1 Background about green initiatives

Humans are degrading or destroying nature's various structures and functions at an alarming rate, jeopardizing essential goods and services upon which the welfare of humanity depends, including food, water, clean air, soil, and biodiversity (Daily & Matson, 2008; Millennium Ecosystem Assessment, 2005). This crisis gave rise to the United Nations' 2030 Sustainable Development Goals in 2015, and Goals 14 and 15 are directly related to conserving life below water and on land (Rosa, 2017). We define green initiatives as any initiatives, including programs, payments, and endeavors, that aim to restore, sustain, or improve nature's capacity to support human well-being. In this context, green initiatives may entail endeavors to sustain or conserve some physical environmental structures and functions, such as the ozone layer in Earth's stratosphere, so that life on Earth's surface is protected from the Sun's ultraviolet radiation (Luken & Grof, 2006). Similarly, green initiatives could be made to protect geological features, landforms, and processes (e.g., glaciers, gushers, and volcano sites) that possess intrinsic, cultural, aesthetic, scientific, or educational value (Kormos et al., 2017).

Under this definition, the United Nations Framework Convention on Climate Change (UNFCCC, 2016), the Green Climate Fund, European Union's Green Deal (European Commission, 2019), and the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program are good examples of green initiatives. Other prominent green initiatives include the so-called payments for environmental services (also named payments for ecological services; PES), programs for integrated conservation and development projects (ICDP), and measures that aim to preserve nature and its services vital to humans. Examples include subsidies, tax exemptions, area-based conservation measures comprised of protected areas, and "other effective area-based conservation measures" (OECMs; Jonas et al., 2014; Maxwell et al., 2020). Green initiatives are widespread across the globe. For instance, the aforementioned REDD+ alone had involved 39 developing countries as of July 2019, covering a forest area of approximately 1.49 billion hectares or 37 percent of the global forest area.

DOI: 10.4324/9781003290292-1

1.1 The concept and popularity of green initiatives

The past two decades have witnessed a large number of initiatives devoted to research on green initiatives, focusing on the principles, design features, implementation, participation and compliance, and socio-environmental impacts and trade-offs (Wunder et al., 2018). A conservative annual monetary value of global environmental services, measured in 2007 $US, was estimated to be US$46 trillion in 1997 and US$145 trillion in 2011 (Costanza et al., 2014), and the latter estimate was twice as much as the global gross national product in the same year (Costanza et al., 1997).

A paper by Ezzine-de-Blas et al. (2016) identified a total of 584 unique payments for environmental (ecosystem) services (PES) programs, among a wide variety of green initiatives worldwide, based on several popular databases (e.g., Science direct and Scopus). The programs were identified using the keywords "payments for environmental services", "payments for ecosystem services", or related terms. Then 55 PES programs were selected, and related program information was collected for the metadata analysis (Table 1.1).

We used these same 55 programs to offer a conservative estimate of the impact of PES programs, which is measured as the total coverage of area and investment. We updated the 55 PES programs and calculated their overall payments based on data and information that became available after 2016 (Table 1.1). Unless there was a one-time buyout format for compensation, the payment for each program was calculated based on the land area involved, compensation rate for a unit area of land, and the program's duration. To make a conservative estimation of the payment amount, we only updated the year of running if we were certain about the program's implementation after 2014 (till 2018). Otherwise, we labeled it as "No" regarding whether it is "still running" in the table.

A few more modifications were applied to Table 1.1, described as follows. (1) For PES programs without "still running" or "year ended" information, we assumed it had run only 2 years to make a very conservative estimate of the total investment; (2) the original paper (Ezzine-de-Blas et al., 2016) mentions that most of the programs were in operation till 2014; therefore the default year of termination was set at 2014 unless we found information indicating otherwise; (3) we searched available information sources mentioned in the paper along with a Google search of all the program names mentioned in Table 1.1 and updated the information about program size, year ended, and payment level. The last column (i.e., References) of Table 1.1 indicates where we obtained updated information for the related PES program: if so, we list the reference; otherwise, we put "S", implying the same as the data in the original paper (Ezzine-de-Blas et al., 2016). When two sources for the same PES program gave different numbers, we chose the one that gave a lower estimate.

