**Technical assessment for**

**Indigenous Peoples’ Forest Management**

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**Prepared by:**

Adrien Salazar, Research Fellow

Abby Rubinson, Research Fellow

Jimena Alvarez, Research Fellow



27 GATE 5 RD., SAUSALITO, CA 94965 [info@drawdown.org](mailto:info@drawdown.org) [www.drawdown.org](http://www.drawdown.org)

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# Executive Summary

Granting indigenous peoples and local communities secure tenure to manage their lands results in carbon benefits in the form of carbon sequestration and CO2 emissions reductions from avoided deforestation on those lands. The legal area under indigenous people’s management is far lesser than the area sustainably managed by them since centuries. Thus, increasing the area of Indigenous Peoples’ forest land represents substantial potential contributions to both reductions in carbon emissions and increases in carbon sequestration. In addition to these mitigation benefits, tenure-secure indigenous and community land management contributes to many co-benefits, including the conservation of biodiversity, the maintenance of a range of ecosystems services, and the preservation of social and cultural systems.

Out of a total land area available for the solution of 1,057 million hectares, the current solution adoption (2014) is 467 million hectares (44.2%). Starting from this adoption value and based on a historical evolution of protected forest area and two different degradation rates, ten custom PDS adoption scenarios were developed for this solution which were combined to produce the *Plausible*, *Drawdown* and *Optimum* scenarios.

In the *Plausible* Scenario, 930 million hectares come under protection totaling 88% of total land area in 2014. Climate impact is 3.56 gigatons of carbon dioxide equivalent. Total carbon stock protected is 643.56 gigatons of carbon dioxide equivalent with the prevention of 8.74 million of non-degraded forest from future degradation.

In the *Drawdown* Scenario, 1,057 million hectares come under protection totaling 100% of total land area in 2014. Climate impact is 5.27 gigatons of carbon dioxide equivalent. Total carbon stock protected is 729.79 gigatons of carbon dioxide equivalent with the prevention of 12.70 million of non-degraded forest from future degradation.

In the *Optimum* Scenario, 1,057 million hectares come under protection totaling 100% of total land area in 2014. Climate impact is 5.78 gigatons of carbon dioxide equivalent. Total carbon stock protected is 727.62 gigatons of carbon dioxide equivalent with the prevention of 13.67 million of non-degraded forest from future degradation.

Financials are not modeled.

# Literature Review

## State of the Practice

Indigenous peoples who manage their natural resources with traditional practices, tools, and knowledge are among those most dramatically impacted by climate change around the world, despite contributing among the least to its causes (Tauli-Corpuz 2015). Due to their resource-based livelihoods; location in vulnerable environments such as small islands, high altitudes, and desert margins; and histories of colonization and social marginalization, indigenous communities are particularly vulnerable to the negative effects of environmental change. As the ecosystems on which indigenous and local communities depend face climate change, these communities are already adapting—using local knowledge, traditional practices, and scientific technologies to adapt their livelihoods and management of local resources to climate change and its effects (Galloway McLean 2010).

Beyond adapting, indigenous peoples and local communities are employing tools and technologies that contribute to mitigating climate change. Indigenous communities have historically contributed to reducing greenhouse gas emissions by resisting deforestation; mineral, oil, and gas extraction; and the expansion of monocrop plantations (Tauli-Corpuz and Lynge 2008). Moreover, traditional practices have developed historically over time in response to dynamic ecosystem changes and to demand for sustainable use of resources over generations, allowing hundreds of millions of indigenous people to manage their resources sustainably for generations with carbon-neutral or even carbon-negative lifestyles (Tauli-Corpuz and Lynge 2008). Such practices include subsistence farming, swidden or shifting agriculture, agroforestry, and fire management (Nakashima et al. 2012).

Central to these practices, considerable evidence demonstrates that secured forest tenure for indigenous peoples and local communities contributes to positive forest health outcomes, including reduced deforestation and degradation, increased carbon sequestration rates, and enhanced biomass growth, compared to similar forest without tenure security (Stevens et al. 2014a; Skutsch and Solis 2012; Nolte et al. 2013; Blackman 2015; Asner et al. 2005; Nepstad et al. 2006; Porter-Bolland et al. 2012; Nelson and Chomitz 2011). For example, community and indigenous forests in Brazil “store 36 percent more carbon per hectare, and emit 27 times less carbon dioxide from deforestation than forests not under community control” (White et al. 2016) citing Stevens). Demonstrating the correlation between secure tenure reduced deforestation, a study in the Brazilian Amazon found that a 10% decrease in insecurity induced a 7% decrease in annual deforestation rates (Araujo et al. 2009).

This Drawdown solution—Indigenous Peoples’ Forest Management—demonstrates the carbon benefits, including reduced CO2 emissions and increased carbon sequestration, of securing tenure for indigenous peoples and local communities. More specifically, this solution assesses net carbon benefits from increasing the area of forest lands to which indigenous peoples or local communities have tenure security, i.e., where forest lands are legally recognized as owned by them or designated as theirs (IPC forest lands). Secure land tenure in form (*de jure*), such as granting title, is not necessarily enough to promote positive forest outcomes. Rather, where effective, secure land tenure encompasses a number of rights, including access; withdrawal or use of the forest’s resources; management; exclusion of others from accessing or using the forest; due process and compensation for government taking of forest rights; duration of tenure; and transfer of the forest to someone else (Stevens et al. 2014b). Thus, this Solution pertains to secure tenure encompassing these rights.

***Indigenous Peoples’ Forest Management Practices***

Indigenous peoples’ forest management encompasses numerous practices, including long-rotation swidden agriculture, non-timber forest products, guiding succession to encourage useful species, and fire management. These practices have been correlated with carbon benefits. For example, swidden cultivation, also known as shifting cultivation or managed fallowing, refers to the burning and clearing of forest land for annual cultivation and the subsequent fallowing of the land over some period to allow regeneration (Roder, Phengchanh, and Maniphone 1997). The dynamics of soil and vegetation succession under swidden cultivation mimic secondary forest succession. Long-term agriculture-forest rotations enable smallholders, particularly in tropical forest regions, to derive multiple products, including cultivated crops, from productive landscapes. While estimates of the extent of swidden cultivation vary widely, relatively recent estimates suggest 37 million people are practicing swidden cultivation on 1 billion ha of land in the tropics (Dixon, Gibbon, and Gulliver 2001). Swidden cultivation is one of the oldest forms of agriculture still practiced today by indigenous peoples and communities.

Unlike short-rotation slash-and-burn agriculture, which is inefficient and destructive to forests and soils, long-term swidden rotation has been shown to have a variety of benefits relative to conversion to permanent agriculture, including improved diversity of food sources and carbon conservation (Ziegler et al. 2011). In fact, numerous studies have shown that swidden cultivation can aid in re-accumulation of carbon during the recovering fallow period (Kotto-Same et al. 1997; Tschakert, Coomes, and Potvin 2007; Trakansuphakon 2015; Tschakert, Coomes, and Potvin 2007; Mutuo et al. 2005; Sanchez et al. 2005). Conversely, transitions from long-rotation swidden systems to annual cropping or short-term fallowing have been shown to reduce time-averaged carbon stocks significantly (Bruun et al. 2009).

To provide another example, indigenous peoples have used fire management to create habitats for useful plant and animal species and control vegetation growth, to keep forest and countryside open, including through forest clearings and prairies, and to comply with cultural obligations (Garde et al. 2009; Fulé et al. 2011)(Storm and Shebitz 2006). Traditional fire management employs low-intensity, early dry season burns to clear vegetation, reducing the prevalence of and intensity of fires, and mitigating area burned, which substantially reduces greenhouse gas emissions. Suppression of biomass can result in carbon losses. Natural fires repress optimum biomass in ecosystems around the world, and thus variations in fire regimes can influence carbon storage in soil and vegetation, and produce non-CO2 emissions. Fire regimes thus can have a significant impact on both biomass production and carbon emissions.

