variation

FIGURE 4 **FOREST COVER IN MYANMAR, 1990–2015**



Source: FAO (2015b)

and controversy regarding its deforestation data and estimates. For example, according to government data, the rates of deforestation are quite low in the northern and more hilly or mountainous states (Kachin, Sagaing, Shan, and Chin) and in the southern mountain state of Tanintharyi, but this claim is contradicted by recent independent studies (Bhagwat et al. 2017; Treue et al. 2016).

Using Landsat satellite imagery, Bhagwat et al. (2017) assessed the spatial distribution of 'intact forest' in Myanmar over 2002–2014.[17] In 2014, over 70% of the 'intact forest' was in the four northern mountain states, and especially in the 'northern forest complex' of over six million ha in northern Sagaing and Kachin states. This area has survived mainly due to its isolation and inaccessibility, but other tracts that were intact forest areas in 2002 have fared less well. This study identified nine 'hotspots' of intact forest loss, four in Kachin State, two in Sagaing State, two in Tanintharyi State and one in Chin State. The largest overall loss, in absolute terms, occurred in Shan and Sagaing states.

Bhagwat et al. (2017) identified agriculture as the main driver of deforestation. This study found that the hotspots of deforestation were mainly in already fragmented areas that were subject to high agricultural pressures; these involved both shifting cultivation and permanent agriculture, including clearance for rubber plantations in Kachin and Shan states. This has been encouraged by the National Plan for Rubber Planting & Production (2014–2030) which aims for an annual production of 300,000 tonnes by 2030. Rubber plantations have also been promoted in border areas of Kachin and Shan states as an alternative to growing opium poppy, catalysed by the demand for tyres from China's car-manufacturing industry, and by roads; much of the rubber expansion in northern Shan State

[17] In an expert workshop conducted in 2015, 'intact forest' was defined as that with over 80% canopy cover. 'Degraded forest' was defined as that with 10%–80% canopy cover. This was because 'most degraded' or 'open canopy' forest according to the FAO definition (10%–40% crown cover) had been replaced by agriculture and it would be misleading to consider it as degraded forest with a potential future forest use.

is along the Burma Road from Lashio to the Chinese border (Treue et al. 2016). Rubber plantations also tend to be accompanied by 'rubber plantation villages' composed of migrant labour, resulting in additional subsistence farming pressures. Kissinger (2017) also noted the importance of maize production via contract farming in Shan State, mainly to supply China.

Timber is a major secondary or sometimes primary driver in clearance for agribusiness concessions (including rubber). A significant proportion of the area officially cleared to establish 'agribusiness' plantations remains unplanted; the real motive is to extract high-value timber, mainly for export to China. Much of it is overland and therefore illegal (Woods 2015), since only timber by sea is legal in Myanmar (EIA 2015). Surface mining is another, increasingly important driver of deforestation in Kachin and Sagaing states. Over 2002–2014, the area under mining increased by 142% in Kachin State and by 744% in Sagaing State (Treue et al. 2016); much of this has been along the rivers, thereby maximising environmental damage.

Other drivers of deforestation of increasing importance are hydropower, transmission power lines and oil/gas pipelines. There were 34 government-approved hydropower projects, mainly in Kachin and Shan states. Transmission lines of a Myanmar–Thailand power project have caused deforestation along the eastern border of Shan and Kachin states, including in areas that have land conflicts with ethnic groups (Kissinger 2017). The main drivers of forest degradation[18] identified by Bhagwat et al. (2017), Myint (2017), and others were logging (high grading) and fuelwood. Only Myint (2017) emphasised fire as a direct driver.

Underlying these direct D&D drivers, the following main indirect drivers have been identified (Kissinger 2017; Treue et al. 2016), most of them interlinked and all involving an element of policy or governance failure:

- Corruption and illegality in the timber sector: Over 2011–2016, about a thousand Forest Department staff were fired for being involved in illegal logging. Many of the problems stem from governance and patronage issues in the state-owned Myanma Timber Enterprise, in coordination with 'crony companies' which has resulted in the systematic overharvesting of high-value timber, especially teak. The Forest Department being 'disempowered' and 'demoralised' (Treue et al 2016, p.26) has resulted in an unregulated and mainly illegal domestic timber supply. Nongovernmental organisations (NGOs) also complain of low transparency, for example, in forest revenue collection.
- The massive demand for forest and agricultural products from China, and to a lesser extent from India, the two most populated countries in the world: The very strong demand from China for 'hongmu' (redwood) is probably the main indirect driver of forest degradation through high grading in Kachin and Sagaing states. Most of this timber is illegally exported to China (see Box 1). China's demand for rubber (from Kachin and Shan states) and maize (from Shan State) has also been a key driver of deforestation in the region. China's demand for charcoal is another strong driver of degradation. In the case of India, Myanmar has been reported as the second largest supplier of its imports of beans and pulses, and timber and wood articles have been 'another important component of Myanmar's exports to India.'[19]
- Conflicting and overlapping priorities of the agricultural and forestry sectors: For example, the National Forest Master Plan 2001–2030 aims to convert 4 million ha of 'wasteland' to private sector agriculture, but much of this is forested. There are also significant forest areas under customary use or of unclarified tenure. Meanwhile Myanmar's *Intended Nationally Determined Contribution–INDC,* submitted to the UNFCCC, aims to increase protected areas from 25% to 30% of the nation's area.
- Insecure land and tree tenure for local people, which has facilitated a form of 'land grabbing' through the state allocation of agricultural concessions to the private sector. The 2012 Farmland Law (Pyidaungsu Hluttaw Law No. II of 2012) grants farmland cultivation rights to households that are able to obtain land use certificates (LUCs). But due to the high transaction costs involved, only 15% of households had obtained LUCs by 2017, and much of the land has been declared as 'vacant', 'fallow', or 'virgin' and therefore eligible for agricultural concessions, leading to confiscation of the land from smallholders.
- The lack of a land use policy,[20] resulting in the uncontrolled allocation and expansion of agricultural concessions (the extension of existing plantations along roads and rivers in Kachin State) (Treue et al. 2016).
- Complex conflict situations in border upland areas involving ethnic insurgency groups: For example, in Kachin State, local political elites and armed

