CONTRIBUTED PAPER

Half century of protected area dynamism in the country of Gross National Happiness, Bhutan

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Abstract
Bhutan is recognized for conservation success under its pro-environmental development philosophy Gross National Happiness (GNH). However, an increase in area coverage alone cannot track the true contribution of protected areas (PAs) to biodiversity conservation. Capturing PA dynamism by tracking PADDD (PA downgrading, downsizing, and degazettement) and gain events can be used as a more comprehensive evaluation method. Based on existing data, we tracked gain events, enacted and proposed PADDD events, proximate causes of PADDD, and gain and PADDD events trends in Bhutan from 1966 to 2016. We also compared PADDD events recorded in www.PADDDtracker.org with the primary data sourced for our study. We discussed the findings in light of four tenets of GNH: good governance, sustainable socioeconomic development, preservation, and promotion of culture, and environmental conservation. We identified 81 gain and 29 PADDD events. All 12 proposed policy downgrading events in 2004 were proximally caused by infrastructure development, while all degazettement (n = 6) in 1993 and all downsizing events (two in 1984 and one in 1993) were proximally caused by conservation planning. Overall the gain and PADDD events were episodic but policy downgrading events occurred only from 2002. Based on our country data, we recorded 4.8 times more PADDD events than was recorded in www.PADDDtracker.org where even some degazetted PAs were not recorded. All gain events and even PADDD events, excluding one enacted and 12 proposed policy downgrading events caused by hydropower projects were aimed to improve conservation thus aligning with tenets of GNH. However, as hydropower is the specific cause for all proposed PADDD, Bhutan should be concerned about PADDD. Our findings provide further evidence for the dynamic nature of PAs, the widespread nature of PADDD and difficulty in detecting it. Furthermore, they also suggest the need to conduct archival case studies to better detect PADDD and PA dynamism.

KEYWORDS
gain events, hydropower, pro-environmental development philosophy, protected area downgrading downsizing and degazettement, proximate causes
1 | INTRODUCTION

Bhutan recently celebrated half a century of modern conservation since the establishment of its first protected area (PA), the Manas Wildlife Sanctuary (Seeland, 1998). Since 1966, Bhutan has seen the designation of additional PAs in 1974 and 1984, an overhaul of the PA system in 1993 (Seeland, 1998), designation of 12 biological corridors in 1999, designation of Wangchuck Centennial National Park in 2008 (Wildlife Conservation Division [WCD], 2010), and declaration of three Ramsar sites (wetlands of international importance) since 2012 (Palden, 2016). Since then Bhutan has protected more than 50% of its land (Buckley, 2017; Dudley, 2016). However, the exact figure differs with official sources reporting 51.44% excluding Ramsar sites (National Biodiversity Centre [NBC], 2014; WCD, 2016), while the United Nations Environment Programme–World Conservation Monitoring Centre (UNEP-WCMC) (2018) reports total PA coverage as 48.01%. Either way, this is a considerable area of the country and conservation success is ascribed to a generally pro-environmental stance of the government (Buckley, 2017; NBC, 2014; Zurick, 2006). This results from the unique development philosophy of Bhutan, known as “Gross National Happiness” (GNH) (Brooks, 2013; Hayden, 2015).

GNH as a concept originated in the 1970s with the Fourth King of Bhutan stating: “Gross National Happiness is more important than Gross National Product (GNP)” (Hayden, 2015). The Bhutan Government now uses an index based on GNH as an indicator of development success (Hayden, 2015; Ura, Alkire, Zangmo, & Wangdi, 2012), it comprises of four pillars: (a) sustainable and equitable socio-economic development, (b) environmental conservation, (c) preservation and promotion of culture, and (d) good governance (Ura et al., 2012). These are further divided into nine domains: psychological wellbeing, health, education, cultural diversity and resilience, time use, good governance, community vitality, living standard, and ecological diversity and resilience (Ura et al., 2012). However, despite the inclusion of the environment in both the “pillars” and the “domains,” pressure on Bhutan’s environment has been increasing due to population growth and economic development (National Environment Commission [NEC], 2016) both inside and outside of PAs. As an example, feasibility studies for hydropower development have been undertaken in biological corridors and PAs (WCD, 2010). Furthermore, the increase in PA coverage alone as an indicator of conservation success is questionable; biodiversity worldwide has continued to decline, despite a gross increase in PA coverage (Barnes, Glew, Wyborn, & Craigie, 2018; Cook, Valkan, Mascia, & Mc Geoich, 2017). Therefore, to track true progress we need to not only record both increases in PA number and area, but also PA dynamism—the level of change in both area and protection level in the PA system (Cook et al., 2017; Mascia & Pailler, 2011). Given the increasing pressure on the environment, and therefore the PAs in Bhutan, it is timely to review the history of PAs with respect to the history of PA dynamism.