Indigenous and community management of forest lands has taken place for centuries, and encompasses forest lands that are stewarded, used, and actively managed by indigenous peoples and local communities. According to the World Bank, roughly 60 million indigenous people are entirely forest-dependent, and about 350 million people living in or next to forests are highly dependent on forests for subsistence and income (World Bank 2004). In some instances, states formally recognize forest lands as owned or managed by indigenous peoples or local communities. However, much indigenous- or community-managed forest land lacks official recognition and occurs under traditional practices and customary law.

Historically, this was not the case; rather, indigenous peoples controlled the lands on which they lived. Yet, as a result of colonization—and its disregard for indigenous peoples’ governance systems and destruction of indigenous peoples’ lives and cultures – indigenous peoples largely lost legal recognition and control over their lands. Thus, the current status of IPC land ownership reflects the post-colonial situation. This Solution would restore indigenous peoples’ legal control over lands they once owned.

Underpinning the global potential for increased carbon sequestration and avoided deforestation on tenure-secure forest land is the gap between the substantial proportion of global forest land area that is managed by indigenous peoples and local communities under customary law without legal recognition (3320 Mha (Rights and Resources Initiative 2014b; Alden Wily 2011)), and the small proportion of that land which is IPC forest land, *i.e.*, legally recognized as owned by or designated for indigenous peoples and local communities (513 Mha (Rights and Resources Initiative 2014b)). This Drawdown Solution thus analyzes the carbon-benefit potential of granting formal land tenure to indigenous peoples and local communities.

***Emissions Reduction from Avoided Deforestation***

As comparative global research, including 130 local studies in 14 countries, has shown, “legal forest rights for Indigenous Peoples and local communities and government protection of those rights tend to lower deforestation and carbon emissions, whereas deforestation rates tend to be higher where communities’ land rights are not secure.”(Rights and Resources Initiative 2015) citing (Stevens et al. 2014b). Granting secure tenure to indigenous peoples and local communities would help realize these potential gains in carbon sequestration.

For example, one study found that community forests were deforested on average four times less than neighboring state-protected areas (Porter-Bolland et al. 2012). According to another study, indigenous and community forests in Brazil exhibited 0.6 percent forest loss from 2000 to 2012, compared to 7 percent outside those lands. In terms of emissions, those indigenous and community forests emitted 27 times less carbon dioxide than forests not under community control (Stevens et al. 2014b). Yet another study found deforestation rates 2.0 to 2.8 times lower on indigenous lands versus non-indigenous lands in Bolivia, Brazil, and Colombia ([WRI 2016](http://www.wri.org/sites/default/files/Climate_Benefits_Tenure_Costs.pdf)). Still another found deforestation rates to be 11 times lower in the Brazilian Amazon, 6 times lower in the Bolivian Amazon, and 20 times lower in Guatemala on legally recognized community forests versus outside community forests in those locales.

In Bolivia, from 2000 to 2010, of the 22 Mha of land held by indigenous peoples, only about 0.5 percent of land was deforested, compared to 3.2 percent deforestation in the Bolivian Amazon overall (Stevens et al. 2014b). In other words, deforestation rates were six times lower in lands to which indigenous peoples and local communities held title than in other forests. Comparing indigenous lands located near privately owned forest lands in Bolivia from 1986 to 2009, two indigenous areas covering 400,000 hectares each lost 3.5 percent and 0.25 percent of their forest lands respectively, while neighboring privately owned forest land lost about 25 percent (Stevens et al. 2014b).

Notably, when deforestation pressures are high, indigenous land has been shown to be particularly effective at reducing deforestation pressure relative to protected areas not designated as indigenous peoples’ (Nolte et al. 2013). A 2013 study on the relationship between deforestation and governance—based on data from 292 strictly protected, sustainable-use, and indigenous land areas in the Brazilian Amazon—found that indigenous lands were most effective, compared to the other two kinds of protected areas, in inhibiting deforestation when deforestation pressures were high (Soares-Filho et al. 2010).[[1]](#footnote-1)

The potential benefit in terms of avoided CO2 emissions from avoided deforestation is significant. According to a 2015 study, 9.1 percent of the tropical forest carbon stored across Mesoamerica, Amazonia, the Democratic Republic of Congo, and Indonesia is in indigenous territories lacking official recognition. Keeping this land intact would equate to 76.4 fewer gigatons of CO2 emissions from avoided deforestation, or nearly 1.5 times the global greenhouse gas emissions in 2014 (Woods Hole Research Center and Environmental Defense Fund. 2015. Tropical Forest Carbon in Indigenous Territories: A Global Analysis). The figure below illustrates benefits of securing tenure to indigenous lands in terms of avoided CO2 emissions, as well as the equivalent number of passenger road vehicles.

***Increased Carbon Sequestration***

Beyond carbon benefits in the form of CO2 emissions reductions, “Indigenous Peoples and local communities with legal forest rights maintain or improve their forests’ carbon storage. (White et al. 2016). Indeed, the potential impacts of securing legal forest rights for indigenous peoples and local communities and government protection of those rights are “significant: legally recognized community forests contain approximately 37.7 billion tons of carbon, and much larger amounts are contained within forests held under customary rights without legal recognition.” (Rights and Resources Initiative 2015) citing (Stevens et al. 2014b).

This is because forests “in particular act as an enormous carbon sink,” with the potential to increase carbon storage by as much as three to five gigatons of carbon per year with sufficient reforestation (White et al. 2016) citing (Houghton 2013). As a result, “halting deforestation and land conversion in tropical forests is one of the most effective and immediate steps the global community can take to reduce emissions” (White et al. 2016) citing (Houghton 2013). Given that community-run forests store more carbon than other forests (as shown by a review of 130 local studies in 14 countries), and the vast area of forest land not currently under indigenous peoples and local communities’ control, securing tenure for indigenous peoples and local communities to manage additional forest land would help realize these potential gains in carbon sequestration () citing (Stevens et al. 2014b).

To provide some examples, in Brazil, indigenous community forests “contain 36 percent more carbon per hectare than other areas of the Brazilian Amazon” (Stevens et al. 2014b). In Niger, government protection of communities’ forest rights added 200 million new trees, absorbing 30 million tons of carbon over the past 30 years (Stevens et al. 2014b). In Nepal, support for community forestry has generated a carbon stock of more than 180 million tons across 1.6 million hectares (Stevens et al. 2014b). Illustrating what is at stake, in the Amazon Basin, 22.2% of forest carbon is stored within indigenous territories lacking official recognition, with potential emissions of 23.0 Gt CO2 (Woods Hole 2015). In the Democratic Republic of Congo, indigenous territories—none of which are IPC land—store 31.4% of the aboveground forest carbon, equivalent to 25.4 Gt CO2 (Woods Hole 2015). In Indonesia, indigenous territories – only about 2 percent of which are IPC land—contain 36 percent of aboveground carbon stored in the country’s tropical forests, equivalent to 24.3 Gt CO2. According to a recent local study, an additional 26 Gt CO2 is stored in large, vulnerable carbon stocks below indigenous territories on highly threatened peat ecosystems (Woods Hole 2015 citing Indigenous Peoples’ Alliance of the Archipelago (AMAN)). The figure below shows additional values for carbon storage of legally recognized community forests in Latin America.

Furthermore, analyzing 80 forests in 10 countries, Chhatre and Agrawal found a correlation between high carbon storage and community-owned forest land. More specifically, where communities had local autonomy in making rules about forest management, forest land provided above average carbon storage and livelihood benefits. This effect increased with forest size, indicating that large expanses of secure-tenure forest are more likely to yield high carbon storage rates than small patches of secure-tenure forest land (Chhatre and Agrawal 2009). Similarly, Chhatre and Agrawal found a positive association between government-owned forest commons and low carbon storage. Importantly, the study elaborated on the importance of secure tenure to carbon storage: “[W]hen local users perceive insecurity in their rights (because central government owns the forest land), they extract high levels of livelihood benefits from them, and when their tenure rights are safe, they conserve the biomass and carbon in such forests.” (Chhatre and Agrawal 2009). Thus, they concluded that affording communities greater rights local to make rules about how to govern forests can lead to improvements in carbon storage and livelihood benefits.