[18] Deforestation and forest degradation were not clearly differentiated by Bhagwat et al. (2017) and other studies such as Treue et al. (2016). Kissinger (2017) noted that there is limited data on, and understanding of forest degradation in Myanmar.
[19] https://thekootneeti.in/2020/09/03/india-myanmar-commercial-relations/
[20] A comprehensive and extensive multistakeholder consultation process on land use planning had been held over 2012–2016, but Kissinger (2017) notes that the capacity to bring social and environmental issues into decision-making is still regarded as weak.

Box 1: China's demand for redwood and charcoal

The main indirect driver of forest degradation in northern Myanmar is China's demand for high-value timber and charcoal, combined with policy/governance failures, resulting in a hugely valuable and illegal cross-border trade of these products. Having long exhausted its own natural forest supply of hongmu (redwood), China relies mainly on Myanmar and other countries of the Mekong (and increasingly on Africa) to meet its almost insatiable demand: Hongmu furniture is seen as an integral part of Chinese culture. The most sought-after species in Myanmar are the increasingly scarce padauk (Pterocarpus macrocarpus) and tamalan (Dalbergia oliveri).

According to internationally reported trade data, China imported 624,000 cubic metres (m^3) of hardwood timber from Myanmar worth about USD $737 million over 2000–2013. But research by the Environmental Investigation Agency reveals that about 10 million m^3 of logs from Myanmar were illegally exported to China over the same period (EIA 2015). In 2013, Myanmar supplied an estimated 39% of China's hardwood timber imports by volume, an increase of about 50% from 2012. Other research found that, while only timber exported from Yangon port is legal, 94% of China's timber imports by volume and all of its charcoal imports from Myanmar in 2013 entered overland and were registered in Kunming customs district (Richer 2014). Interviews with timber traders also revealed that timber supplies close to the China border were exhausted, so that loggers and traders were having to go deeper into forest areas; this has resulted in increased timber flows through Kachin State from Sagaing Division, a prime source of tamalan and Shan State, a major source of teak (Treue et al. 2016).

Myanmar has also become one of the world's biggest exporters of fuelwood and charcoal; in 2014, it supplied an estimated 2.8% of the world's total export value of these products (Kissinger 2017). Again, the main demand is from China, which uses charcoal in smelting in its silicon metal industry: in 2013, charcoal exports made up 32% of Myanmar's wood product exports by value to China (Richer 2014).

ethnic groups control the expansion of agribusiness, sometimes in combination with Chinese investors who have facilitated timber exports across the border into Yunnan (Woods 2015).

- Lack of empowerment of community forestry enterprises, including their being allocated degraded forest of low economic value.

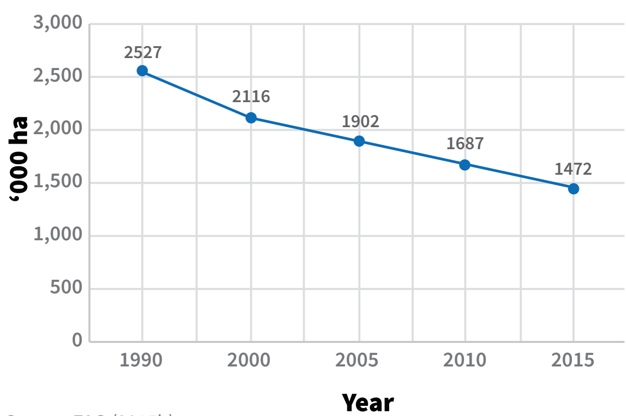
Policy and governance issues were also prominent in another recent study (Banikoi et al. 2019), with a focus on teak production. The key challenges to sustainable teak management include illegal logging and the illegal timber trade; barriers in the 'institutional environment and value chain governance'; the state monopoly of the timber trade; political/ethnic conflicts; and the low investment in community forestry and smallholder teak plantations.

4.5 Pakistan

As in some other countries in the region, estimates of forest cover and deforestation in Pakistan are a source of contention. According to FAO (2015b), forest cover in Pakistan in 2015 was 1.9% and has been in sharp decline (Figure 5). But another source, the *Land Cover Atlas of Pakistan* (FAO et al. 2017, has estimated Pakistan's forest cover at 5.1%.