The dynamism of PAs can be tracked through the study of protected area downgrading, downsizing, and degazettement (otherwise known as PADDD; Cook et al., 2017; Mascia & Pailler, 2011; Mascia, Pailler, & Krithivasan, 2012). Downgrading is the “legal or policy change that permits an increase in the type, magnitude or extent of human activities within a PA,” downsizing is the “loss of legal protection for a portion of a PA as a result of its excision from the PA,” and degazettement is the “loss of legal protection for an entire PA” (Mascia et al., 2012; Mascia & Pailler, 2011). PADDD is a widespread conservation phenomenon spanning almost the whole modern PA history (Mascia & Pailler, 2011); this history, however, sees a range of very different trends (see Bernard, Penna, & Araújo, 2014; Cook et al., 2017; Mascia et al., 2014; Pack et al., 2016). Interestingly, PADDD often occurs against a background of increasing PA coverage (Cook et al., 2017) across a range of settings; in countries with a good history of conservation policy like Brazil (Bernard et al., 2014; Ferreira et al., 2014), both developed and developing countries (Cook et al., 2017; Mascia et al., 2014) and in iconic PAs like Yosemite National Park (Golden Kroner, Krithivasan, & Mascia, 2016). PADDD occurs due to different proximate causes (Mascia et al., 2014) and risk factors like PA size, local population density (Symes, Rao, Mascia, & Carrasco, 2016), and ineffective PAs (Tesfaw et al., 2018). PADDD occurrences are often either not reported transparently (Pack et al., 2016) or underreported (Cook et al., 2017; Symes et al., 2016). However, understanding the causes of PADDD (Mascia & Pailler, 2011) will help design robust PA systems against PADDD, or more specifically those PADDD events that are detrimental to conservation (Mascia & Pailler, 2011). Though literature covering various aspects of PADDD (see Cook et al., 2017; Lewis et al., 2017; World Wildlife Fund [WWF], 2017) along with media coverage (WWF, 2017) is increasing, there is a growing recognition of the need to study PADDD and its proximate causes to understand PA dynamism and conservation implications. PADDD in the PAs of Bhutan has been explored in the context of a multiregional study (see Mascia et al., 2014). Here, we build on this to demonstrate the difficulty in tracking PADDD events in remote areas, coupled with the lack of transparent reporting, based on a case study in Bhutan, a country with a strong history of PA designation.

Focusing on PADDD alone captures only one element of PA dynamism—the loss of protection. In order to truly...
capture holistic PA dynamism studies must also include corresponding gains in protection (Cook et al., 2017). Therefore, in this paper we: (a) study the PA dynamism sensu Cook et al. (2017) of Bhutan's modern PA system spanning over half a century from 1966 to 2016, (b) record and discuss temporal trends, and the trends among individual PAs of both “gain” and “PADDD” events, (c) record proximate and specific causes of PADDD and their trend, and (d) compare PADDD events recorded by us against those recorded in www.PADDDtracker.org (WWF, 2017).

In recognition of Bhutan being a country with a unique development philosophy of GNH, we discuss PA dynamism and its causes in light of the GNH philosophy. We hope our development philosophy of GNH, we discuss PA dynamism case studies, not only in those countries yet to meet the target to keep track of PA dynamism.

2 | METHODS

2.1 | Study system

Reported data on the current composition of Bhutan's PA system, in terms of total number, total area and percentage coverage, differs between sources (DoFPS, 2015; NBC, 2014; UNEP-WCMC, 2018; WCD, 2016); although all sources agree on five national parks, four wildlife sanctuaries and one strict nature reserve. Differences occur within the number of biological corridors (e.g., 7 by WCD, 2016; 8 by NBC, 2014; DoFPS, 2015 & UNEP-WCMC, 2018), inclusion (e.g., by NBC, 2014; WCD, 2016) or exclusion (e.g., by DoFPS, 2015; UNEP-WCMC, 2018) of the Royal Botanical Park, inclusion (e.g., by UNEP-WCMC, 2018) or exclusion (e.g., by NBC, 2014; DoFPS, 2015; WCD, 2016) of Ramsar sites among the PA system, and area calculation. Since the Royal Botanical Park and Bumdeling Ramsar sites are located within the Jigme Dorji National Park (JDNP)-Jigme Singye Wangchuck National Park (JSWNP) Biological Corridor (NBC, 2009) and Bumdeling Wildlife Sanctuary (Ramsar, 2012) respectively, we considered them multiple designations and excluded them from the area calculation and PA number. Collating these sources we considered 20 PAs with a total area of 19,196.51 km² (Supporting Information Table S1) covering 50% (exact value being 49.999%) of the country's total land area of 38,394 km² (NBC, 2014) in 2016 (Figure 1).

2.2 | Gain and PADDD events, count, and area affected

We identified PADDD events after Mascia and Pailler (2011), Mascia et al. (2012), Cook et al. (2017) and WWF (2017). We used the decision tree by Mascia et al. (2012) to consistently identify PADDD events and types and followed Cook et al. (2017) for identifying gain events. However, unlike Cook et al. (2017), when defining new PAs we considered the entire area of newly gazetted/designated PAs as new additions to the PA system. This was done despite some PAs incorporating a portion of already protected land, or including a portion of land from degazetted or downsized PAs when newly designated. For instance, Wangchuck Centennial National Park (WCNP) not only contains part of three biological corridors but also includes portions of downsized former Jigme Dorji Wildlife Sanctuary (WCD, 2010). If we were to follow Cook et al. (2017) the WCNP's area would need to be categorized into “new area” and “reversed PADDDed area”; however, for this study we considered the whole area of WCNP as a “new area” added to the PA system. We did this because spatially explicit data on the PA system of Bhutan spanning the entire study period was not available.