***Co-Benefits***

Besides carbon benefits, secure tenure contributes numerous social and economic benefits to communities, including preservation of cultural identities, reduced resource conflicts, improved food security, and enhanced community development (Sunderlin, Hatcher, and Liddle 2008; Ricketts et al. 2010).

## Adoption Path

### Current Adoption

Current adoption is estimated at 5112.5 Mha, some 15.4% of global forest lands (Rights and Resources Initiative 2014).

### Trends to Accelerate Adoption

One indication of a country’s intention to increase forest tenure for indigenous peoples and local communities is whether they have pledged to do so in the context of an agreement. For instance, when countries submitted their Nationally Determined Contributions (NDCs) in relation to the United Nations Framework Convention on Climate Change (UNFCCC), some included clear commitments to implement community-based tenure or natural resource management strategies. However, only 21 countries, representing less than 13 percent of the world’s tropical and subtropical forest area, included such commitments. (Over 70% of those countries are in Africa.) Only one country, Cambodia, tied its commitment to a quantity of forest land, setting a target to reclassify 2 Mha of forest, or 21% of Cambodia’s forested areas, as Community Forests—an almost tenfold increase in area of Community Forests recognized by 2013. These pledges can form the basis for a conservative adoption scenario. At the same time, under a more optimal scenario, the 110 countries with tropical and subtropical forest area that did not include these commitments in their NDCs could nonetheless increase forest tenure to indigenous peoples and local communities. Those 110 countries include many of the largest forested countries with high rates of deforestation, like Brazil and Indonesia (Rights and Resources 2016 citing Keenan, Rodney J., Gregory A. Reams, Frederic Achard, Joberto V. de Freitas, Alan Grainger, and Erik Lindquist. 2015. Dynamics of global forest area: Results from the FAO Global Forest Resources Assessment 2015. Forest Ecology and Management 352, 9-20).

Similarly, United Nations Reducing Emissions from Deforestation and Forest Degradation (REDD+) Programme initiatives often recognize tenure security as a key requirement for success in 28 of the 33 countries participating in REDD+ (RRI 2014). However, only 17 of 64 UN-REDD Programme Partners made clear commitments to implement natural resource management or tenure security for indigenous peoples and local communities in their climate change mitigation strategies (RRI 2016 citing UN-REDD Programme, UN-REDD Programme Collaborative Online Workspace, 2016). While these 17 countries’ commitments provide a plausible basis for inclusion under the conservative scenario, it is entirely plausible that additional countries of the 64 total will also implement tenure security in the next 30 years, under a more optimal scenario.

In Indonesia, 40 Mha of forest land could become IPC forest land with full implementation of a 2013 court decision invalidating a law that had claimed government ownership of customary forests ((Rights and Resources Initiative 2014b). In India, full implementation of its 2006 Forest Rights Act would transfer title to communities based on their customary ownership such that IPC forest land would comprise 40 percent of Indonesia’ forested lands. Signifying the largest ever land reform in the country, “[t]his could transform India” by putting almost half of India’s forests into the hands of the 150 million people (around half of its rural households) who depend on community or common lands for part of their livelihoods (Rights and Resources Common Ground April 2016). As a result, IPC forest land is projected to increase by at least 40 Mha (Rights and Resources 2015).

Even more promising, “[s]everal land and forest reform processes are underway, particularly in Africa. Reform of land law is currently being discussed in Cameroon, Democratic Republic of the Congo, Kenya, and Liberia, while forest law reform processes are underway in Cameroon, the Republic of the Congo, Kenya, Zambia, and Nigeria, as well as in Malaysia and Peru. The results of these processes are likely to have a significant effect on the extent and quality of recognition of Indigenous Peoples and community rights to forest resources and land in the near future.” (RRI 2014).

While indigenous peoples and local communities living on forest land span the globe, a handful of countries account for all of the area under indigenous and community ownership or control. According to a Rights and Resources Initiative (RRI) study using data from 2002 to 2013, five countries accounted for 80 percent of the total forest area legally owned by indigenous peoples and local communities in 2013. “China and Brazil account[ed] for 55 percent of the global area, while Colombia, Mexico, and Papua New Guinea account[ed] for another 25 percent.” RRI 2016. Three countries – Brazil, India, and Tanzania – accounted for 84% of forest area designated for use by indigenous peoples and other communities. At the other end of the spectrum, another study found only 0.5% of forest land in sub-Saharan Africa to be community owned (Alden Wily 2011). Sampling 18 African states, that study found forest ownership by communities and indigenous groups in only three: Tanzania and Mozambique, each with about 2 Mha of community-owned forests, and the Gambia, with 0.03 Mha (Alden Wily 2011). In Madagascar, only 2 Mha of forests are community owned, compared to 12.7 Mha of forests that are government property (RRI).

In the past two decades, local communities and users acquired use and management rights to over 200 Mha of forest land across 60 countries (Chhatre and Agarwal citing Sunderlin, Hatcher, Liddle).

Examining forest trends from 2002 to 2013 in 52 countries representing 90% of global forest land area, the Rights and Resources Institute documented an increase in global IPC forest area from 385.24 Mha in 2002 to 512.64 Mha in 2013 (Rights and Resources Initiative 2014b; FAO 2010). This corresponds to a percentage of IPC forest lands as a proportion of all forest lands from 10.8% to 15.4% during that period. Although this increase in IPC forest land largely resulted from states’ increased recognition of indigenous and community forest rights between 2002 and 2013, the security of new rights recognized since 2008 is qualitatively weaker. This outcome reinforces the need for IPC land with rights with effectively secure tenure.

Of 27 countries representing about 41% of global forest area, 24 had enacted at least one domestic legal regime recognizing some form of community forest tenure between 2002 and 2013. This represents a notable change, especially given that in 2002, nine of those countries did not recognize the rights of indigenous peoples and local communities to forest land and resources in their national laws (Rights and Resources Initiative 2014b). At the same time, of 280 Mha of protected forest area in 30 African states, less than 5 Mha will become or is designated to become Community Forests due to new forest laws in those states.[[2]](#footnote-2)

### Barriers to Adoption

The percentage of government-owned forests is high in several regions, for instance 85% in Europe, 95% in 17 sub-Saharan African countries, 99% in peninsular Southeast Asia and 73% in archipelagic Southeast Asia (Alden Wily 2011); (Rights and Resources Initiative 2014b). Not counting China, (which alone accounts for 78% of Asia’s IPC forest land), only 10% of Asia’s forest land is under community ownership (Rights and Resources Initiative 2014b). Thus, “significant forest tenure reforms in peninsular … and archipelagic Southeast Asia … would be needed to shift the balance of government and community forest rights in Asia” (Rights and Resources Initiative 2014b).

Differences in extent of forest land, existing land tenure laws, and government receptivity to enhancement of forest tenure policies can lead to differences in countries’ levels of IPC forest lands. Demonstrating the discrepancy between IPC and total forest land with country-level examples, the table below compares IPC forest land to community forest land without legal recognition in 14 countries collectively representing 68 percent of the estimated total IPC forest area in low- and middle-income countries (about 323 million hectares) (Stevens et al. 2014b).

In four of the eight most-forested countries by area, governments own and control at least 90 percent of their respective forest lands (Rights and Resources Initiative 2014a). The Russian Federation, which holds nearly 20 percent of global forest land, and the Democratic Republic of the Congo each have 100 percent of their forests under government administration (Rights and Resources Initiative 2014a). Indonesia holds 96 percent, and Canada nearly 92 percent, of their respective forests under government control (Rights and Resources Initiative 2014a). These four countries hold over a third of the world’s forests and almost 57 percent of forest land area under government administration, signifying that “the absence of significant tenure reforms in these countries presents major impediments to global progress in the recognition of local rights to forest land” (Rights and Resources Initiative 2014a).