The so-called Western Himalaya forest (including the Hindu Kush) of northern Pakistan is located mainly in the province of Khyber Pakhtunkhwa, the administrative region of Gilgit–Baltistan, and Azad Jammu and Kashmir (Qamer et al. 2016). While this area comprises just under a quarter of Pakistan's landmass, it contains two-thirds of its forested area. The significance of the Himalayan region of Pakistan in the context of this literature review is that most recent studies of D&D drivers have been in the eastern rather than Western Himalaya, and the former appears to have followed a different dynamic from the western Himalayan countries. For example, forest loss in the

FIGURE 5 **FOREST COVER IN PAKISTAN, 1990–2015**



Source: FAO (2015b)

Western Himalaya was faster and more damaging than in the eastern Himalaya during the last quarter of the twentieth century, according to spatial analysis (Joshi et al. 2001).

However official estimates of deforestation in Pakistan have been controversial. Qamer et al. (2016) have observed that it is difficult to measure deforestation in Pakistan, pointing out errors in previous studies due to limited data availability, unclear definitions, and problems with the interpretation of images. Such errors led to the Government of Pakistan and NGOs reporting a deforestation rate of 2% per annum, the second highest in the world at one point (Ali et al. 2005).

However, some contextually specific examples show that such a high deforestation rate is plausible. For example, almost half the forested area of Siran Valley was lost over 1979–1988 due to an Afghan resettlement programme (Lodhi et al. 1998). And in the Basho Valley, about half the forest cover was lost between 1968 and 2002 due to a combination of mainly illegal felling for government construction (including for bridges), 'legalised' commercial logging, and political and governance issues. In Basho Valley, while timber extraction to meet government building needs was banned in 1987, large-scale logging continued through a 'mafia' of timber contractors and government officials, who provided Forest Department 'chits' to the contractors. Since the chits were not official permits, there were no records. When local people saw contractors cutting down valuable timber, they too started cutting standing trees for fuelwood, driven by harsh living conditions and high poverty (Ali et al. 2005).

Spatial analysis by Qamer et al. (2016) found that forest loss was 0.38% per annum during 1990–2010, and that the deforestation rate during 2000–2010 was significantly higher than during the previous decade, 1990–2000. The main D&D drivers in Khyber Pakhtunkhwa – where the deforestation rate was the highest of the three areas (0.42% per year) – were identified as fuelwood collection and commercial logging. Population pressure was the main indirect driver for fuelwood collection. The logging was being mainly driven by security issues on the province's western border, specifically by a nexus of the timber mafia and combatant groups, and forest clearances by security forces for tactical reasons (Shah 2012). Fuelwood collection and population were also important factors in Azad Jammu and Kashmir, but in the absence of large-scale logging, the deforestation rate here was much lower, 0.13% per annum. Agriculture may not be as important a driver in this region as in the eastern Himalaya; the agricultural area, found mainly at lower altitudes (below 2,000 masl), declined by 30% from 1990 to 2010, principally due more intensive farming as a result of the development of irrigation and the simultaneous abandonment of some rainfed agricultural areas (Qamer et al. 2016).

A number of other authors have identified policy and governance failures as the main indirect D&D drivers: for instance, Gohar (2002) reported that deforestation in the Darel, Tangir, and Chilas valleys was mainly due to difficulty of road access, sectarian disputes, and mismanagement by the Forest Department; when the Forest Department took over management of these areas in 1951, loggers were given a free hand, helped by the Karakorum Highway linking Pakistan and China. Ali et al. (2005) argued that deforestation was mainly due to poor management by the government and commercial/illegal logging. Khan and Khan (2009) stated that one of the main problems has been the disconnect between de jure and de facto tenurial rights. Finally, Pellegrini (2016) identified institutional problems and poor state forest management as the main causes of deforestation in northern Pakistan.

4.6 Afghanistan

The Afghanistan Country Report of the 2015 *Global Forest Resources Assessment* (FAO 2015a) did not contain estimates of forest cover or of the rate of deforestation due to the lack of reliable data; according to official data, national forest cover has remained at 2.1% since 1990. FAO (2015a) commented however that Afghanistan has undergone 'massive reforestation', and cited a 'post-conflict assessment' report by the United Nations Environment Programme which estimated that 50%–80% of Afghanistan's forests were lost between 1977 and 2002 (UNEP 2003). Rapid deforestation has continued in the current century according to qualitative accounts, though no empirical studies were identified. According to Sadeq (2015), Afghanistan has lost over 70% of its forests 'in the last two decades of war', and the eastern province of Nangarhar has lost about 90% of its forest since 1989. A more recent report (Zarifi 2018) describes uncontrolled illegal logging in the northeastern state of Kunar.