To describe systemic change or policy change that affected multiple PAs, we considered the total number of PAs that existed in the year of a specific policy change as the total number of PADDD or gain events. When the specific affected region or locality within the PA was not specified, we considered the whole area of a PA as the affected area. When the policy change specified the region or locality within a PA, but did not provide the area of the region or locality, we considered the area affected “unknown.” For instance, we considered the area affected by the policy downgrade that allowed harvesting of the Chinese caterpillar fungus (Ophiocordyceps sinensis)—a high value fungal parasite of caterpillars belonging to the ghost moth genus Thitarodes (Cannon et al., 2009)—as unknown. The elevation above which Chinese caterpillar fungus is found was provided, however, the area of the species range falling within PAs was not given in the literature (see Cannon et al., 2009; Wangchuk, Norbu, & Sherub, 2012). We considered the area affected by enlarged and downsized events as the difference in area before and after the event when sources did not mention the area affected.

2.3 | Proximate causes and count

We followed the definition of Mascia et al. (2012, 2014) and the details provided by WWF (2017) for the proximate cause of PADDD events. Mascia et al. (2014) identified and defined 16 proximate causes: forestry, mining, oil and gas, industrial agriculture, industrialization, infrastructure, land claims, rural settlement, subsistence, degradation, shifting sovereignty, refugee accommodation, conservation planning, other, unknown and multiple. For each affected PA we counted the number of events caused by a particular proximate cause (Appendix 1).
Following the definitions and operational criteria described above for gain and PADDD events, and proximate causes we created a comprehensive database through reviewing peer reviewed articles, government documents, PA management plans, media reports and social media between 1966 and 2016. We mainly sourced the documents from websites through Google search engines using various combinations of the search terms Bhutan, protected area, reserve, national park, biological corridor, Ramsar sites, botanic garden, management, plan, reviews, legalization, policy, acts, regulations, fishing, forestry, history, PADDD, Cordyceps, road,
NWFP, collection, designation, removed, gazettement (Bernard et al., 2014), as well as sourcing relevant documents from government organizations where possible. We modeled our PA dynamism record format after the PADD event record format used in www.PADDDtracker.org (WWF, 2017). We recorded separately details of gain events (Appendix 2) and PADD events (Appendix 1).

2.5 | Data analyses

Using both the median and range of the area affected, we summarized the number of gain and PADD events, number of separate PAs affected, total area affected and percentage affected. We also calculated the percentage share of individual gain and PADD event types over total gain and PADD events. We summarized types, area impacted and number of gain and PADD events and status of PADD events for each year and PA. Additionally, we summarized the number and percentage of proposed and enacted PADD events, proximate causes of PADD and types of PADD events. We highlighted the difference in the number of PADD events and the area affected in our data compared with that recorded in www.PADDDtracker.org (WWF, 2017) by dividing the corresponding number of PADD events and area affected recorded in the former by the latter.

3 | RESULTS

3.1 | Summary of gain and PADD events

We recorded a total of 110 gain events which affected 52,847.96 km² of area excluding the unknown area affected by three policy upgrade events (Table 1). The actual area added to the PA system by gain events was only 23,710.30 km², this was calculated by combining the area added through new (21,964.38 km²) and enlarged PAs (1,746 km²) with the further 24,214.58 km² in total gain events that were only upgraded to a higher level of protection. Gazettement of new PAs was the most prevalent gain event by number of PAs affected (n = 35) and policy upgrade the most prevalent by total area affected (24,214.58 km²; Table 1). However, when only the number of gain events was considered then policy upgrade was the most prevalent (n = 36, 44.4%) and class upgrade the least prevalent (n = 2, 2.5%; Table 1; Table S2).

We recorded 29 PADD events which removed a total area of 4,393 km² from the PA system (Table 1), excluding areas that were, or may be, subjected to higher disturbance by enacted and proposed policy downgrage events respectively (Table 1). Among PADD events policy downgrade was the most prevalent by number of events (n = 7) and downsizing by area lost (3,808 km²; Tables 1 and S2). Four policy downgrade events were systemic: two of these resulted from legalization of the collection of Chinese caterpillar fungus and the other two allowed for an increase in the number of people allowed per household to collect the fungus (Appendix 1). Of the total area lost due to PADD, downsizing removed 86.7% (area = 3,808 km²; n = 3) with the remaining 13.3% (area = 585 km²; n = 6) lost to degazettement (Tables 1 and S2). However, some area lost due to downsizing of Jigme Dorji Wildlife Sanctuary was reversed through the designation of the Bumdeling Wildlife Sanctuary, Wangchuck Centennial National Park, and North Corridor, while some area lost due to the degazettement of Shumar Wildlife Reserve and Dungsam Wildlife Reserve was reversed through the designation of Royal Manas National Park–Jomotshangkha Wildlife Sanctuary biological corridor (Appendix 1 and Figure 1).

3.2 | Enacted versus proposed PADD events

Out of 29 PADD events, 17 (58.6%) were enacted against 12 (41.4%) proposed (Table S3). All degazettement (n = 6) and downsizing (n = 3) events were enacted, while only 8 (40%) of the policy downgrading events were enacted (Table S3). All the 12 proposed PADD events were policy downgrading events which made up 60% of the total policy downgrading events (Table S3).

3.3 | Gain and PADD events temporal trend

Overall, gain events occurred sporadically with almost decadal gaps between events from 1966 to 1992; however, since 1992 gain events have increased, with a maximum gap of 4 years between 2012 and 2016 (Figure 2a and Table S3). Among the gain events, both types, new PA and PA enlargement, were more spread out. Policy upgrades occurred only in 1992, 2006 and 2009, with both class upgrade events occurring in 1993 (Figure 2a and Table S3). The highest number of gain events was recorded in the year 2006 (n = 22; 27.2%; Figure 2a and Table S4), with 21 of these being policy upgrade events and only 1 being a PA enlargement event, contributing just 0.58% (137 km²) of the total actual area added to the PA system by gain events between 1966 and 2016 (Figure 2b and Table S4). The highest number of new PAs was added in 1999 (34.29%) when 12 biological corridors were added, while the highest total area added through new PA designation was in 1974 (8,772 km²; 39.94%; Figure 2a and Table S5).