Our results indicate that the total land area devoted to these 55 programs is 61.57 million ha, with a total investment of US$140.78 billion. However, China's Natural Forest Conservation Program (NFCP) was not included in the paper (Ezzine-de-Blas et al., 2016). If including forestland areas under NFCP (i.e., 117

Table 1.1 PES program information based on Ezzine-de-Blas et al. (2016)

Id	*Id_L*	*PES program name*	*Year of start*	*Program size (ha)*	*Total payment (USD/ha/year)*	*Still running*	*Year ended*	*# of years*	*Program overall payment ($)*	*References**
1	NegB	Los Negros, Bolivia	2003	2,774	1.8	No	2014	11	54,925.2	S
2	PimE	Pimampiro, Ecuador	2000	550	9	No	2014	14	64,400(1)	1
3	ProE	PROFAFOR, Ecuado	1993	22,287	17.1	No	2014	21	7,994,602(1)	2
4	VitF	Vittel (Nestlé Waters), France	1993	5,100	1,283.8	No	2014	21	137,494,980	S
5	SloCh	Sloping Land Conversion, China	1999	33,866,667	263.9	Yes		19	73,028,571,400	3
6	HydoMX	Payments for Hydrological Environmental Services (PSAH), Mexico	2003	598,100	31.9	Yes		15	286,190,850	4
7	ConsUS	Conservation Reserve Program, USA	1985	9,700,000(3)	192(4)	Yes		33	61,459,200,000	5
8	EnvUS	Environmental Quality Incentives Program (EQIP), USA	1996		n.d.	Yes		22		6
9	SenUK	Environmental Quality Incentives Program (EQIP), USA	1987	1,400,000(3)	98.4	No	2017(2)	30	4,132,800,000	7
10	CouUK	Countryside Stewardship Scheme (CSS), United Kingdom	1991	530,620	124.4	Yes		27	1,782,246,456	8
11	NotrG	Northeim model project, Germany	2004	288	208.2	No	2006	2	119,923.2	S
12	CamZ	CAMPFIRE, Zimbabwe	1989	4,300,000	0.2	Yes		29	24,940,000	9

(*Continued*)

Table 1.1 Continued

Id	*Id_L*	*PES program name*	*Year of start*	*Program size (ha)*	*Total payment (USD/ha/year)*	*Still running*	*Year ended*	*# of years*	*Program overall payment ($)*	*References**
13	LavCo	CIPAV-Río La Vieja, Colombia	2003	3,536	18.6	No	2005	2	131,539.2	S
14	ChaE	Chachis, Ecuador	2005	7,200	20	No	2014	9	1,296,000	S
15	ChaCo	Chaina, Colombia	2005	444	328.9	No	2014	9	1,314,284.4	S
16	ProcCo	Procuenca, Chinchina, Colombia	1999	18,650	106.7	No	2014	15	29,849,325	S
17	CelE	Celica, Ecuador	2006	49	96	No	2014	8	37,632	S
18	ChacE	Chaco, Ecuador	2005	70	36	No	2014	9	22,680	S
19	RichS	Richtersveld, South Africa	1991	162,445	0.1	No	2015	24	389,868	10
20	KitK	Kitengela, Kenya	2000	4,650	10[4]	No	2017[2]	17	790,500	11
21	MenM	Menabe, Madagascar	2003		n.d.	No	2008	5	42,500[1]	12
22	TurtT	Sea turtle nest, Tanzania	2001		5.3	No	2014	13		S
23	BirwCa	Bird watch & ecotourism, Cambodia	2004	25,165[3]	0.2	No	2017[2]	13	65,429[1]	13
24	BirnCa	Bird nest protection, Cambodia	2002	200,000[3]	92.5	No	2017[2]	15	277,500,000[1]	14
25	SocE	SocioBosque, Ecuador	2008	1,468,306[3]	30[4]	No	2017[2]	9	396,442,620[1]	15
26	JesH	Jesús de Otoro, Honduras	2002	74	12.4	No	2014	12	11,011.2	S
27	HerCR	Heredia, Costa Rica	2002	2,021	45.4	No	2014	12	1,101,040.8	S
28	SanNC	San Pedro del Norte, Nicaragua	2003	39	26.3	No	2014	11	11,282.7	S
29	KulN	Kulekhani, Nepal	2006	12,492[3]	17.5	No	2014	8	1,748,880	16
30	DonV	Da Nhim PWS, Dong Nai watershed, Vietnam	2009	209,705	15.7	No	2014	5	164,618,42.5	S
31	SonV	Son La PWS, Vietnam	2009	50,900	21	No	2014	5	5,344,500	S