A list of D&D drivers, although without any empirical analysis, was presented by Sadeq (2015):

1. **Smuggling and illegal activities:** The police and military were suspected of heavy involvement in an illegal logging 'mafia'. After logging, the timber (mainly pine and spruce) was transported across the border to Pakistan for processing into furniture. Local people participated in the illegal logging due to the lack of alternative livelihood and income sources.
2. **War:** Afghanistan has been more or less in a continuous state of war since the Soviet invasion in 1979. Various armies have inflicted major forest damage, sometimes to unearth hiding places for

ambushes, and uncontrolled forest fires have often followed battles. The Taliban has also used a ‘scorched earth’ policy. The state of war has made it very difficult for the government to control illegal logging. Zarifi (2018) also reported that insurgent groups like ISIS were receiving money from the illegal sale of timber.

3. **Fuelwood demand:** Afghanistan’s electric power infrastructure is in a poor state and most of Afghanistan’s population depends on fuelwood for energy.
4. Agriculture (no details provided).
5. **Migration to forest areas:** ‘As living resources get less and less, people are moving in and settling in forest areas’ (Sadeq 2015, p. 7).

4.7 Tibet Autonomous Region, China

There is also very limited information on D&D drivers in the Himalayan region of China, the Tibet Autonomous Region (TAR), due to a ban on external research. The only available source was two reports of the Central Tibetan Administration (CTA 2007, 2013) which is based in India and has an explicitly political standpoint and mission[21]. Although the information in these reports is presented in a popular, nonscientific way, and is highly qualitative, they do provide some clues about the likely main drivers of D&D in the TAR and how they have changed over time.

According to CTA (2007), during the second half of the twentieth century, the TAR’s forests were viewed by Beijing as a resource to be mined – whole valleys were clear-felled with chainsaws, and that mining, mainly for gold and silver, took place on multiple scales, especially in areas opened up by the Gormo–Lhasa railway line built through areas with the richest mineral deposits in the TAR. Extensive road and rail expansion in the 1970s and 1980s were clearly major (direct and indirect) D&D drivers, facilitating mining, logging, and dam-building, as well as large-scale harvesting of wild medicinal herbs. The Siling–Lhasa highway is also reported to have had a major deforestation impact, including in areas with permafrost. In 1998 however, the soil erosion caused by D&D contributed to disastrous floods when the Yangtze River burst its banks; the enormous social and economic costs of this disaster resulted in an abrupt change of policy towards forest conservation and reforestation.

However, it appears that the overharvesting of valuable NTFPs, such as caterpillar fungus (Cordyceps sinesis) and matsutake mushrooms (Tricholoma matsutake) continued to be a significant driver of degradation, although much of it takes place in the grasslands. Governance failure has been an important indirect driver of NTFP extraction: it was common for local officials to take bribes from outsiders who were extracting NTFP, and this resulted in conflicts with the local population (CTA 2007). It is unclear how much NTFP extraction continues, at least of these two products.

Another driver was illegal logging – one strategy used by loggers was to start fires that killed the trees but did not burn the trunks. The trees would then be erroneously declared as valueless, making it legal to harvest them.

4.8 Regional Himalayan study

Brandt et al. (2017) used a matching methods approach[22] to analyse how national forest management regimes (policies, tenurial arrangements, and institutional factors) in five countries relate to deforestation rates in the Himalayan temperate forest zone. The study, which did not have an explicit focus on D&D drivers, found that countries prioritising protected areas and community forestry (such as Bhutan and Nepal) had lower rates of deforestation in unprotected areas. It observed that this reflected greater public support for conservation and better tenurial policies. The study also reported that Bhutan ranked the highest in terms of a set of international governance indicators[23] in the Himalayan region, and Myanmar the lowest.

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[21] According to Wikipedia (https://en.wikipedia.org/wiki/Central_Tibetan_Administration) the literal translation of the Tibetan for CTA is the ‘Tibetan People’s Exile Organisation’). It goes on to say that the CTA ‘is Tibet’s elected parliamentary government based in Dharamshala, India. It is also referred to as the Tibetan Government in Exile. Since its formation in 1959, the Central Tibetan Administration has not been recognised by China. The Tibetan diaspora and refugees support the Central Tibetan Administration by voting for members of Parliament, the President and by making annual financial contributions through the use of the “Green Book”. The Central Tibetan Administration also receives international support from organisations and individuals.’

[22] Matching methods is a statistical technique used to evaluate the effect of a treatment by comparing the treated and nontreated units in an observational study or quasi-experiment (i.e. when the treatment is not randomly assigned). The goal of matching is to reduce bias for the estimated treatment effect in an observational-data study, by finding, for every treated unit, one (or more) nontreated unit(s) with similar observable characteristics against who the covariates are balanced out. By matching treated units to similar nontreated units, matching enables a comparison of outcomes among treated and nontreated units to estimate the effect of the treatment reducing bias due to confounding. An approach to examining the effect of conservation policies is to isolate policy and management regime effects via quasiexperimental counter-factual matching analysis (Andam et al. 2008). Bias is controlled by matching treatments with controls. So-called treatment parcels (e.g., forested parcels under management regime A) are randomly selected and matched to so-called control parcels (e.g., forest parcels under regime B that are statistically similar in terms of their deforestation pressure to those under regime A). With the matched samples, it is possible to predict what outcomes would have been observed in forests under regime A had they been subject to regime B.