The highest number of PADD events was recorded in 2004 (n = 14; 48.3%; Figure 2c and Table S4); however, these were all policy downgrage events (Figure 2c and Table S4), two were enacted and the remaining 12 were
proposed (Table 2). All degazettement events occurred in 1993 \((n = 6)\) and all downsizing events in 1984 \((n = 2)\) and 1993 \((n = 1)\), policy downgrade events occurred almost every 2 years from 2002 (Figure 2b and Table S3). Despite this range of PADDD events, an actual area lost from the overall PA system only occurred in 2 years, 1984 and 1993, due to degazettement and downsizing (Figure 2d and Table S5).

### 3.4 | Gain and PADDD events trend among individual PAs

Many PAs were affected multiple times by both gain and PADDD events during the period covered by this study. Out of a total of 34 PAs that gained area, seven gained multiple times from PA enlargement, policy and class upgrades (Table 2). When only currently existing PAs were considered 44.44% \((n = 18)\) gained multiple times (Table 2). Among currently existing PAs JDNP gained the maximum by number of events \((n = 6)\), while the highest total area \((580 \text{ km}^2)\) was added to Royal Manas National Park through two PA enlargement events (Table 2).

Three PAs were subjected multiples times to PADDD events. JDNP recorded the highest number of PADDD events \((n = 8, \text{Table 3})\) and also lost the highest total area \((3,716 \text{ km}^2)\) through two downsizing events (Table 3). However, of the six remaining PADDD events JDNP recorded, three were proposed PADDD events while the other three were policy downgrade events, and hence no actual area was lost.

### 3.5 | Proximate causes of PADDD

Only three types of proximate causes were responsible for all 29 PADDD events recorded during the period covered by this study. Infrastructure development was the most frequent proximate cause \((n = 14, 48.3\%)\) followed by conservation planning \((n = 9, 31\%)\) and subsistence \((n = 6, 21.4\%; \text{Table S6})\). However, all degazette and downsize events were caused by conservation planning, while 70% \((n = 14)\) of policy downgrade was caused by infrastructure with the remaining 30% \((n = 6)\) by subsistence (Table S6). The specific cause for all infrastructure developments was hydropower projects, while specific causes for subsistence were fishery and NWFP (nonwood forest product) collection rights (Table 3). Conservation planning was recorded more frequently until 1993, while in the latter part of the study period more of subsistence and infrastructure development events were recorded (Figure 3 and Table 3). Both subsistence and conservation planning were responsible for only

### TABLE 1 Summary of changes to protected area system of Bhutan between 1966 and 2016

| Event Type       | No. of events | No. of PAs affected | Total area affected (km²) | Median area affected (km²) (range) |
|------------------|---------------|---------------------|---------------------------|----------------------------------|
| Gain Gazettement | 35            | 35                  | 21,964.4                  | 233 (1.14–3,736)                 |
| PADDD Degazettement | 6            | 6                   | 585                       | 110 (5–180)                      |
| Enlargement      | 8             | 6                   | 1,746                     | 162 (20–560)                     |
| Downsizing       | 3             | 2                   | 3,808                     | 103 (92–3,613)                   |
| Upgrading Class  | 2             | 2                   | 4,923                     | 2,461.5 (1023–3,900)             |
| Policy Class     | 36            | 31                  | 24,214.6                  | 222.5 (0–7,813)                  |
| Downgrading Class| —             | —                   | 7                         | —                                |
| Total number of events | 81      | 29                  |                            |                                  |

*Protected area downgrading, downsizing and degazettement.

*Protected areas.

*Area affected unknown for three policy upgrade events.

*Area affected by all policy downgrade events unknown.

*Fourteen were proposed and six enacted policy downgrade events.
enacted PADDD events, but infrastructure development was responsible for only one enacted PADDD while it caused all 12 proposed PADDD events (Table 3).

3.6 | PADDD events recorded in www.PADDDtracker.org versus current study

Compared with the PADDD tracker database (www.PADDDtracker.org) our study recorded a higher number of every PADDD event type and area affected, except for the area lost due to downsizing (Table 4). We also found differences in specific PAs subjected to PADDD. For example, Mochu Reserve Forest (MRF), and Namgyel Wangchuck Reserve (NWR) were wrongly recorded as degazetted in the database, while the degazetted Zoshing Reserve Forest and Sinchula Reserve Forest were not recorded at all in the database (Table S7). By number of events we recorded 20, 3, and 1.5 times more downgrading, downsizing and degazettement events respectively than recorded in www.PADDDtracker.org (Table 4). When we discounted two wrongly listed degazettement events in www.PADDDtracker.org we had recorded three times more degazettement events than recorded in www.PADDDtracker.org (Table 4). When all PADDD events were added we recorded 4.8 times (including wrong records) and 7.3 times (discounting wrong records) more PADDD events than recorded in www.PADDDtracker.org. However, our data was aligned with www.PADDDtracker.org in the area lost to PADDD, both when assessed against specific PADDD events or in total (Table 4). The difference between the datasets was highest for the area lost to degazettement, we recorded 1.7 times more area when we used corrected data