In some countries, implementation of laws remains limited, inhibiting communities from effectively realizing rights accorded to them by statutory laws or court decisions (RRI 2014). For instance, “[i]n sub-Saharan Africa, only seven of 17 forest tenure regimes that recognize the rights of Indigenous Peoples and local communities have been implemented on the ground, primarily due to a lack of implementing laws, regulations, and procedures. This explains, for example, why no area is allocated as local community forest concessions in the DRC, even though the legal basis for such concessions has been established for more than 10 years. The implementation of this regime requires a supplemental decree that has not yet been approved.” RRI 2014. Bureaucratic requirements to gain legal recognition of tenure also pose challenges for increasing land rights. For example, many forestry laws require approval of formal management plans before granting community-based use rights (Alexiades et al. 2013).

Furthermore, pressure on forest land is mounting due to industry demands, and “dominant business models do not respect or promote local rights” (Rights and Resources Initiative 2014a).

### Adoption Potential

To implement this solution globally, indigenous peoples and local communities need recognition of their rights to manage additional land than is currently under their control. Conducting an assessment of lands in 52 countries whose land area constitutes nearly 90% of global forest area, the Rights and Resources Institute found that 15.4% of global forest lands (513 Mha) are IPC lands (Rights and Resources Initiative 2014b). Yet estimates of total forest lands under community management regardless of ownership reach up to 3320 Mha (Rights and Resources Initiative 2014b) (Alden Wily 2011).

## Advantages and disadvantages of Forest plantations

### Similar Solutions

The primary alternative to this solution is keeping forest land under government control rather than securing tenure for indigenous peoples and local communities. For forest land under government control, the likelihood and rates of deforestation are higher, and carbon storage rates are lower, compared to IPC forest land. Furthermore, from a human rights perspective, indigenous peoples have rights to their land, including lands they have traditionally occupied, and placing these lands under government control is inconsistent with those rights.

The primary alternative to this solution is keeping forest land under government control rather than securing tenure for indigenous peoples and local communities. For forest land under government control, the likelihood and rates of deforestation are higher, and carbon storage rates are lower, compared to IPC forest land. Furthermore, from a human rights perspective, indigenous peoples have rights to their land, including lands they have traditionally occupied, and placing these lands under government control is inconsistent with those rights.

Among the disadvantages of securing land tenure are that deforestation can be profitable for governments and/or indigenous peoples and local communities who can sell trees and forest resources. In addition, converting forest land to IPC land could displace deforestation to other forest land (Nolte et al. 2013). From a tactical perspective, securing land tenure can prove difficult given that a large amount of available forest land is in a handful of countries—some of which have difficult political climates for recognizing land rights. Additionally, while indigenous protected areas typically reduce deforestation, deforestation does continue to occur on them (Ricketts et al. 2010; Asner et al. 2005). Nonetheless, a robust amount of evidence indicates that granting indigenous peoples and local communities’ tenure over their forest lands is associated with carbon benefits, including avoided deforestation and enhanced carbon sequestration.

However, the advantages of securing tenure for indigenous peoples and local communities to manage their lands are significant. Correlating with carbon benefits, their lifestyles are low-carbon and thus contribute to climate change mitigation: “There are at least 370 million indigenous people throughout the world practicing mostly sustainable, carbon-neutral, or even carbon-negative, lifestyles, which have sustained them over thousands of years and which make a substantial contribution to the mitigation of climate change” (Tauli-Corpuz and Lynge 2008). Indigenous peoples’ tenure-secure land management has been shown to provide social and economic benefits to communities, including preservation of cultural identities. In addition, because many indigenous peoples and local communities depend on their lands as a food source, securing tenure for their management improves their food security. Other livelihood benefits include enhanced community development. Clear delineation of indigenous peoples’ rights to their land also creates incentives to conserve forests and helps to reduce resource conflicts. Moreover, lower deforestation rates on IPC land allow greater conservation of biodiversity, which is particularly important given the high contribution of forests, particularly tropical forests, to biodiversity. In addition, this Solution’s model underestimates carbon benefits because it does not account for the fact that indigenous peoples’ land has been shown to sequester carbon at a higher rate than non-indigenous peoples’ land. (See Section 1.1, “Increased Carbon Sequestration”; (Stevens et al. 2014a; Skutsch and Solis 2012)).

### Arguments for Adoption

For indigenous communities, the impacts of climate change go beyond impacts to physical landscapes, affecting human rights, cultural and traditional knowledge, and customary governance, as well as having age- and gender-differentiated impacts (Tebtebba Foundation 2012). The IPCC has recognized the unique impacts of climate change on indigenous communities, as well as the contributions of their traditional knowledge and science to the development of effective and culturally appropriate adaptation and mitigation strategies (Field et al. 2014). Numerous government agencies, non-governmental organizations (NGOs) and states across scales are integrating knowledge systems to provide more effective adaptation for vulnerable communities. Effective participation of indigenous and local communities and integration of traditional knowledge and practices in climate change adaptation and mitigation can ensure that climate change solutions are relevant to local contexts and responsive to the needs of the most vulnerable.

### Additional Benefits and Burdens

Here this solution is compared with other solutions in the land use sector for farm, ecosystem, and social impacts. Like other ecosystem protection, *Indigenous Peoples’ Forest Management* protects vast carbon stocks, but it offers the unique strength within the sector of being a targeted human rights solution.

Table . Land Use Solutions Comparison: Economic Impacts

**First Cost**: Free is $0**,** Low is $1-100, Medium is $100-500, Expensive is $500+. **Net Profit Margin:** Low is $0-100/ha, Medium is $100-500, High is $500+. **Value of Ecosystem Services:** Set values for very high, high, medium, low. **Timber and Biomass Production:** Decrease indicates restriction of logging where it currently occurs; Increase indicates new commercial biomass production where it does not currently occur.

|  | **First Cost $/ha** | **Net Profit $/ha** | **Value of Ecosystem Services** | **Timber and Biomass Production** |
| --- | --- | --- | --- | --- |
| Afforestation | Expensive | Medium | High | Increase |
| Bamboo | Expensive | Medium | High | Increase |
| Forest Protection | Not calculated | Not calculated | Very high | Decrease |
| Indigenous People’s Forest Management | Not calculated | Not calculated | Very high | Decrease |
| Peatland Protection | Not calculated | Not calculated | Very high | Decrease |
| Perennial Biomass | Expensive | Medium | Medium | Increase |
| Temperate Forest Restoration | Not calculated | Not calculated | High | n/a |
| Tropical Forest Restoration | Not calculated | Not calculated | High | n/a |

Table .: Land Use Solutions Comparison: Social and Climate Impacts

**Carbon Stock Protected:** Low 0-500 Gt CO2-eq, Medium is 500-1000 Gt CO2-eq, high is 1000+ Gt CO2-eq. **Ecosystem Services** is subjective based on impacts on biodiversity, water quality, etc. **Social Justice Benefits:** Is solution Targeted to disadvantaged producers like smallholders and women, Relevant to them, or Not Applicable (n/a). **Climate Impacts per Hectare:** Low 0-3.7 t CO2-eq/ha/yr (0-1tC),Medium 3.8-11.0 t CO2-eq/yr (1-3 tC), High 11.1-18.0 tCO2-eq/yr (3-5 tC), Very High 18.1 tCO2-eq/yr (5tC+). **Global Adoption Potential:** Low 0-100Mha, Medium 101-500 Mha, High 500+ Mha

|  | **Carbon Stock Protected** | **Social Justice Benefits** | **Climate Impact/ha** | **Global Adoption Potential** |
| --- | --- | --- | --- | --- |
| Afforestation | Medium to High | Relevant | High | Medium |
| Bamboo | Medium | Relevant | High | Medium |
| Forest Protection | High | Relevant | Very High | Medium |
| Indigenous People’s Forest Management | High | Targeted | Very High | Medium to High |
| Peatland Protection | n/a | Relevant | Very High | High |
| Perennial Biomass | n/a | Relevant | Low | Medium |
| Temperate Forest Restoration | n/a | Relevant | Medium | Low to Medium |
| Tropical Forest Restoration | n/a | Relevant | High | Medium |

# Methodology

## Introduction

Project Drawdown’s models are developed in Microsoft Excel using standard templates that allow easier integration with each other since integration is critical to the bottom-up approach used. The template used for this solution was the Land Model, which accounts for:

1. Sequestration of carbon dioxide from the atmosphere into plant biomass and soil; and
2. Reduction of emissions for a solution relative to a conventional practice.