[23] These indicators are not discussed or presented by Brandt et al (2017) who merely state that they were developed by the Worldwide Governance Indicators project (Kaufmann et al. 2011).

SECTION V

Discussion: Narratives of D&D drivers

5.1 Introduction

Several main narratives of D&D drivers in the Himalayan region can be deduced from the main sources (summarised in Table 4) and the preceding country-by-country analysis. These narratives can be summarised as follows:

- Policy gaps and weak governance associated especially with unsustainable or illegal timber extraction, including the absence or ineffectiveness of collective action associated with community forestry management and the VP in India;
- The 'theory of Himalayan environmental degradation', mainly associated with subsistence agriculture, fuelwood collection, and population pressure;
- The increasing influence of climate change and 'natural' drivers; and
- Hydropower projects, mining, roads, and infrastructure development.

These narratives influence the mindsets of policy makers and carry major policy implications for tackling D&D. For example, when the theory of Himalayan environmental degradation is prevalent, the strategies or REDD+ policies and measures most likely to receive high-level political support are those that aim to reduce the use of fuelwood (for example, via the expansion of alternative renewable energy resources and improved cook stoves), increase farm productivity, or stimulate off-farm livelihoods, rather than tackle policy gaps and weak governance.

5.2 Policy gaps and weak governance

The dominant narrative from the literature is that policy and governance failures are the main indirect drivers of D&D. They take varied forms in the different Himalayan countries or regions. The main types or examples of governance and policy failures are the following:

- Illegal logging and corruption, often in contexts in which there is a conflict situation or there are security issues, in which there is a governance vacuum and insurgent groups are active, as found in Myanmar, Pakistan, and Afghanistan (Ali et al. 2005; Qamer et al. 2016; Sadeq 2015; Treue et al. 2016). These situations have usually involved powerful timber mafias that include senior government officials.
- Policy and legal frameworks that have prevented effective collective action or created a 'tragedy of the commons' situation. Several papers (Nagahama et al. 2016; Paudel 2013; Ranjan 2018; Rimal et al. 2014) show how a constrictive regulatory framework involving restrictions on the autonomy of community FUGs (in Nepal) and local government authorities (VP in India), including restrictions on the trade in forest products, have sapped economic incentives for SFM and reduced the checks on individual behaviour. The incentives are further weakened when degraded forest is allocated to communities (Baland et al. 2011). In northern India, policies and programmes to replace shifting cultivation with permanent agriculture have eroded traditional institutions of 'common resource management' and led to a 'tragedy of the commons' situation for forests (Pant et al. 2018). In another recent paper, Maraseni et al. (2019) also shed light on stakeholder perspectives of governance issues

TABLE 4 ANALYSIS OF RECENT STUDIES ON D&D DRIVERS IN THE HIMALAYA: A SYNTHESIS

Country and subregion	Source	Methodological basis and limitations	Time period of data analysis	Prioritization/narrative of D&D drivers	
				Deforestation	Forest degradation
Nepal: hills and mountains of the Central Development Region	Bhattarai et al. (2009)	Spatial analysis using satellite imagery, regression analysis	1975–2000	Agricultural expansion due to falling farm productivity; river erosion in areas at higher altitudes due to snowmelt/the monsoons	Subsistence agriculture (including grazing) Indirect drivers: population/human settlement; dependence on forest products
Nepal: hills and mountains of the Central Development Region	Bhattarai et al. (2009)	Spatial analysis using satellite imagery, regression analysis	1975–2000	Agricultural expansion due to falling farm productivity; river erosion in areas at higher altitudes due to snowmelt/the monsoons	Subsistence agriculture (including grazing) Indirect drivers: population/human settlement; dependence on forest products
Nepal: analysis is mainly at the national level, with limited distinction between mountain, hill and Terai areas	Paudel et al. (2013)	Literature review, qualitative approach. Sometimes unclear distinction with lowland areas	No primary data	Fire in higher areas; policy failures, for example, environmental impact assessment waived for hydropower projects	Mountain areas: grazing, NTFP harvesting, timber felling Indirect drivers: policy and governance failures. For example, weak SFM incentives for community forestry; poor management of state forests has led to illegal logging
Nepal: national scale, including central and western mountain and hill regions	Rimal et al. (2014)	Literature review, participatory rural appraisal, 'regional consultations', satellite data. Prioritised drivers not separated by geographical area	Participatory rural appraisal probably in 2013 or 2014	Fire, infrastructure, resettlement, urban expansion, and agriculture in some hill areas, but drivers weaken with altitude; fire, natural disasters in areas at higher altitudes	Fire, unsustainable harvesting, overgrazing, use of NTFPs in areas at higher altitudes Indirect drivers: mix of policy/governance failures; population/demand for forest products (but de-intensification or abandonment of some areas)
India: Himachal Pradesh and Uttarakhand	Baland et al. (2011)	Satellite imagery, statistical analysis of household survey and transects (covering forest quality/management) in remote villages	Satellite data: 2006 and 2009; transects and surveys: 2002–2003	Not analysed	Fuelwood, fodder, grazing Indirect drivers: population; low economic incentives for collective action due to low value of labour (opportunity cost)
India: Uttarakhand	Ranjan (2018)	Computer model of typical village in Uttarakhand developed from secondary data, literature review	No date given	Not analysed	Fire, overharvesting timber, the demand for fuelwood, fodder, and NTFPs Indirect drivers: population; governance failures in VP with higher population pressure
India: Mizoram (Mamit district)	Rawat et al. (2017)	Household survey and key informant interviews (with Forest Department officials and village council members). Based on perceptions; unclear differentiation of D&D	March 2017	Shifting cultivation (but deforestation not clearly differentiated)	Shifting cultivation, overharvesting fuelwood, the demand for fodder, timber, and NTFPs Indirect drivers: population; high dependence on forest products; unemployment; roads