FIGURE 2  Gain and PADDD events across PA system of Bhutan between 1966 and 2016 (a) number of gain events; (b) area gained from new protected area, enlarged PA and total; (c) number of enacted and proposed PADDD events, and (d) area lost to downsizing, degazettement and total. PADDD, protected area downgrading, downsizing, and degazettement.
| Name (current)a | Name (primary)b | Name (after)c | Typed | Yeare | Areakm² |
|----------------|----------------|--------------|-------|-------|---------|
| BWS BWS | Policy 2006 1,521 |
| JDNP JDNP | Enlarge 1995 300 |
| JDWS JDNP | Policy 1992 7,813 |
| JKSNR TSNR | Policy 2006 650.74 |
| JSWNP JSWNP | Enlarge 2003 323 |
| JWS KRF | Policy 1992 233 |
| PWS PRF | Policy 1992 175 |
| PNP TNP | Enlarge 2006 137 |
| RMNP Manas WS | Policy 1992 463 |
| SWS SWS | Policy 2006 650 |
| WCNP WCNP | Policy 2009 0 |
| JDNP-JSWNP C | JDNP-JSWNP C | Policy 2006 275 |
| JKSNR-JDNP C | TSNR-JDNP C | Policy 2006 147 |
| JSWNP-WCNP-JDNP-BWS/NC JSWNP-JDNP C | Policy 2006 600 |
| JWS-SWS C | Policy 2006 376 |
| PNP-BWS C | Policy 2006 79 |
| PWS-JSWNP-RMNP C | PWS-RMNP C | Policy 2006 160 |
| RMNP-JSWNP-PNP C | JSWNP-TNP C | Policy 2006 385 |
| RMNP-JWS C | RMNP-KWS C | Policy 2006 212 |
| PWS | Policy 1992 21 |
| DNP | Policy 1992 180 |
When area lost to PADDD was added we recorded 1 and 1.1 times more area lost respectively using uncorrected and corrected www.PADDDtracker.org data (Table 4).

4 | DISCUSSION

4.1 | Overall gain and PADDD events

Our study showed that the PA system of Bhutan was as dynamic as in any other country where PADDD has been studied (Bernard et al., 2014; Cook et al., 2017; Mascia et al., 2014). This is despite Bhutan being recognized for conservation success ascribed to its unique (Brooks, 2013; Hayden, 2015) and pro-environmental development philosophy of GNH (Buckley, 2017; Zurick, 2006). Inclusion of gain events in this PA dynamism study revealed more dynamism than in either a PADDD study alone or in a study focused just on an increase in the area covered (Cook et al., 2017). The total area captured by PAs grew in Bhutan during the period of study, this reflected the total area added through new PA and PA enlargement events (23,710.4 km²), these were far greater than the area lost to enacted degazettement and downsizing (4,393 km²) events. This may suggest that the occurrence of PADDD amidst major PA growth (Cook et al., 2017) is a prevalent phenomenon among countries of any size or any particular economy, however this requires further study.

We found that although the total number and area affected by PADDD events was naturally smaller in Bhutan than in bigger countries (e.g., Cook et al., 2017; Pack et al., 2016) it impacted a higher proportion of PAs. Degazettement of just six PAs with a total area of 585 km² accounted for 15.7% of the total number of PAs designated (n = 35) and 2.6% of the total area added to the PA system through gazettement (21,964.38 km²) in Bhutan, while 108 degazetted PAs with 4,122.3 km² accounted for only 1.8 and 0.3% by number and area respectively in Australia (Cook et al., 2017). Similarly, removal of 95,768 km² accounted for only 6% of potential national park in Brazil (Pack et al., 2016). However, Bhutan has not fallen back on its Aichi target despite only having designated 35 PAs over 50 years. This may reflect the role played by its strong pro-environmental development philosophy of GNH which considers preservation of environment as one of its four pillars (Ura et al., 2012; Zurick, 2006). This may also explain why all degazettement and downsize events we recorded in Bhutan were caused by conservation planning (Seeland, 1998). Also, all recorded policy upgrade events (n = 36), which contributed to the highest number of gain events in Bhutan were aligned to its GNH philosophy. Thirty-three policy upgrade events were related to an increase in the number of days on which fishing was restricted, a blanket rule applied throughout the country including within PAs (Forest Department, 1974; Ministry of Agriculture, 1992). This aligned with the “preservation and promotion of culture” pillar of GNH (Ura et al., 2012) by restricting fishing on Bhutanese holy days or months. While, reduction in the number of persons allowed per household to harvest Chinese caterpillar fungus in JDNP, Wangchuck Centennial National Park and Bumdeling Wildlife Sanctuary (Cannon et al., 2009) reflects the “environmental preservation” pillar of GNH (Ura et al., 2012).

4.2 | Gain and PADDD events temporal trend

Our study showed that similar to Australia (Cook et al., 2017) both gain and PADDD events in Bhutan were episodic. While PAs were designated sporadically over almost...
every decade since the first PA was designated in 1966, PA enlargements were recorded only from 1993. The PA designations in 1974 and 1984 may have been influenced by informal relationships between some officials of WWF(US) and the Bhutan Government, along with the recognition that PA creation can be a mechanism to protect wildlife and forest produce from poaching and illegal harvesting (Seeland, 1998). The PA system revision in Bhutan in 1993 was the consequence of recommendations from PA system reviews done by the World Conservation Union (IUCN) in 1984, the Food and Agriculture Organization of the United Nations (FAO) in 1988 and 1989, Bhutan's Master Plan for Forestry Development Project in 1991 and the WWF in 1993 (NCD, 2004).