These practices are assumed to use land of a specific type that may be shared across several solutions. Actual and maximum possible adoptions are therefore defined in terms of land area (million hectares). The adoptions of both conventional and solution were projected for each of several Drawdown scenarios from 2015 to 2060 (from a base year of 2014) and the comparison of these scenarios with a reference (for the 2020-2050 segment[[3]](#footnote-3)) is what constituted the results.

In order to maximize climate, environmental, economic and social benefits, Drawdown’s *bamboo* solution models future adoption on marginal, degraded, forest and grasslands, in particular sloped or eroded lands that could benefit from stabilization while boosting or maintaining economic productivity. Current adoption is estimated at about 34 million hectares, all allocated on the forest AEZs (Du et al., 2018; FAO, 2010a; Lobovikov et al., 2012).

*Agency Level*

Government is selected as the agency level for this solution. Though certainly other agents can, do, and should play an important role in this solution, government is the most critical player in implementation.

## Data Sources

Key data sources include the GAEZ database, FAO forest area data, Right and Resource Institute publications. Data from 19 peer-reviewed papers was used in the model.

## Total Available Land

Drawdown’s agricultural production and land use model approach defines the Total Land Area for each solution as the area of land (in million hectares) suitable for adoption a given solution. Determining this figure for Total Land Area is a two-part process.

1. First, the technical potential is determined, based on: current land cover or land use; the suitability of climate, soils, and slopes; and degraded or non-degraded status. Relevant data on global land-use and availability is acquired from Global Agro-Ecological Zones database, developed by the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA).
2. In the second stage, land is allocated using the Drawdown Agro-Ecological Zone model, based on priorities for each class of land. The Drawdown Land-Use Model categorizes and allocates land according to agro-ecological zones based on the following factors: thermal climate, moisture regimes, soil quality, slope, cover type, and degradation status. These characteristics influence the suitability of different practices, and solution adoption scenarios are restricted by one or more of these factors (see Section 2.7 for more details).

The total land allocated for each solution is capped at the solution’s maximum adoption in the *Optimum* Scenario. Thus, Drawdown estimates of total available land are very conservative as final allocation numbers are less than those determined purely through technical potential. Thus maximum area allocated to *Indigenous Peoples' Land Management* is 1,057 million hectares.

## Adoption Scenarios

Two different types of adoption scenarios were developed: 1) a Reference (REF) Case which was considered the baseline, where not much changes in the world; and 2) a set of Project Drawdown Scenarios (PDS) with varying levels of ambitious adoption of the solution. Published results show the comparison of one PDS to the REF, and therefore focus on the change to the world relative to a baseline.

*The estimation of future protected and unprotected land for peatland was estimated based on the following indicators.*

1. Cumulative degraded land that is unprotected in the PDS - This represents the total land degraded that was never protected in the PDS considering the rate of annual degradation. This rate is applied only to the land that is not covered by the solution (ie land not artificially protected) and that is not degraded.
2. Total at risk land in the PDS - This represents the total land that is neither covered by the solution nor degraded in the PDS. It's land that is potentially at risk of degradation by anthropogenic or other means. It is calculated by identifying how much land is degraded, and how much is under the solution.
3. Total undegraded land in the PDS - This represents the total land that is not degraded in any particular year of the PDS. It takes the total land area and removes the degraded land, which is the same as summing the undegraded land under the solution and at-risk land.
4. Cumulative Degraded Land Under Protection in the PDS - Even protected land suffers from degradation via disturbances (perhaps due to natural or anthropogenic means such as logging, storms, fires or human settlement). The rate of this disturbance is assumed equal both in the PDS and REF. This disturbance rate affects annually, the degradation of protected land, but is expected to be much less than the degradation rate of unprotected land.

*The above four variables were also calculated for the REF case and the net area protected in the future under the PDS is estimated based on the following indicators*.

1. Annual reduction in total degraded land (or annual increase in total undegraded land) (protected and unprotected) - This is the decrease in total degraded land in the PDS versus the REF in each year.
2. Net at-risk land - This is the increase in land that is neither under the solution nor degraded (ie open to nature and at risk of degradation) in the PDS versus the REF.
3. Cumulative reduction in total degraded land (or cumulative increase in undegraded land) over base year (protected and unprotected) - This is the increase in undegraded land in the PDS versus the REF (cumulatively in any year) and can be traced to the direct action of increasing solution adoption.

Six custom adoption scenarios were developed. All begin with current adoption of 466.87 million hectares (61 percent of the total area allocated to this solution). A total of 1,057 million hectares of non-degraded forest area was allocated to this solution.

1. ***Custom adoption scenario one:*** Future adoption of forest area under Indigenous People management was built based on the adoption in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication[[4]](#footnote-4).
2. ***Custom adoption scenario two:*** Future adoption of forest area under Indigenous People management was built based on the adoption in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication. Further assumption was made that the forest area under indigenous people management will increase to 75% by 2050 in Low and Middle Income Countries.
3. ***Custom adoption scenario three:*** Future adoption of forest area under Indigenous People management was built based on the adoption in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication. Further assumption was made that the forest area under indigenous people management will increase to 100% by 2050 in Low and Middle Income Countries.
4. ***Custom adoption scenario four:*** Future adoption of forest area under Indigenous People management was built based on the adoption in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication. However, the 2030 projected area is calculated with reference to the assigned TLA of the solution and not by the total area as calculated for the Low and Middle Income Countries.
5. ***Custom adoption scenario five:*** Future adoption of forest area under Indigenous People management was built based on the adoption in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication. Further assumption was made that the forest area under indigenous people management will increase to 75% by 2050 in Low and Middle Income Countries. However, the 2030 and 2050 projected area is calculated with reference to the assigned TLA of the solution and not by the total area as calculated for the Low and Middle Income Countries.
6. ***Custom adoption scenario six:*** Future adoption of forest area under Indigenous People management was built based on the adoption in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication. Further assumption was made that the forest area under indigenous people management will increase to 100% by 2050 in Low and Middle Income Countries. However, the 2030 and 2050 projected area is calculated with reference to the assigned TLA of the solution and not by the total area as calculated for the Low and Middle Income Countries.

### Reference Case / Current Adoption

Current adoption was calculated as 466.87 Mha based on the area under IP management in Low and Middle Income Countries given for the year 2002, 2008, 2013, and targeted percentage for the year 2030 by Rights and Resources 2018 publication.

### Project Drawdown Scenarios

Three Project Drawdown scenarios (PDS) were developed for each solution, to compare the impact of an increased adoption of the solution to a reference case scenario, being:

#### Plausible Scenario – A conservative approach is adopted for the plausible scenario, and future growth of the solution is estimated based on the “average of all” custom adoption scenarios as listed above

#### Drawdown Scenario – For the optimum scenario, highly ambitious approach is adopted, and future growth of the solution is estimated based on the “high of all” custom adoption scenarios as listed above

#### Optimum Scenario – For the optimum scenario, highly ambitious approach is adopted, and future growth of the solution is estimated based on the “custom adoption scenario 3”, scenario with high adoption and low degradation rate

## Inputs

### Climate Inputs

One-time emissions from deforestation (above and below- ground carbon) are set at 280.87 tons of carbon dioxide-equivalent per hectare, a low conservative estimate based on meta-analysis of 19 data points from 6 sources was considered.