32	OacI	Oach Kalan—Kuhan mini micro watershed, India	2005	10	2.6	No	2014	9	234	S
33	ZapMX	Saltillo, Zapaliname, Mexico	2006	25,000	25[4]	No	2014	8	5,000,000	17
34	SimT	Simanjiro valley, Tanzania	2005	10,000	0.3	No	2014	9	27,000	S
35	BioN	NRCB management, Namibia	1998	6,767,389	0.3	No	2017[2]	19	38,574,117.3	18
36	CatUS	Catskills, NYC, USA	1997	272,592	234	Yes		21	1,339,517,088	19
37	UlgT	Tanzania, PWS	2009	2,240	167.4	No	2016	7	2,624,832	20
38	SilNC	Silvopastoril, Nicaragua	2003	3,139	65.5	No	2005	2	411,209	S
39	SilCR	Silvopastroril, Costa Rica	2003	3,124	77	No	2005	2	481,096	S
40	CidIS	Cidanau watershed PES scheme, Indonesia	2005	100	350[4]	No	2014	9	315,000	21
41	TreU	Uganda, Trees for Global Benefits Programme	2003	1,320	52.1	No	2017[2]	14	962,808	S
42	FirPH	Philippines, No Fire Bonus Scheme	1996	37,500	6.2	No	1998	2	465,000	S
43	TreMZ	Mozambique, carbono.	2002	8,000	60[4]	No	2014	12	5,760,000	22
44	TreMX	Scolel Té	1997	8,947[3]	33.4	Yes		21	6,275,425.8	23
45	MonMX	Monarch	2000	13,551	14.5	No	2014	14	2,750,853	S
46	PwsG	PWS en Munich	1993	1,800	380[4]	No	2014	21	14,364,000	S
47	SumIn	Sumberjaya AF conservation auction	2007	25	171	No	2009	2	8,550	24
48	RefK	Reforestation conservation auction in W Kenya	2009	9	44	No	2011	2	792	S
49	FuqCo	Fuquene, Colombia	2004	202	385.1	No	2014	10	777,902	S
50	KmpfB	Noel Kempff Mercado REDD+project	1996	642,184 [3]	0.6	No	2014	18	6,935,587.2	25
51	PesCR	Payments for Environmental Services (PSA)b, Costa Rica	1997	250,000	71[4]	No	2014	17	301,750,000	26

(*Continued*)

Table 1.1 Continued

Id	*Id_L*	*PES program name*	*Year of start*	*Program size (ha)*	*Total payment (USD/ha/year)*	*Still running*	*Year ended*	*# of years*	*Program overall payment ($)*	*References**
52	MunCo	CIPAV- La Salvajina & PNN Munchique, Colombia	2011	42	1,173.8	No	2014	3	147,898.8	S
53	MakMa	Makira WCS Madagascar	2005	345,764	1	No	2017(2)	12	4,149,168	27
54	LrcB	Landrace conserv payments Bolivia & Peru	2010	8	1,700	No	2012	2	27,200	S
55	BfeB	Bolsa Floresta—Brasil	2010	589,611(3)	60	Yes		8	283,013,280	S

Notes: The information in this table is based on Table 1 in Ezzine-de-Blas et al. (2016), with the updated sources listed at the end of this table. The cells with superscript numbers are the places with updated information based on the source listed in the last column: (1) for overall program payment, (2) for the year ended, (3) for program size, and (4) for total payment.

References of Table 1.1:

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2. The original paper by Ezzine-de-Blas et al. (2016).
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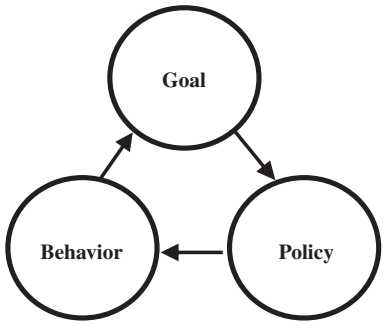

Figure 1.1 Elements of green initiatives. The circles represent the three key elements, and the arrows the influences between elements.

million ha; China Forestry Network, 2013), then the total area of the 56 (55 + 1) PES programs may increase to 178.57 million ha, more than the area of Iran ("World Population Review", 2019).

Regardless of the differences in detail, green initiatives primarily contain the following three elements (Figure 1.1): initiating a *policy*, engaging people in a particular *behavior* or change(s) in *behavior*, and achieving specific *goals* in terms of, e.g., conserving natural capitals, protecting biodiversity, and achieving climate neutrality (Ocasio-Cortez, 2021). The current research focuses on the links between the three elements of the same green initiative: how a certain *goal* may stimulate and formulate a specific *policy*, how a specific *policy* may provide incentives or motivations for people to engage in a particular *behavior* or changes in previous *behaviors*, and whether and how such *behavior* or changes in behaviors may help achieve the *goal*. Undoubtedly, it is imperative to study these elements and the relevant links among them.

1.2 Green initiatives in practice

We begin with introducing several green initiative programs as examples, showing what they are, how they work in real socio-environmental contexts, and what challenges are present in these programs. These programs are selected to cover regions or program types that are not included in the coming chapters.

1.2.1 Incentive-based programs in Nepal

The Chitwan National Park (CNP), Nepal was established in 1973 with the management responsibilities given to the Department of National Parks and Wildlife Conservation. With the Nepali army in charge of enforcing park regulations, resource collection is prohibited in the park except for a 3-day grass gathering

window. This policy gave rise to several negative outcomes for local people, which triggered the national park agency and its various partners to develop new complementary policies in the park's buffer zones. Specifically, such policies aim to develop incentive-based programs (IBPs), which can empower local people, e.g., by offering skill training. Furthermore, these policies develop revenue-sharing mechanisms, sustainable extraction regulations, and tourist markets. These programs have a very important goal of continued, sustainable ecosystem protection, which is realized through creating linkages between the social/economic benefits and conservation efforts (Nepal & Spiteri, 2011).