The more recent gain events recorded in our study can be argued to be the result of scientific findings; for example, the declaration of biological corridors after surveys of tiger occurrence (NCD, 2004) and the designation of Khotokha and Gangtey-Phobji Ramsar sites as important winter habitat for the globally vulnerable black-necked crane (*Grus nigricollis*; Ramsar, 2012, 2016). The PA enlargement events in 1993 were part of a total PA system overhaul to include better ecosystem representation (Seeland, 1998; NBC, 2009), while latter enlargement events were probably due to the adaptive management of PAs, with the actual management of PAs beginning only from 1995 onwards (NBC, 2009). For example, new areas were added to the

### TABLE 3

Protected areas of Bhutan affected by PADDD events between 1966 and 2016 with PADDD events type, area lost, status, year of event, and proximate and specific causes

| PA name<sup>a</sup> | Type            | Area<sup>b</sup> | Status | Enacted | Proposed | Year | Proximate cause<sup>c</sup> | Specific cause<sup>d</sup> |
|--------------------|-----------------|------------------|--------|---------|----------|------|-----------------------------|---------------------------|
| BWS                | Downgrading     | —                |        | 0       | 2        | 2004 | Infrastructure              | Hydropower                |
|                    |                 | —                |        | 1       | 0        | 2008 | Subsistence                | NWFP                      |
| DNP                | Degazettement   | 20               |        | 1       | 0        | 1993 | Conservation planning      |                           |
| DWR                | Degazettement   | 180              |        | 1       | 0        | 1993 | Conservation planning      |                           |
| JDNP               | Downgrading     | —                |        | 1       | 0        | 2002 | Subsistence                | NWFP                      |
|                    |                 | —                |        | 1       | 0        | 2004 | Subsistence                | NWFP                      |
|                    |                 | —                |        | 0       | 3        | 2004 | Infrastructure              | Hydropower                |
|                    |                 | —                |        | 1       | 0        | 2008 | Subsistence                | NWFP                      |
|                    |                 | 103              |        | 1       | 0        | 1984 | Conservation planning      |                           |
|                    |                 | 3,613            |        | 1       | 0        | 1993 | Conservation planning      |                           |
| JSWNP              | Downgrading     | —                |        | 1       | 0        | 2010 | Subsistence                | Fishery                   |
|                    |                 | —                |        | 1       | 0        | 2012 | Subsistence                | Fishery                   |
|                    |                 | —                |        | 1       | 0        | 2014 | Infrastructure              | Hydropower                |
| JSWNP-JDNP C       | Downgrading     | —                |        | 0       | 1        | 2004 | Infrastructure              | Hydropower                |
| MRF                | Downsizing      | 92               |        | 1       | 0        | 1984 | Conservation planning      |                           |
| PRF                | Degazettement   | 20               |        | 1       | 0        | 1993 | Conservation planning      |                           |
| PWS                | Downgrading     | —                |        | 0       | 1        | 2004 | Infrastructure              | Hydropower                |
| PNP                | Downgrading     | —                |        | 0       | 3        | 2004 | Infrastructure              | Hydropower                |
| SWS                | Downgrading     | —                |        | 0       | 2        | 2004 | Infrastructure              | Hydropower                |
| SWR                | Degazettement   | 160              |        | 1       | 0        | 1993 | Conservation planning      |                           |
| SRF                | Degazettement   | 80               |        | 1       | 0        | 1993 | Conservation planning      |                           |
| ZRF                | Degazettement   | 5                |        | 1       | 0        | 1993 | Conservation planning      |                           |

Abbreviations: BWS, Bumdeling Wildlife Sanctuary; DNP, Doga National Park; DWR, Dungsam Wildlife Reserve; JDNP, Jigme Dorji National Park; JSWNP, Jigme Singye Wangchuck National Park; JSWNP-JDNP C, Jigme Singye Wangchuck National Park–Jigme Dorji National Park Corridor; MRF, Mochu Reserve Forest; PA, protected area; PADDD, protected area downgrading, downsizing, and degazettement; PRF, Pachu Reserve Forest; PWS, Phibsoo Wildlife Sanctuary; PNP, Phrumensgla National Park; SWS, Sakteng Wildlife Sanctuary; SWR, Shumar Wildlife Reserve; SRF, Sinchula Reserve Forest; ZRF, Zoshing Reserve Forest.

<sup>a</sup>Current name of PA used if it exists as in 2016.

<sup>b</sup>Area affected by downgrade not known.

<sup>c</sup>Proximate, proximate cause; conservation, conservation planning.

<sup>d</sup>Specific, specific cause; NWFP, nonwood forest product.
Bumdeling Wildlife Sanctuary, and the then Thrumshingla National Park, to bring additional tiger and snow leopard habitats into the PA system in 2001 and 2006 respectively (NBC, 2009). Also, an increase in the area of Jomotshangkha Wildlife Sanctuary from 337 to 1,160 km² occurred with the inauguration of its independent park management on February 5, 2017 (Lhamo, 2017) and reflects the government’s strong commitment to environmental conservation and willingness to enlarge PAs. Historical events also led to the designation of PAs, for example the Wangchuck Centennial National Park was designated in 2008 to celebrate 100 Years of Wangchuck Dynasty’s reign (DoFPS, 2015).