Country and subregion	Source	Methodological basis and limitations	Time period of data analysis	Prioritization/narrative of D&D drivers	
				Deforestation	Forest degradation
Bhutan: national scale, mainly temperate forests	WMD (2017)	Satellite imagery, key informant interviews, literature review	Satellite data: 2000–2015	State Reserve Forest Land allotment (including for agriculture), hydropower, roads, agriculture (net), mining/ quarrying, power lines Indirect drivers: state policies on energy and infrastructure	Timber, fuelwood, forest fire, grazing Indirect drivers: demographic change favourable: urban migration causing farm abandonment, reduced grazing; poverty rate halved during 2007–2012
Myanmar: Shan State	Myint (2017)	Satellite imagery, socio-economic studies of villages in D&D hotspots. Shifting cultivation is included in deforestation	First half of 2017	Agricultural plantations, shifting cultivation, mining, infrastructure, including pipelines Indirect drivers: population and economic growth; weak law enforcement; poverty; conflicting policies	Timber, fuelwood, fire No separate analysis of indirect drivers for forest degradation
Myanmar: Kachin and Sagaing states	Treue et al. (2016)	Key informants, ground truthing (for example, visits to log depots), satellite data	Interviews and ground truthing: 2015; satellite data: 2002–2014	Commercial agriculture, mining, hydropower dams, infrastructure Indirect drivers: policy/governance failures; insecure tenure; roads	Not analysed separately
Myanmar: national scale, but some separate data on Himalayan states	Kissinger (2017)	Stakeholder/key informant interviews, literature review, spatial analysis	Probably 2016	Plantations (including rubber) following timber clear felling, mining, hydropower, infrastructure Indirect drivers: Policy/governance failures; insecure tenure; demand from China; roads; conflicts	Logging, charcoal, fuelwood Indirect drivers: policy/governance failures; China's demand for high-value timber, charcoal and food; roads
Myanmar: national scale, but significant focus on Himalayan states	Bhagwat et al. (2017)	Satellite imagery, literature review	Satellite data: 2002–2014	Commercial agriculture, timber clear felling, mining, infrastructure	Logging (high grading), fuelwood, shifting agriculture
Pakistan: Basho Valley, Gilgit–Baltistan Region, northern Pakistan	Ali et al. (2005)	Qualitative data, meetings and interviews including village workshops, satellite imagery	Data collected: 1996–2004	Illegal/commercial logging, fuelwood Indirect driver: policy and governance failure	Uncontrolled commercial/illegal logging, fuelwood, shifting cultivation Indirect driver: policy and governance failure
Pakistan: Western Himalayan region	Qamer et al. (2016)	Satellite data and expert/key informant interviews	Spatial analysis: 1990–2010	Logging by timber mafia Indirect drivers: governance failure; security issues; poor state forest management	Commercial timber, fuelwood Indirect drivers: policy and governance failures; population (secondary factor)
Himalaya forest biome: Bhutan, China, India, Myanmar, Nepal	Brandt et al. (2017)	Matching methods' analysis of national forest management regimes (policy, tenure, institutional factors)	Based on satellite data, 2000–2014	Not analysed	Indirect drivers: Policy gaps and weak governance; unclear tenure; lack of community forestry

for community forestry in India, Nepal, Myanmar, and Bhutan.

- Conflicting policies between different ministries for agriculture and the environment or forests, associated with the lack of a strong national land use policy in Myanmar (Kissinger 2017; Treue et al. 2016).
- Poor governance displayed in the allocation of agricultural concessions combined with insecure tenure of local forest landholders in northern Myanmar (Treue et al. 2016).
- The poor management of state forests has contributed to illegal logging in Pakistan and Nepal (Paudel et al. 2013; Qamer et al. 2016).
- 'Strategic' clearance of forests by the military to 'flush out' insurgent groups or eliminate potential spots for ambush in Pakistan, Afghanistan, and Nepal (Bhattarai et al. 2009; Sadeq 2015; Shah 2012).

This narrative is most dominant in Myanmar. For example, of the six indirect drivers of D&D prioritised by Treue et al. (2016), the first five had a very strong element of policy or governance failure: they include major institutional failures associated with illegality, conflicting sectoral land use policies, agri-business concessions that amount to land grabbing, and insecure land tenure. The main direct driver of forest degradation in northern Myanmar was logging for high-value timber species (or 'high grading') in order to supply the market in China (Bhagwat et al. 2017). Almost all of the timber and charcoal imported by China from Myanmar enters overland and is therefore illegal, and much of it comes from agribusiness concessions obtained under doubtful governance arrangements, and which are often abandoned after high grading or clear felling (Woods 2015). In general, the dominant narrative for northern Myanmar can be summed up as one of weak national governance combined with the very high demand for agricultural and forest products from China. The situation is even more complex in the conflict border regions.