In a survey administered to 189 randomly selected household heads in 2004, questions were asked about their perceptions of program benefits, linkages between conservation and livelihood, and attitudes toward park management. The survey results suggested that because IBPs provide many benefits to local people, it successfully established a perceived direct connection between benefits and livelihoods. About 99% of respondents felt it was good that the land was protected. Tourism turns out to be the primary source of funds, and the continuation of future benefits depends on preserving the park that attracts tourists. Of the survey respondents, 62% reported having obtained benefits from tourism. Of that percentage, 53% had a household member directly employed in tourism services (Nepal & Spiteri, 2011).

However, these policies are reported to have some weaknesses because they are limited in altering the extractive behaviors of local residents. The policies are unable to deliver benefits to the broader population surrounding the park. Villagers far from tourist entry points recognize fewer benefits than the gateway village. Also, extraction opportunities are limited. As a result, the actions of villagers do not always support the views that they express about the importance of conservation. Residents surrounding CNP continue to disregard legal restrictions on resource collection. "Poaching in CNP is often carried out to fulfill subsistence needs of local people, including the collection of forest products for house construction, livestock fodder, and consumption" (Nepal & Spiteri, 2011).

It turns out that IBPs will not guarantee a permanent abandonment of negative behaviors in relation to conservation. Only when benefits outweigh opportunity costs will positive behaviors continue. One major concern is that IBPs may lose persuasion when alternative options that provide greater economic benefits arise. Therefore, "the social and ecological circumstances surrounding CNP suggest IBPs will never preclude the need for effective enforcement mechanisms" (Nepal & Spiteri, 2011).

1.2.2 Multiple green initiatives in Europe

Europe has adopted an integrative conservation approach, which features the High Nature Value farming program. This program aims to connect ecology, land use, and public policies. Woody pastures contribute to landscape-level biodiversity, which simultaneously acts as a repository of genetic resources. This program promotes a range of management practices, including crop rotation, grazing, shrub clearing, and pollarding (a pruning technique), which are instrumental in

protecting biodiversity and changing landscape mosaics. Aiming to restore woody pasture landscapes, these practices are widely used as a conservation management method in Western Europe. However, wood-pastures were facing abandonment in recent years (Plieninger et al., 2015).

The Common Agricultural Policy (CAP) provides essential economic support to farmers sustainably managing wood-pastures. The CAP makes direct payments to low-intensity livestock farmers for a variety of ecosystem services they provide. Currently, CAP has established rules that determine which lands and projects are eligible for funding. Member states of the European Union are given the right to determine tree density levels. However, the European Commission can impose heavy fines on member states that are too lax.

Under the European Union's Rural Development Policy, the European Union can make payments to wood-pasture farmers if their lands go above and beyond environmental standards established by CAP. While precise data are not available, few wood-pastures have been involved in this program. Therefore, the support for wood-pastures from the Rural Development Policy could be much more intensive. Additionally, this policy also establishes agro-forestry systems on agricultural land.

A pan-European network of protected areas, known as Natura 2000, is at the core of the European Union's Habitats Directive, which maintains and restores natural habitats. Of the 233 natural habitat types included in this directive, 65 of them have some relationship to wood-pastures even though many are referred to as forest habitats. The criteria for forest habitats under Natura 2000 call for the restoration of tall, ungrazed, dense forests which do not allow sustainable livestock grazing in forests and do not safeguard wood-pastures (Plieninger et al., 2015).

Therefore, there are many policy contradictions surrounding the conservation of European woody pastures. The CAP supports low-intensity farming, while the Rural Development policy seems to supplement those efforts yet also contradicts them by promoting agro-forestry. The Natura 2000 and EU Habitat Directive seem to contradict the CAP.

The study by Pleininger et al. (2015) introduces the CAP as a conservation policy, yet the CAP is more of an overall agriculture policy for the European Union that dates back to the early 1960s. More recent CAP reforms include conservation programs and policies. This is probably why conservation policies within CAP contradict the Habitat Directive and Natura 2000 which were primarily developed for habitat conservation purposes. This issue is probably inherent in other policy contradictions as well. Although programs or policies may consider themselves "green" or "sustainable", their primary goals could be very different or even conflict with one another, which might stall the advancement of other conservation programs or policies.

1.2.3 Green policy-mix in Brazil

The Brazilian Forest Code was established as a federal law, which demands a percentage of rural properties or areas to be maintained as a permanent forest

reserve. As of 1996, deforestation was prohibited in 80% of private landholdings in the country's "Legal Amazon" region. However, controversies began to surround this policy. Landowners were not able to easily invest in these areas; for instance, they rarely occupied streambanks with crops and pastures. In parallel to this, governments at various levels did not have the capacity, nor will, to enforce it fully (May et al., 2012).