Policy downgrades influencing PAs in Bhutan were recorded only after 2002 and occurred almost every 2 years thereafter until 2014. These affected more PAs in terms of number, and occurred at multiple times, compared with any other PADDD or gain event. Policy downgrade events, 70% of which were due to the proximate cause infrastructure development, with both enacted and proposed hydropower being the specific cause for all of these, may signify a shift in the Bhutanese government's development policy. A similar shift in policy was recorded in Brazil where hydropower development became a major proximate cause of PADDD (Bernard et al., 2014; Pack et al., 2016). The Bhutanese government also considers hydropower as one of the five jewels of economic development (RGoB, 2016). Although the Bhutan government is guided by the overarching philosophy of GNH in the pursuit of economic development, the need for greater transparency with respect to hydropower development plans has been raised (Premkumar, 2016). All proposed policy downgrades recorded in 2004 were due to hydropower development compared to just one enacted policy downgrade due to hydropower in 2014. Although all the proposed hydropower projects may not actually be implemented (WBG, 2016) there are chances many could be enacted eventually, given Bhutan is under pressure for continued economic growth coupled with increasing materialistic wealth in Bhutan (Hayden, 2015). Although hydropower projects in Bhutan are run-of-the-river schemes which do not involve large water storage dams and therefore absolute area lost within PAs will be minimal (WBG, 2016), hydropower projects, if enacted, will have adverse impacts on biodiversity conservation.

A further 30% of the policy downgrade events were the result of subsistence, for example, the legalization of Chinese caterpillar fungus harvesting and fishing through the formation of community capture fishery groups. Legalization of both the Chinese caterpillar fungus harvesting and fishing aimed to reduce illegal harvesting and increase the practice of sustainable management of resources, to bring equitable socioeconomic development and recognize communities’ traditions (RNR-RDC Bajo, 2012; Thapa, 2017). Reflecting GNH philosophy these subsistence based policy downgrades would actually help conserve biodiversity by garnering support from local communities (Mascia & Pailler, 2016).

**TABLE 4** Difference between PADDD events recorded in www.PADDDtracker.org and current study for PA system of Bhutan

| Event type       | Current study | PADDD trackera | Difference (number of times)b |
|------------------|---------------|----------------|-------------------------------|
|                  | No.c          | Area (km²)     | No.                           | Area (km²)     | No.   | Area (km²) |
| Downgradingd     | 20            | 0              | 1                             | 0              | 20    | NAe        |
| Downsizing       | 3             | 3,808          | 3                             | 3,534          | 0     | 1.1        |
| Degazettement    | 6             | 585            | 2                             | 670 (335)      | 1.5   | 0.9 (1.7)  |
| Total            | 29            | 4,393          | 6                             | 4,204 (3869)   | 4.8   | 1.0 (1.1)  |

Abbreviations: PA, protected area; PADDD, protected area downgrading, downsizing, and degazettement.

aValues within parenthesis ( ) are after discounting two wrongly included PAs as degazetted in www.PADDDtracker.org.

bValues within parenthesis ( ) are difference (number of times) derived using corrected values of www.PADDDtracker.org data.

cNo., number of events.

dAll were policy downgrade events and area affected unknown.

eaNA, not applicable since area affected unknown.
2011). However, care must be taken as Chinese caterpillar fungus harvesting has not only increased degradation of the alpine environment (Wangchuk et al., 2012), but has also harmed the traditional yak husbandry by rendering it to second place in income generation after that of Chinese caterpillar fungus sale and also by placing the burden of yak herding on female members of the household while traditionally male members herded the yaks (Wangchuk & Wangdi, 2015). In another example, the increased human activities associated with the legalization of fishing in Berti and Harachhu villages could disturb the habitat of critically endangered White Bellied Heron (*Ardea insignis*) in the Berti and Harachhu rivers (Wangdi et al., 2017).

All six degazettements occurred in 1993, while two of the three downsizing events occurred in 1984 and the other one in 1993. Thus, PADDD events which resulted in actual area lost from PAs occurred episodically. However, these events were the result of conservation planning. Designation of additional PAs and changes made to existing PAs for better management led to both recorded downsizing events in 1984 (Seeland, 1998), while a review to ensure adequate ecological representation within the PA system of Bhutan caused all six degazettlement and one downsizing event in 1993 (Seeland, 1998). The PADDD events of 1993 resulted in a PA system considered to be the most comprehensive by area coverage and representativeness of all ecoregions across the country (NBC, 2009). Thus, PADDD can be used as tool to make the PA system more effective in biodiversity conservation (Fuller et al., 2010). However, when we visually compared degazetted PAs and the current PA system it revealed some PAs were degazetted from the under-represented South-Western region of Bhutan (Figure 1). *Furthermore, though some portions of degazetted and downsized PAs were re-designated, or added to existing PAs, they occurred in already well represented regions like northern Bhutan or South Eastern Bhutan (Figure 1) and not where there is a need for adequate representation of biological corridors such as in the South-Western region of Bhutan (WCD, 2010). Hence, there is need for further studies that employ spatially explicit methods to study PA dynamism in Bhutan to truly assess conservation gain and loss since our findings suggest the PA system in Bhutan will remain dynamic and can be subject to both gain and PADDD events in future as were the PAs in other countries (Cook et al., 2017; Mascia et al., 2014; Pack et al., 2016).