By contrast, in Bhutan, the main reason for the lower rates of D&D has been its strong environmental policies and relatively good governance (Brandt et al. 2017). This is not to say that policy failure has been completely absent: weak decision-making underlay 'State Reserve Forest Land allotment', a high-priority indirect driver (WMD 2017).

5.3 The 'theory of Himalayan environmental degradation'

The 'theory of Himalayan environmental degradation' (Ives 1987) is that forest degradation is mainly caused by subsistence agriculture (including grazing, fodder collection, and shifting cultivation) and fuelwood collection, driven by population pressure, the main indirect driver. This was the dominant narrative in the literature during the second half of the twentieth century (Ali et al. 2005) and continues to be very prominent in Nepal (Acharya et al. 2011; Baland et al. 2011; Bhattarai et al. 2009; Paudel et al. 2013) and India (Baland et al. 2011; Ranjan 2018; Rawat et al. 2017). For example, it is clear that the sustainability of shifting cultivation, which is predominant in Mizoram, depends on the population pressure (Rawat et al. 2017). This driver can also be identified in the other Himalayan countries or regions, but is less dominant there.

Satellite data also seems to confirm that forest degradation and deforestation decreases with increasing altitude and declining population pressure (due to the lower accessibility, extreme cold, and general harshness of life in the mountains) (Bhattarai et al. 2009). On the other hand, the lower population pressure at higher altitudes does not necessarily translate into reduced pressure on forest resources since more, especially fodder and fuelwood, are needed to maintain a given farm area, livestock, and human population (due to the higher calorific requirements). There may also be forest degradation at higher altitudes due to the collection of NTFPs, and increased deforestation because of river erosion and/or hydropower projects.

There is also a linkage or downward spiral between forest degradation and deforestation: when farm productivity falls due to forest degradation (for example., due to reduced fodder availability), farmers are more likely to encroach into new forest areas (Bhattarai et al. 2009). But this does not mean that increased farm productivity (and income) will necessarily reduce pressure on forests: statistical analysis shows that per capita fuelwood consumption can be higher with higher farm incomes, at least in Nepal (Baland et al. 2011).

In contrast to Nepal and India, population was not identified as an indirect driver in Bhutan. This is because population pressure is declining in many temperate forest areas: forest cover and conditions have been favoured by urbanisation, which results in the abandonment of some farming areas and reduced grazing density (WMD 2017).

5.4 Climate change: An increasing influence

According to an international conference on Himalayan mountain forestry in 2015, mountain forests are 'in crisis, as evidenced by the increasing incidence of forest fires, drying springs, the scourge of invasive species, loss of biodiversity, and increasing human–wildlife conflict' (Kotru et al. 2015, p. 1). An emerging narrative is that climate change is altering the dynamics of D&D, including changing the balance between natural and anthropogenic drivers. The relative importance of fire as a direct D&D driver is probably increasing; for example, some of the studies from Nepal (Chaudhary et al. 2016; Rimal et al. 2014) list fire, rather than subsistence agriculture, as the most important direct driver of D&D in both hilly and mountain areas (but without much of an empirical basis).

One way in which climate change may be changing the dynamic of D&D drivers is through its effects on farming and demographics. For example, there have been increasing problems being faced by rainfed agriculture due to more uncertain rainfall patterns in some hill or mountain areas in Nepal. This has resulted in the 'de-intensification' or abandonment of farming areas, and in some cases urban migration (therefore representing a reduction in population pressure) (Rimal et al. 2014). Climate change can also strain the capacity of collective action to counteract D&D drivers: Droughts and higher temperatures in Uttarakhand, India have been resulting in the degradation of oak forests and their replacement by pine forests, which are less able to meet fodder and fuelwood needs (Ranjan 2018).

5.5 Increasing importance of hydropower projects, mining, roads, and infrastructure

Several sources point to the increasing importance of hydropower projects and mining as drivers of deforestation in mountain areas. All the countries have ambitious plans for hydropower project development, for example:

- In Myanmar, 34 hydropower projects have been approved, mainly in Kachin and Shan states (Kissinger 2017).
- In Bhutan, hydropower already provides almost all the nation's electricity and has a central role in the national economic development plan. Hydropower was rated as the second-most important driver for deforestation, and power lines (from hydro projects) were identified as another significant driver (WMD 2017).
- In India, a Rs 52.8 billion (US$ 724 million) investment was approved in early 2021 for developing a hydropower project on the Chenab river in Jammu and Kashmir (https://www.pinsentmasons.com/out-law/news/india_s-government-approves-$724m-hydropower-project).
- In Nepal, the 2013 National Energy Strategy of Nepal relaxed requirements for EIAs of hydropower projects (Paudel et al. 2013).