***Table 2.1 Climate Inputs***

| **Indigenous Peoples' Land Management** | **Units** | **Project Drawdown Data Set Range** | **Model Input** | **Data Points (#)** | **Sources (#)** |
| --- | --- | --- | --- | --- | --- |
| Avoided emissions from deforestation | *tCO2-e (one-time)* | 280.87 - 578.34 | 280.87 | 19 | 6 |
| Biosequestration | *tC/ha/yr* | 0.38 – 0.97 | 0.68 | 8 | 2 |

Note: Project Drawdown data set range is defined by the low and high boundaries which are respectively 1 standard deviation below and above the mean of the collected data points[[5]](#footnote-5).

### Financial Inputs

It is assumed that, the costs of securing legal recognition of indigenous and community forest under national land tenure regimes, including administrative costs, legal costs, staff, and equipment, are largely borne by the government, not at the land-manager level, and thus are outside the scope of this Solution and its model. In addition, this model does not account for revenues from ecosystem services or forest management, such as potential revenues from timber or non-timber forest products, nor does it put a price on carbon.

## Assumptions

Six overarching assumptions have been made for Project Drawdown models to enable the development and integration of individual model solutions. These are that infrastructure required for solution is available and in-place, policies required are already in-place, no carbon price is modeled, all costs accrue at the level of agency modeled, improvements in technology are not modeled, and that first costs may change according to learning. Full details of core assumptions and methodology will be available at [www.drawdown.org](http://www.drawdown.org). Beyond these core assumptions, there are other important assumptions made for the modeling of this specific solution. These are detailed below.

**Assumption 1:** IPC forest expansion will follow a linear or an exponential trajectory over the next 30 years. However, IPC forest expansion is highly dependent on national policy climates for forest tenure policy, and most forest land exists in a handful of countries. In some instances countries have dramatically increased the amount of formally recognized indigenous and community forest over the last decade or so, and in other cases IPC forest extent has declined. Many countries also still have not formally recognized any IPC forest.

**Assumption 2:** Indigenous peoples and local communities have statutory or customary tenure to 65% of each land class (including forests). This is based on evidence that Indigenous peoples and local communities have statutory or customary tenure to 65% of all of the world’s land.

**Assumption 3:**  It is assumed that IP forest management will be given priority over forest protection. This is because a) indigenous people are already living in, and sustainably managing, many of these forests, b) other social co-benefits, and c) avoiding displacement of indigenous people in the name of climate change mitigation.

**Assumptions 4:** A lower rate of carbon sequestration is observed and used in the model, as it is believed that these primary forests have already reached or are near saturation of their carbon sequestration saturation level.

**Assumption 5:** CO2 emissions from deforestation are assumed to be (and calculated as) one-time emissions per unit area of deforestation.

**Assumption 6:** It is assumed that there will be no first (establishment) cost for the IP forest management solution as the indigenous people are already living in and managing the forest ecosystem (though this may not always be the case).

**Assumption 7:** The deforestation and disturbance will continue with the current rate of deforestation and disturbance both under the solution and the conventional case.

## Integration

The complete Project Drawdown integration documentation (will be available at [www.drawdown.org](http://www.drawdown.org)) details how all solution models in each sector are integrated, and how sectors are integrated to form a complete system. Those general notes are excluded from this document but should be referenced for a complete understanding of the integration process. Only key elements of the integration process that are needed to understand how this solution fits into the entire system are described here.

*Indigenous Peoples’ Forest Management* is part of Drawdown’s land-use sector.

***The Agroecological Zone model***

Drawdown’s approach seeks to model integration between and within sectors and avoid double counting. Several tools were developed to assist in this effort. The Agroecological Zone (AEZ) model categorizes the world’s land by: current cover (e.g. forest, grassland, cropland), thermal climate, moisture regime, soil quality, slope, and state of degradation.  Both Food (supply-side) and Land Use solutions were assigned to AEZs based on suitability. Once current solution adoption was allocated for each zone (e.g. semi-arid cropland of minimal slopes), zone priorities were generated and available land was allocated for new adoption. Priorities were determined based on an evaluation of suitability, consideration of social and ecological co-benefits, mitigation impact, yield impact, etc. For example, *Indigenous peoples’ land management* is given a higher priority than *forest protection* for AEZs with forest cover, in recognition of indigenous peoples’ rights and livelihoods. *Multistrata agroforestry* is highly prioritized in tropical humid climates due to its high sequestration rate, food production, and highly limited climate constraints.

Each unit of land was allocated to a separate solution to avoid overlap between practices. The exception to this are *farmland irrigation*, *nutrient management*, and *women smallholders*, which can be implemented in addition to other practices. The constraint of limited available land meant that many solutions could not reach their technical adoption potential. The AEZ model thus prevents double-counting for adoption of agricultural and land use solutions.

Drawdown’s agricultural production and land use model approach defines the Total Land Area as the area of land (in million hectares) suitable for adoption a given solution. Data on global land is acquired from Global Agro-Ecological Zones database, developed by the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA). The Drawdown Land-Use Model categorizes and allocates land according to agro-ecological zones based on the following factors: thermal climate, moisture regimes, soil quality, slope, cover type, and degradation status. These characteristics influence the suitability of different practices, and solution adoption scenarios are restricted by one or more of these factors.

Determining the total available land for a solution is a two-part process. The technical potential is based on: current land cover or land use; the suitability of climate, soils, and slopes; and on degraded or non-degraded status. In the second stage, land is allocated using the Drawdown Agro-Ecological Zone model, based on priorities for each class of land. The total land allocated for each solution is capped at the solution’s maximum adoption in the *Optimum* Scenario. Thus, in most cases the total available land is less than the technical potential.

***The Biomass Model***

Drawdown’s Biomass model begins with projected global biomass demand through 2060, based on FAO historical data and other sources, in categories including sawnwood, other woody biomass, and herbaceous biomass (which includes crop residues). It determines the impact of demand reduction solutions including *clean cookstoves* and *recycled paper*, resulting in an adjusted demand projection through 2060. Biomass supply reductions are modeled as well, which result from protection of forests including *Indigenous Peoples’ forest management*, reducing biomass availability. Biomass supply increases are modeled through the increased adoption of solutions including *afforestation, bamboo, perennial biomass* andagroforestry solutions like *tree intercropping, silvopasture,* and *multistrata agroforestry.* Biomass availability from crop residues, *seaweed farming*, and dedicated biomass crops planted on cropland freed up by *sustainable intensification* is also modeled.

Surplus biomass is allocated to climate solutions that require biomass as feedstock. These include *biochar, biomass electricity, bioplastic, 2nd generation biofuels, building with wood, insulation, small-scale biogas,* and *district heating.* This biomass feedstock allocation was a constraint to the adoption of this solution.

## Limitations/Further Development

One limitation is that some studies may infer a causal relationship between reduced deforestation on IPC land and legal recognition and government action to protect community forest rights. However, “[s]ubstantiating a causal relationship—as opposed to an association” of this kind “is difficult” (Stevens et al. 2014b). Many variables can lead to deforestation; it can be hard to find precise location data for community forests; and researchers’ definitions of terms and concepts may differ (Stevens et al. 2014b). In addition to the strength of a community’s forest rights, factors such as forest location and size, as well as the value of forest resources or land to potential investors, can affect deforestation levels and forest health.

Regarding further development, few studies analyze carbon sequestration rates in IPC land, yet some have shown that IPC land sequesters more carbon than non-IPC land. Deriving carbon sequestration rates for IPC versus non-IPC land would quantify additional carbon benefits from enabling indigenous peoples to manage additional land with secure tenure.

# Results

## Adoption

Below are shown the world adoptions of the solution in some key years of analysis in functional units and percent for the three Project Drawdown scenarios.

Total adoption in the *Plausible* Scenario is 930 million hectares in 2050, representing 88 percent of the total suitable land in 2014. Of this, 310.87 million hectares are adopted from 2020-2050.