### 4.3 Gain and PADDD events trend among individual PAs

Many PAs were affected multiple times by both gain and PADDD events (Cook et al., 2017) with bigger PAs subjected a greater number of times to both gain and PADDD events. For example, JDNP, which was the largest PA until the designation of Wangchuck Centennial National Park in 2008 and is till currently the second largest PA (Thinley et al., 2015), was impacted the most frequently by both gain and PADDD events. JDNP also lost the highest total area to PADDD, due to conservation planning, and was also subjected to three policy downgrade events to allow collection of Chinese caterpillar fungus (Cannon et al., 2009). Likewise, JSWNP, the third largest PA, was the only PA where two local communities were granted legal rights for a community capture fishery (JSWNP, 2013). This supports the earlier finding where larger PAs were more prone to PADDD due to higher opportunity cost (Symes et al., 2016).

### 4.4 Proximate cause of PADDD

Our study detected only three types of proximate causes for PADDD in Bhutan - *infrastructure development, subsistence and conservation planning* against 16 recognized categories (Mascia et al., 2014). A fewer number, and a smaller total area of PA system in Bhutan, compared to other countries where PA dynamism has been studied might have exposed PAs in Bhutan to fewer types of proximate causes. For instance, Bhutan has designated only 35 PAs covering only 21,964.4 km² during 50 years (1966–2016) compared with larger countries like Australia which had 7,281 PAs covering 1.22 million km² in 2014 (Cook et al., 2017) and Brazil which had 1,762 conservation units that covered 1.5 million km² in 2013 (Bernard et al., 2014). Although the country is small with a small number of PAs there is strong support from the Bhutan Government for conservation (Wangchuk, Lham, Dudley, & Stolton, 2017) which is reflected and embedded in its legislation; for example, the provision of “Article 5 on Environment” under which the Bhutan Government is mandated to protect a minimum of 60% of the country under forest cover for all times (The Constitution of the Kingdom of Bhutan, 2008) or maintain a ban on mining within PAs (Department of Forest, 2006). While legal rights accorded to local communities inside or around PAs for traditional land use in Bhutan (NBC, 2009, 2014; Wangchuk et al., 2017) may explain absence of rural human settlements as proximate cause which accounted for 20% of PADDD events in Brazil (Pack et al., 2016).

### 4.5 PADDD recorded in www.PADDDtracker.org versus current study

Our study recorded 29 PADDD events against 6 recorded in www.PADDDtracker.org for Bhutan. Furthermore, when corresponding individual PADDD types were compared we recorded very large differences in the number of events although the area impacted by PADDD did not differ that...
much. For instance, we recorded 20 times more policy downgrade events than recorded in www.PADDDtracker.org, and when we discounted 2 PAs wrongly reported as degazetted in www.PADDDtracker.org we recorded 3 times more degazettement events than that recorded in www.PADDDtracker.org. These differences may reflect additional years included in our study (see Mascia et al., 2014) or they may reflect the difference in identifying an event as a PADDD event. For instance, we did not consider the road constructed through JDNP in 2011 as a PADDD event (Thinley et al., 2015) while it was recorded as a proposed downgrade in www.PADDDtracker.org. Road construction is legal within buffer and multiple use zones, and not in core zones, but in the absence of official zonation within PAs there is no legal basis to object to road construction (WWF Bhutan & Sakteng Wildlife Sanctuary, 2011). However, even degazetted PAs were not recorded or some PAs were wrongly recorded as degazetted in www.PADDDtracker.org. Probably, the relatively small size and remote location of PAs like Zoshing Reserve Forest (5 km²) and Sinchula Reserve Forest (80 km²; Symes et al., 2016) might have made it difficult to detect and record in the broader database. Also, a lack of transparent records of PADDD events could have contributed to the incorrect record of MRF and NWR as degazetted. Actually, MRF was downsized and a portion of it was renamed Phibsoo Reserve Forest (Seeland, 1998), while NWR was amalgamated with Manas Wildlife Sanctuary as Royal Manas National Park (RMNP) (2015). These examples add evidence to a global difficulty in detecting PADDD events and the lack of transparent reporting. Furthermore, these differences may suggest the need for specific case studies from individual countries, or the need to include professionals from native countries in multiregional studies (e.g., Mascia et al., 2014). While our study was not designed to be comprehensive archival research, we feel differences in PADDD recorded between studies could also be the result of involving a co-author from the relevant country, this might have resulted in better access to available data sources or key persons from whom to source the data. This may suggest the importance of archival research, where possible, on PA dynamism studies over opportunistic or crowd sourcing methods if PA dynamism in general, and PADDD in particular, are to be better detected. Of course, we feel the current ability of individuals to report or correct PADDD events in www.PADDDtracker.org (WWF, 2017) is a positive development in understanding PADDD as a conservation phenomenon.

Our study shows inclusion of both gain and PADDD events, even when a spatially explicit method is not used, can reveal higher PA dynamism than a PADDD study alone. Our findings provide further evidence about the episodic, widespread nature of PADDD and the difficulty in detecting it. While gain events were all designed to improve biodiversity conservation, excluding proposed and enacted policy downgrade events caused by infrastructure development with hydropower as its specific cause, all other PADDD events caused by conservation planning and subsistence were aimed at improving biodiversity conservation in Bhutan. This may reflect Bhutan’s commitment to environmental conservation guided by its GNH philosophy.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

T.D. designed the paper, collated and analyzed the data, and led the writing, revision and final submission of the paper. S.L. and F.S. provided critical comments to overall presentation and content of multiple drafts and two revised manuscripts. S.L. and F.S. did final language correction of the draft and the revised manuscripts.

DATA ACCESSIBILITY

All data used to generate this paper are presented in the paper or the supplemental materials, except the data used for Figure 1 which is available upon request from the corresponding author.

ETHICS STATEMENT

The authors are not aware of any ethical issues regarding this paper.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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