The increasing importance of mining as a driver is particularly noticeable in northern Myanmar: for example, the mining area of Sagaing State increased sevenfold from 2002 to 2014 (Treue et al. 2016). In Bhutan, key informants ranked mining as the fifth-most important driver of deforestation currently, but the second-most important, together with roads, in the future (WMD 2017).

5.6 Interacting drivers

As is the case with most approaches to classification, which involves elements of simplification and generalisation, any attempt to classify driver narratives is bound to be flawed because D&D drivers are complex and interact with each other, especially indirect drivers, as implied in the definition by Geist and Lambin (2002). As an example, the rapid growth of rubber plantations in Kachin and Shan states in northern Myanmar has been due to a combination of government policies that promote rubber production; weak governance in the allocation of agricultural concessions; insecure land tenure of smallholders, which facilitates 'land confiscation'; China's huge demand for rubber and high-value timber; road construction; and the search for alternatives to opium production in border conflict areas (Treue et al. 2016; Woods 2015). There is also often a cumulative or mushroom effect – one driver builds on another. A driver can also act both directly and indirectly at the same time. For example, mining is inevitably accompanied by human settlement, roads, and other infrastructure; in northern Myanmar, new rubber plantations have been followed by the establishment of 'rubber plantation villages' (Treue et al. 2016).

In sum, these narratives are likely to be present in most situations, but vary in their relative importance in each local context. There is therefore no substitute for a local contextual understanding of D&D drivers. In particular, the investigation of indirect drivers requires multilayered analysis using both quantitative techniques (such as multiple regression analysis) and qualitative methods, including political economy analysis.

SECTION VI

Conclusions

This literature review of the drivers of D&D in the Himalaya reveals a wide variation in the methods and rigour of analyses in the studies included. They ranged from those with a strong empirical basis derived from an analysis of satellite data and/or multiple regression analyses of statistically representative data to studies that rely mainly on key informant interviews, local stakeholder views, and secondary data. In this review, studies with a strong empirical basis are given precedence over more qualitative ones.

Also, in many cases, the analysis was insufficiently or not clearly disaggregated by eco-region, so it was not always clear whether the observations referred to the Himalayan temperate forests or included lower, subtropical forests, and whether they referred to high- or low-altitude areas. Some sources were also unclear in their distinction between drivers of D&D, which is especially important in the analysis of indirect drivers.

Notwithstanding these caveats, an initial conclusion is that in most of the Himalayan countries or regions, forest degradation is more important than deforestation (or has been until now), barring areas or countries impacted most by governance failure (Myanmar, Pakistan, and Afghanistan). This has often been associated with military conflict and the presence of insurgent groups. The TAR, China also underwent rapid deforestation, driven by development policies and poor governance in the last quarter of the twentieth century. This review identified several narratives, mainly around forest degradation:

- Policy or governance failure is the dominant overall narrative, except for Bhutan. It has been particularly prevalent in Pakistan, Afghanistan, and northern Myanmar. It has been the main cause of unsustainable logging in northern Myanmar, together with China's demand for timber. Policy or governance failures have also significantly constrained the effectiveness of collective action in counteracting D&D drivers.
- Some studies highlight the so-called 'theory of Himalayan environmental degradation' in which the direct drivers are subsistence agriculture (including shifting agriculture), livestock grazing, the demand for fuelwood and fodder and (subsistence) timber extraction, and the primary indirect driver is population pressure (thereby increasing the demand for forest products). While this narrative is relevant to all areas except possibly Bhutan, it is most strongly reported for Nepal and northern India; it also helps explain lower levels of forest degradation in areas at higher altitudes. In Bhutan, there has been a rapid process of urbanisation involving agricultural de-intensification or land abandonment, resulting in a considerable net increase in the forest area.
- The emerging role of climate change, which may be increasing the relative importance of fire as a direct driver. However, this is hard to substantiate from the literature. Climate change may also be contributing to agricultural de-intensification or abandonment of land in some areas.
- The increasing importance of hydropower projects and mining as drivers of deforestation, especially in Myanmar and Bhutan.
- In contrast to other areas or ecological zones, commercial agriculture has not been an important driver of D&D except in northern Myanmar where it has been driven by demand from China, and where the failure of governance has facilitated forest clearance for rubber and food crops.

- In many areas these narratives intersect in the form of complex and multilevel interactions of indirect and direct drivers (for example, population pressure and policy failure, or governance failure and international demand). This makes it a demanding area of research that requires both quantitative and qualitative research methods. The research methodology implications from this review are:
  - Spatial analysis using remote-sensing data is a vital starting point for identifying direct drivers, although the drivers of forest degradation are more difficult to identify from satellite images and more observations are needed.[24]
  - Statistical techniques using multiple regression analysis is important to establish an empirical basis for the analysis of indirect drivers. But it can also be quite challenging, due to, for example, interrelationships between explanatory variables (or 'multicollinearity').
  - Quantitative analysis should be complemented by higher-level policy and governance analysis, or what is sometimes called 'political economy analysis'.

[24] Although spatial analysis is constantly improving (for example, with the use of lidar and radar) so that forest density can more effectively analysed (Houghton 2012).

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The International Centre for Integrated Mountain Development (ICIMOD), is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalaya – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.

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