Total adoption in the *Drawdown* Scenario is 1057 million hectares in 2050, representing 100 percent of the total suitable land in 2014. Of this, 396.90 million hectares are adopted from 2020-2050.

Total adoption in the *Optimum* Scenario is 1057 million hectares in 2050, representing 100 percent of the total suitable land. Of this, 403.46 million hectares are adopted from 2020-2050.

***Table 3.1 World Adoption of the Solution***

| **Solution** | **Units** | **Base Year (2014)** | **New Adoption by 2050** | | |
| --- | --- | --- | --- | --- | --- |
| **Plausible** | **Drawdown** | **Optimum** |
| Indigenous Peoples' Land Management | Mha | 466.87 | 463 | 590 | 590 |
| % Total Land Available | 44.2% | 88% | 100% | 100% |

Figure 3.1 World Annual Adoption 2020-2050 in Mha (a) and as a percentage of TLA (b).

## Climate Impacts

Below are the emissions results of the analysis for each scenario which include total emissions reduction, atmospheric concentration changes, and sequestration where relevant. For a detailed explanation of each result, please see the glossary (Section 6).

Emissions reduction impact is 3.56, 5.27, and 5.78 gigatons of carbon-dioxide equivalent in the *Plausible, Drawdown,* and *Optimum* Scenarios respectively.

***Table 3.2 Climate Impacts***

| **Scenario** | **Maximum Annual Emissions Reduction** | **Total Emissions Reduction** | **Max Annual CO2 Sequestered** | **Total Additional CO2 Sequestered** | **Total Atmospheric CO2-eq Reduction** | **Emissions Reduction in 2030** | **Emissions Reduction in 2050** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *(Gt CO2-eq/yr.)* | *Gt CO2-eq/yr. (2020-2050)* | *(Gt CO2-eq/yr.)* | *Gt CO2-eq/yr. (2020-2050)* | Gt CO2-eq (2020-2050) | (Gt CO2-eq/year) | *(Gt CO2-eq/year)* |
| ***Plausible*** | 0.10 | 2.43 | 0.08 | 1.13 | 3.56 | 0.09 | 0.18 |
| ***Drawdown*** | 0.13 | 3.51 | 0.12 | 1.76 | 5.27 | 0.15 | 0.25 |
| ***Optimum*** | 0.13 | 3.77 | 0.13 | 2.01 | 5.78 | 0.18 | 0.25 |

The solution was integrated with all other Project Drawdown solutions and may have different emissions results from the models. This is due to adjustments caused by interactions among solutions that limit full adoption (such as by feedstock or demand limits) or that limit the full benefit of some solutions (such as reduced individual solution impact when technologies are combined).

***Table 3.3 Impacts on Atmospheric Concentrations of CO2-eq***

| **Scenario** | **GHG Concentration Change in 2050** | **GHG Concentration Rate of Change in 2050** |
| --- | --- | --- |
| *PPM CO2-eq (2050)* | *PPM CO2-eq change from 2049-2050* |
| **Plausible** | 0.30 | 0.01 |
| **Drawdown** | 0.44 | 0.02 |
| **Optimum** | 0.47 | 0.02 |

*Figure 3.2 World Annual Greenhouse Gas Emissions Reduction*

## Financial Impacts

Currently financial impacts are not modeled for this solution.

## Other Impacts

Protection of high carbon ecosystems, like protection of intact forests also results in the increase of carbon stock in their soil and biomass as well as prevents degradation of significant amount of the intact/non-degraded ecosystems. The results for these indicators are listed below for the three drawdown scenarios.

Table .: Carbon stock and reduced land degradation

| **Scenario** | **Reduced Land Degradation** | **Total CO2 Under Protection by Second Year** | **Total Carbon Under Protection by Second Year** |
| --- | --- | --- | --- |
| *Million Hectares* | *Gt CO2* | *Gt Carbon* |
| **Plausible** | 8.74 | 643.56 | 175.65 |
| **Drawdown** | 12.70 | 729.79 | 199.18 |
| **Optimum** | 13.67 | 727.62 | 198.59 |

# Discussion

Based on data from numerous studies, this solution found a significant difference in mean carbon sequestered and avoided deforestation between indigenous and community (IPC) forest and similar forest not granted IPC tenure, indicating that forest lands owned by indigenous peoples or local communities or designated as theirs (IPC forest lands) represent a substantial potential protected reserve of carbon sequestered in biomass over the next 30 years. IPC forest lands undergo a lower deforestation rate than land not held by indigenous peoples or local communities, and the costs of granting land rights to these communities—many of whom are already living on and managing their forest lands—is relatively low. In fact, the costs are virtually zero to those managing the land—the indigenous peoples and local communities themselves. Moreover, our findings likely underestimate the carbon benefits of designating forests as IPC forest land, for example, given that IPC forest lands sequester more carbon on average than forest lands not held by indigenous peoples or local communities (Baccini et al. 2012; Walker 2013). Thus, this solution builds on the literature that suggests granting indigenous and local communities legal rights and ownership of their forest produces forest health benefits, including carbon benefits.

Central to this solution’s findings, several studies show statistical difference in deforestation rates, often indicating that indigenous or community-managed forest lands experience less deforestation and deforestation pressure (Nolte et al. 2013; Porter-Bolland et al. 2012 (a meta-analysis)). While the rates of deforestation were derived from narrow studies that attempted to isolate the impacts of land tenure on deforestation rates, nearly no similar studies exist for isolating the impacts of forest tenure on carbon sequestration rates. Further study to isolate the impact of tenure on sequestration would help to identify the additional sequestration benefits of IPC tenure. Further analyses of indigenous and traditional land management practices such as indigenous agroforestry, pastoral management, shifting cultivation, and fire management would demonstrate additional carbon benefits and other benefits these practices already provide today, as well as the substantial carbon benefits they can deliver under continued or expanded practice into the future.

Beyond the carbon benefits of indigenous and community forests, granting forest tenure to communities provides additional environmental, cultural, and socio-economic benefits. Indigenous and community-managed forest have been demonstrated to enhance biodiversity, conserve local culture, and empower local communities to engage in stewardship of their lands (Stevens et al. 2014a; Sunderlin, Hatcher, and Liddle 2008; Ricketts et al. 2010; Robinson, Holland, and Naughton-Treves 2014). Traditional management practices and the social-ecological relationships of indigenous peoples and local communities to the forests on which they depend correlate with healthier forests and forest conservation outcomes.

In conclusion, this report demonstrates the carbon benefits of indigenous and traditional land management practices with secure tenure by developing models projecting the avoided deforestation and carbon sequestration potential of increasing legally-recognized indigenous and community forest lands. The findings demonstrate a substantial net carbon benefit of projected increases in tenured forest lands from 2020-2050. This solution involves a conversion of state- or privately-owned forest land to forest land securely managed by indigenous peoples and local communities. Given the wide discrepancy between forest land area indigenous peoples and local communities securely manage and forest land area under state or private ownership, this Solution requires increased recognition of land rights. Latin America and China have made strides in designating forest land as indigenous peoples’ while Asia and Africa have significant forest lands that are not under indigenous or community ownership. Understanding the carbon benefits of this shift should help to propel change toward secure forest land management for indigenous peoples.

## Limitations

This study would benefit from data on financials and ecosystem services.

## Benchmarks

Griscom et al (2017)’s “Natural climate solutions” calculates an annual impact from “avoided forest conversion” of 1.82-3.60 gigatons of carbon dioxide equivalent per year in 2030. It is not clear if their figure includes avoided land use from demand reduction, or only forest protection. Note that Food sector solutions *reduced food waste* and *plant-rich diet* also incorporate substantial avoided land use change emissions not accounted for here.