While the Forest Code continued to maintain the legal baseline, the federal government established an Ecological-Economic Zone (EEZ) in various states within the "Legal Amazon". This policy allocates credit and other public incentives, allowing the reserved area to be reduced to 50% in designated, productive-use areas if they are involved in the EEZ. Forests may be managed for timber and non-timber forest production extraction. Landowners, if not complying with this EEZ policy, must restore forests up to required, baseline limits or purchase "compensation" land elsewhere (May et al., 2012).

Similar to the federal Forest Code, Social, Ecological, and Economic Zoning is implemented as a state zoning strategy. Areas that fall within this policy are part of the PROBIO 2005 listing, which supports Brazil's national policy. This state-level policy also complies with the United Nation's Millennium Development Goals and 2020 Targets adopted in COP10 in Nagoya. These zones have generated controversy, however. Landowners have called for reductions or elimination of the zones. Local, state, and federal authorities have debated microzonation involving local communities.

A complementary policy that aids in conservation is the 1998 Environmental Crime Law. This policy broadens liability for environmental violators, consolidates and imposes greater penalties, and improves the ability of agencies to apply sanctions. At the same time, this policy establishes the liability of corporations and speeds up court proceedings for environmental crimes.

Monitoring of conservation efforts is also enforced at the state level. Since 2000, the State of Mato Grosso has required that all rural properties seek to apply for a license to fell trees, clear brush, and engage in forestry, agriculture, and livestock activities. They must register on an integrated system that relies on satellite images for forest monitoring and inspections with the license. With enrollment waning, a program was launched in 2010 to offer a moratorium on fines in order to stimulate enrollment (May et al., 2012). In addition, a rural credit system complements this program. A direct stimulus for landowners to join the system is the ability to be screened for credit from government banks. Some bank branches require a declaration of compliance with legal reserve requirements and bring properties in line with the Forest Code. Advantageous terms are offered to landowners that are in accordance with environmental codes. Critics of this method claim that environmental restrictions make it more difficult for smallholders to access credit, forcing them to sell their holdings to larger operators (May et al., 2012). Overall, this report portrays a very complementary and synergistic mix of policies at a variety of levels that coordinate to achieve conservation in the Amazon.

1.3 Concurrent green initiatives

The growing impetus to balance ecological and human well-being worldwide has led to simultaneous implementation of multiple green initiatives covering the same geographic area(s) and/or involving the same entities (e.g., persons, households, farms, communities, and groups), which we define as *concurrent* green initiatives. For the popularity of *concurrent* green initiatives, we refer to Section 2.2, where we provide partial evidence that pertains to payments for environmental services only.

Surprisingly, concurrent green initiatives were generally treated as if no-spillover effects (i.e., interrelationships between concurrent green initiatives) existed among them (Figure 1.2), as in the case of the Environmental Quality Incentives Program (EQIP) and the Conservation Reserve Program (CRP)—two of the most extensive concurrent PES programs in the USA (see Chapter 3). Similar to the case in the USA, we have found evidence of spillover effects between two concurrent green initiatives in China's Grain-to-Green Program (GTGP) and Forest Ecological Benefit Compensation (FEBC) Fund. We name this no-spillover presumption, symbolically expressed by the vertical line in Figure 1.2. According to Börner et al.'s synthesis of 14 PES review articles published between 2008 and 2016 (Börner et al., 2017), none explicitly mentioned the existence of concurrent PES programs, let alone examined potential spillover effects among them and the mechanisms underlying such effects. In the very few cases implicitly pointing to interactions between payments (Ezzine-de-Blas et al., 2016; Wunder et al., 2018), very little systematic research—quantitative efforts in particular—has been devoted to revealing and understanding such spillover effects.

Does this no-spillover presumption reflect reality? If not, overlooking these spillover effects may hinder our ability to maximize synergistic effects—or minimize offsetting effects—among concurrent green initiatives. The central goal of this book is thus to determine whether and how such spillover effects exist, understand potential mechanisms behind them, and discuss pathways to escalate the

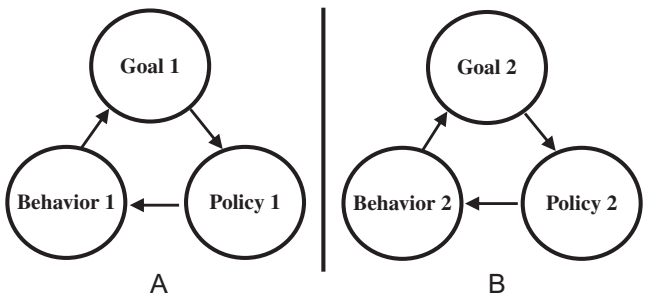

Figure 1.2 Concurrent green initiatives. The vertical line in the middle represents that the two initiatives (one on its left and the other on its right) are treated separately without coordination (i.e., under the no-spillover presumption).

effectiveness of green initiatives. Secondary to this goal, we also aim to show the relevant techniques, models, and methods that are instrumental in detecting the hidden spillover effect between such concurrent green initiatives. This explains why we provide all the data, models (code), and relevant metadata files on the book website (see the Preface of this book).

1.4 A conceptual framework for concurrent green initiatives

Therefore, we design a conceptual framework that examines spillover effects among concurrent green initiatives and integrates the associated elements or links that are displayed in Figure 1.2. We symbolize that Initiatives 1 and 2 stand for two concurrent green initiatives, *Behaviors* 1 and 2 for the (kinds of) behaviors or actions expected from *Policies* 1 and 2, respectively, and *Goals* 1 and 2 for the (kinds of) goals or outcomes expected from *Behaviors* 1 and 2, respectively (Figure 1.3). The current green initiative research broadly focuses on links within the same initiative, specified here as internal links. Specifically, current green initiative literature revolves on (1) whether and in what ways *Policy* 1 may lead

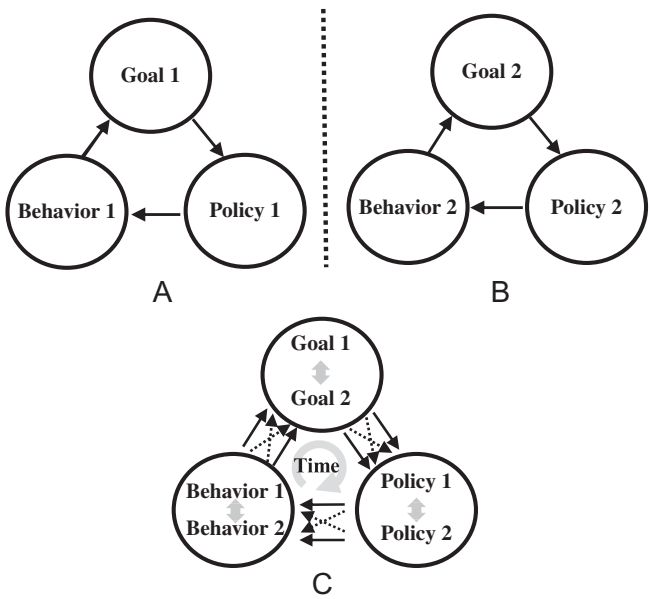

Figure 1.3 Framework for studying concurrent green initiatives. The vertical dotted line stands for removing or minimizing the separation of the two concurrent green initiatives in panels A and B; consequently, we study the concurrent green initiatives as illustrated in panel C. The solid one-way arrows stand for internal influences from one element to another within the same initiative, while the dashed one-way arrows and double two-way arrows for potential spillover effects across different initiatives. The circular one-way arrow represents Time–Time spillover effects.

to *Behavior* 1, generating the *Policy–Behavior* internal link; similarly, current research may explore another internal link from *Policy* 2 to *Behavior* 2, etc.; (2) whether and how *Behavior* 1 may lead to positive (occasionally negative or no) changes in *Goal* 1, such as intended ecosystem services, which represents the *Behavior-Goal* internal link; and in less frequent cases, (3) how changes in *Goal* 1 may loop back and affect *Policy* 1, the original policy scheme, represented as the *Goal–Policy* internal link (Figure 1.3).

What this framework clarifies is the potential spillover effects among concurrent payments (Figure 1.3C). We posit that *Policy* 1 may also affect *Behavior* 2 via *Policy–Behavior* spillover effects. Note that numbers 1 and 2 are interchangeable, as this statement also applies to a spillover effect from *Policy* 2 to *Behavior* 1 (the same hereafter). Similarly, *Behavior* 1 may affect *Goal* 2 via *Behavior-Goal* spillover effects. Equally important is that changes in *Goal* 1 can loop back and affect not only *Policy* 1 via a *Goal–Policy* internal effect (Figure 1.2) but also *Policy* 2 via a *Goal–Policy* spillover effect.

Furthermore, *Policy–Policy* spillover effects may exist, suggesting that one policy directly affects another. To examine such *Policy–Policy* spillover effects, we leverage the current PES stacking literature (for more detail, we refer to Chapter 2). First, horizontal stacking refers to multiple payments made to different parcels of the same recipients, who may respond to these payments differently (e.g., due to time limit) and thus offset or strengthen the goal(s) that would have come out had only one payment been implemented. Second, vertical stacking means that payments are made on the same (or overlapping) parcels, which are often owned or operated by the same recipients. The third type of stacking is temporal stacking, where a landowner receives only one payment at a certain time, yet may receive other payments for different ecosystem services at later times. For more information about these types of stacking, we refer to Section 2.3. Similarly, *Behavior–Behavior* spillover effects and/or *Goal–Goal* spillover effects may occur (Figure 1.3).

In addition to addressing internal links (solid arrows in Figure 1.3), we propose systematically examining spillover effects (dashed arrows in Figure 1.3) and identifying the direction, magnitude, and potential mechanisms behind them. Inspired by the temporal stacking of payments for environmental services, we propose that a temporal dimension (the circular one-way arrow with a Time label; Figure 1.3C) is essential, indicating that internal and spillover effects may evolve.

1.5 The area-based conservation concept

Protected areas serve as the foundation of biodiversity conservation, and more recently, areas outside of protected areas called "other effective area-based conservation measures" (OEABCM) have been recognized for their contribution to nature conservation (Jonas et al., 2014; Maxwell et al., 2020). The Convention on Biological Diversity (CBD) defined area-based conservation measures in 2018 as

> a geographically defined area other than a protected area, which is governed and managed in ways that achieve positive and sustained long-term outcomes

> for the *in situ* conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values
>
> (CBD, 2018).

In 2018, 193 parties of the CBD adopted 20 "Aichi Targets", including Aichi Target 11 that commits governments to conserve ≥17% of terrestrial and >10% of marine environments globally, especially areas of high conservation importance for biodiversity through securing protected areas or "other area-based conservation areas". Target 11 provides a challenge that will require accelerating designation of appropriate protected areas and securing "other area-based conservation areas" specifically targeted toward biodiversity.

Land-use planning for systematic conservation has begun to incorporate policy tools for sustainable use and restoration of biodiversity and ecosystem services, especially for production landscapes outside of protected areas (Xu et al., 2021). Under OEABCM, programs include areas designated for other management purposes. These areas generate a spectrum of cobenefits, such as supporting the fabric of biodiversity conservation and connectivity on the broader landscape. Examples of areas under the OEABCM concept include places receiving payments for ecosystem services, conservation easements or private conservation lands, military areas, community forests, designated areas with land stewardship implemented by local communities and indigenous peoples, and sustainably managed forestry or fisheries. Deficiencies have been identified in implementing Aichi Targets through inadequate national policy response, funding shortages, science-policy knowledge gaps, and imperfect review mechanisms that can be addressed for more effective implementation of the upcoming post-2020 Global Biodiversity Framework (Xu et al., 2021).

The European Union implemented the European Green Deal to meet the global IUCN Global Standards for Nature-based Solutions. A core part of the European Green Deal includes 2030 Biodiversity Strategies that aim to establish protected areas for 30% of land in Europe and 30% of the sea in Europe. The Green Deal adopts the concept of area-based conservation measures, restoring degraded ecosystems and lands. For instance, the Green Deal promotes sustainable agriculture (e.g., increasing organic farming and biodiversity-rich landscape features on agricultural lands) and aquaculture, reforestation, green infrastructure, river and peatland restoration, and natural coastal protection.

Other conceptual contributions and policy tools have sought to consider meeting specified "retention targets". These targets focus on securing habitat areas that support interconnected biotic and abiotic attributes comprising the corresponding ecosystems (Simmonds et al., 2020). In this way, these areas seek to retain certain species or ecosystem functions as their overarching target. Alternatively, the restoration of degraded land has been the goal of the United Nations' Decade of Ecosystem Restoration program, which aims to restore 350 million acres of land by 2030 and halt and reverse global degradation. However, identifying priority areas on the landscape for restoration becomes challenging in the complexity of ecological,

economic, and biocultural considerations. In the USA (Chapter 3) and China (Chapter 4) cases, we design and implement area-based conservation experiments, showing practical ways to maintain the total area of two green initiatives unchanged in the context of budget cuts (more information in Section 1.6).

1.6 The COVID-19-induced budget cuts on green initiatives

The COVID-19 pandemic has placed extensive budget pressure on countries, regions, and organizations worldwide, already or potentially leading to cuts to various sectors, including green initiatives. According to literature, very little of the US$9 trillion of fiscal spending toward the pandemic has been allocated to green policies (Barbier, 2020). The mounting financial burden accruing as part of the COVID-19 pandemic relief efforts has been ravaging economies, which has consequently tied up many financial resources previously anticipated for ensuring progress toward Sustainable Development Goals (SDGs), especially for environmental programs in mitigating climate change, water-related services, and biodiversity (Barbier & Burgess, 2020). Post-pandemic strategies for policy-based environmental programs may involve restructuring distorted policies, which can initiate a transformative reform through approaches such as analysis of policy-mix designs.

Programs like the United Nations' Green Climate Fund (GCF) and the European Union's Green Deal have witnessed the impacts of this crisis on the limited financial resources available to deal with multiple and overlapping issues. These programs have been contending with the high costs of implementing climate adaptation and mitigation actions (Antimiani et al., 2017) and seeking synergies to leverage resources effectively (Markard & Rosenbloom, 2020). These programs require rethinking how transitions toward sustainability can be long-term commitments, requiring policy-mix designs for spending and finance reforms. There are calls for a closer coupling of socioeconomic and environmental goals, seeking to reevaluate policies about air pollution, forestry, and trade in nature-based goods and services to make post-quarantine economic recovery toward a sustainable trajectory (López-Feldman et al., 2020).

A report by the United Nations shows that more than half of the national statistical offices in low-income or lower-middle-income countries encountered COVID-19-related funding constraints. Such constraints are significantly impacting data production for measuring the progress of implementing Sustainable Development Goals (SDGs) (United Nations, 2020, p. 81). In another instance, over 800 research projects worldwide were affected by a significant budget cut to the UK Research & Innovation program, where the reduction in budget ranged from ~US$580 million to ~ US$172 million for the fiscal year of 2021–2022 due to the COVID-19 pandemic (Barclay et al., 2021). The UK's Global Challenges Research Fund experienced similar impacts, and a nearly 50% cut was reported (Foulds et al., 2021).

In the European Union's meeting on July 21, 2020, a budget negotiation reached an agreement on expenditure cuts to essential climate and environmental

programs, despite a substantial share of the pandemic recovery budget allocated for climate protection (International Institute for Sustainable Development, 2020). Among the impacted funding pots that carry green goals (e.g., reducing greenhouse gas emissions from burning fossil fuels), InvestEU had a budget cut by 87%, from EUR 31 billion (~US$37.39 billion) down to less than EUR 4 billion (~US$4.82 billion), and the Just Transition Fund was cut by more than half from EUR 37.5 billion (~US$45.23 billion) to EUR 17.5 billion (~US$21.11 billion) (Reuters News, 2020).

Several Latin American countries have announced a reduction in funds allocated for promoting environmental protection and combating climate change (López-Feldman et al., 2020; Mohan et al., 2021). For instance, 75% of the total budget of the National Natural Protected Area Commission in Mexico was stripped by the federal government (SEGOB, 2020), meaning the cessation of protection for the 25 protected areas regulated by the Yucatán peninsula offices (Varillas, 2020). In El Salvador, with the approved reform of the Budget Law on June 4, 2020, the Ministry of Environment and Natural Resources faced a reduction of US$1.4 million, a shrinkage of 63% of the resources for protecting natural landscape and wildlife (GatoEncerrado, 2020).

Green funds for protected and conserved areas are severely impacted by the pandemic crisis (IUCN Press, 2021). From January to October 2020, a total of 64 cases from at least 22 countries were found to have experienced rollbacks on green initiatives, especially for environmental protection, which is accompanied by a drastic reduction in budgets for preserved areas (Kroner et al., 2021). A synthesis survey at the global scale showed that half of the protected areas reported cuts in national government funding as a result of the pandemic, and the pandemic most severely impacted conservation efforts in Latin America, Africa, and Asia, with a budget reduction up to 60–70% (Waithaka et al., 2021). According to another survey from 60 countries, 20% of the protected area rangers lost their jobs, and more than 25% experienced salary cuts or delays due to COVID-19-related budget shortage (Singh et al., 2021).

Environmental funding reductions in coping with the pandemic are also observed locally or regionally. For example, the government of Alberta (Canada) decided a province-wide cut of $5 million (Canadian dollars) of the 2020–2021 budget by entirely or partially closing 20 provincial parks that have critical conservation values for supporting rare local plants and wildlife (CBC News, 2020). The marine preserved area in Nusa Penida (Indonesia) lost 50% of the government funding reallocated to prioritize COVID-19 responses and the loss of tourism revenue (Phua et al., 2021). Facing a budget deficit of nearly US$9 billion under the COVID-19 crisis, the Parks Department of New York City suffered a cut of US$84 million (15%) from the US$540 million budget, threatening the essential services provided by well-managed parks (Columbia Climate School News, 2020; The Hill News, 2020). California ceased the ambitious plan of climate catalyst that aimed to provide a US$1 billion green loan fund for environmental projects (CalMatters, 2020).

1.7 Summary

Green initiatives are widespread across the world with increasing popularity. In many instances, these initiatives are developed and implemented on a piecemeal basis, lacking overall, comprehensive, and systematic thinking. On the other hand, concurrent green initiatives are becoming prevalent globally, yet very little attention has been given to them. These challenges may give rise to hidden losses or cobenefits in these green initiatives.

Maintaining a considerable amount of protected areas and "other effective area-based conservation measures" is crucially important to conserve nature and vital products and services. This concept accounts for the area-based conservation experiments in Chapters 3 and 4, where we aim to keep constant—at least minimize the loss of—the total area of two or more green initiatives given some level of budget cut. Facing unprecedented challenges such as the COVID-19 pandemic and the subsequent financial crisis, the conservation community should seek to utilize existing funds and resources efficiently. In this regard, we explore a set of measures: integrating and synergizing various policy instruments, minimizing redundancies in green initiative efforts, and exploring pathways that lead to sustainable human–environment dynamics in the following chapters.

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