Grassi et al. (2017) analysis of full- implementation of ‘(Intended) Nationally Determined Contributions ((I)NDCs) shows that “land use, and forests in particular, emerge as a key component of the Paris Agreement: turning globally from a net anthropogenic source during 1990–2010 (1.3 +- 1.1 GtCO2e yr-1) to a net sink of carbon by 2030 (up to -1.1 +- 0.5 GtCO2e yr-1), and providing a quarter of emission reductions planned by countries” with a range of 0.8-3.1 GtCO2e yr-1 to 1.5- 3.8 GtCO2e yr-1 for unconditional and conditional (I)NDCs mitigation calculation respectively.

Dooley et al. (2018)’s “Missing Pathways to 1.5°C: The role of the land sector in ambitious climate action” analysis on ecosystem- based approaches “estimate the mitigation potential from avoided forest loss as equivalent to current global emissions (from both deforestation and degradation), at 4.07 Gt CO2/year” by 2050.

Table . Benchmarks

| **Source and Scenario** | **Assumptions** | **Mitigation Impact Gt CO2-eq in 2030** |
| --- | --- | --- |
| Grassi (2017) | Forest-based solutions | 0.8-3.8 |
| Dooley (2018) | Avoided forest loss | 4.07 |
| Griscom (2017) | Avoided forest conversion | 1.82-3.60 |
| *Plausible* Scenario | Forest protection and Indigenous People’s forest management | 0.23 |
| *Drawdown* Scenario | Forest protection and Indigenous People’s forest management | 0.31 |
| *Optimum* Scenario | Forest protection and Indigenous People’s forest management | 0.40 |

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# Glossary

**Adoption Scenario** – the predicted annual adoption over the period 2015 to 2060, which is usually measured in **Functional Units**. A range of scenarios is programmed in the model, but the user may enter her own. Note that the assumption behind most scenarios is one of growth. If for instance a solution is one of reduced heating energy usage due to better insulation, then the solution adoption is translated into an increase in use of insulation. There are two types of adoption scenarios in use: **Reference (REF)** where global adoption remains mostly constant, and **Project Drawdown Scenarios (PDS)** which illustrate high growth of the solution.

**Approximate PPM Equivalent** – the reduction in atmospheric concentration of CO2 (in **PPM**) that is expected to result if the **PDS Scenario** occurs. This assumes a discrete avoided pulse model based on the Bern Carbon Cycle model.

**Average Abatement Cost** – the ratio of the present value of the solution (**Net** **Operating Savings** minus **Marginal First Costs**) and the **Total Emissions Reduction**. This is a single value for each solution for each **PDS Scenario**, and is used to build the characteristic “*Marginal Abatement Cost*” curves when Average Abatement Cost values for each solution are ordered and graphed.

**Average Annual Use** – the average number of functional units that a single implementation unit typically provides in one year. This is usually a weighted average for all users according to the data available. For instance, total number of passenger-km driven by a hybrid vehicle in a year depends on country and typical number of occupants. We take global weighted averages for this input. This is used to estimate the **Replacement Time**.

**Cumulative First Cost** – the total **First Cost** of solution **Implementation Units** purchased in the **PDS Scenario** in the analysis period. The number of solution implementation units that are available to provide emissions reduction during the analysis period is dependent on the units installed prior to the analysis period, and hence all implementation units installed after the base year are included in the cumulative first costing (that is 2015-2050).

**Direct Emissions** – emissions caused by the operation of the solution, which are typically caused over the lifetime of the solution. They should be entered into the model normalized per functional unit.

**Discount Rate**- the interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows. The discount rate in DCF analysis takes into account not just the time value of money, but also the risk or uncertainty of future cash flows; the greater the uncertainty of future cash flows, the higher the discount rate. Most importantly, the greater the discount rate, the more the future savings are devalued (which impacts the financial but not the climate impacts of the solution).

**Emissions** **Factor**– the average normalized emissions resulting from consumption of a unit of electricity across the global grid. Typical units are kg CO2e/kWh.

**First Cost**- the investment cost per **Implementation Unit** which is essentially the full cost of establishing or implementing the solution. This value, measured in 2014$US, is only accurate to the extent that the cost-based analysis is accurate. The financial model assumes that the first cost is made entirely in the first year of establishment and none thereafter (that is, no amortization is included). Thus, both the first cost and operating cost are factored in the financial model for the first year of implementation, all years thereafter simply reflect the operating cost until replacement of the solution at its end of life.

**Functional Unit** – a measurement unit that represents the value, provided to the world, of the function that the solution performs. This depends on the solution. Therefore, LED Lighting provides petalumen-hours of light, Biomass provides tera-watt-hours of electricity and high speed rail provides billions of passenger-km of mobility.

**Grid Emissions** – emissions caused by use of the electricity grid in supplying power to any operation associated with a solution. They should be in the units described below each variable entry cell. Drawdown models assume that the global electric grid, even in a Reference Scenario, is slowly getting cleaner, and that emissions factors fall over time resulting in lower grid emissions for the same electricity demand.

**Implementation Unit** – a measurement unit that represents how the solution practice or technology will be installed/setup and priced. The implementation unit depends on the solution. For instance, implementing electric vehicles (EV) is measured according to the number of actual EV’s in use, and adoption of Onshore Wind power is measured according to the total terawatts (TW) of capacity installed worldwide.

**Indirect Emissions** – emissions caused by the production or delivery or setup or establishment of the solution in a specified area. These are NOT caused by day to day operations or growth over time, but they should be entered into the model normalized on a per functional unit or per implementation unit basis.

**Learning Rate/Learning Curve** - Learning curves (sometimes called experience curves) are used to analyze a well-known and easily observed phenomenon: humans become increasingly efficient with experience. The first time a product is manufactured, or a service provided, costs are high, work is inefficient, quality is marginal, and time is wasted. As experienced is acquired, costs decline, efficiency and quality improve, and waste is reduced. The model has a tool for calculating how costs change due to learning. A 2% learning rate means that the cost of producing a *good* drops by 2% every time total production doubles.

**Lifetime Capacity** – this is the total average functional units that one implementation unit of the solution or conventional technology or practice can provide before replacement is needed. All technologies have an average lifetime usage potential, even considering regular maintenance. This is used to estimate the **Replacement Time**. and has a direct impact on the cost to install/acquire technologies/practices over time. E.g. solar panels generate, on average, a limited amount of electricity (in TWh) per installed capacity (in TW) before a new solar panel must be purchased. Electric vehicles can travel a limited number of passenger kilometers over its lifetime before needing to be replaced.

**Lifetime Operating Savings**–the operating cost in the PDS versus the REF scenarios over the lifetime of the implementation units purchased during the model period regardless of when their useful life ends.

**Lifetime Cashflow NPV**-the present value (PV) of the net cash flows (PDS versus REF) in each year of the model period (2015-2060). The net cash flows include net operating costs and first costs. There are two results in the model: Lifetime Cashflow NPV for a Single **Implementation Unit**, which refers to the installation of one **Implementation Unit**, and Lifetime Cashflow NPV of All Units, which refers to all **Implementation Units** installed in a particular scenario. These calculations are also available using profit inputs instead of operating costs.

**Marginal First Cost** – the difference between the **First Cost** of all units (solution and conventional) installed in the **PDS Scenario** and the **First Cost** of all units installed in the **REF Scenario** during the analysis period. No discounting is performed. The number of solution implementation units that are available to provide emissions reduction during the analysis period is dependent on the units installed prior to the analysis period, and hence all implementation units installed after the base year are included in the cumulative first costing (that is 2015-2050).

**Net Annual Functional Units (NAFU)** – the adoption in the PDS minus the adoption in the REF in each year of analysis. In the model, this represents the additional annual functional demand captured either by the solution in the **PDS Scenario** or the conventional in the **REF Scenario**.

**Net Annual Implementation Units (NAIU)** – the number of **Implementation Units** of the solution that are needed in the PDS to supply the **Net Annual Functional Units (NAFU).** This equals the adoption in the PDS minus the adoption in the REF in each year of analysis divided by the average annual use.

**Net Operating Savings** – The undiscounted difference between the operating cost of all units (solution and conventional) in the **PDS Scenario** minus that of all units in the **REF Scenario**.

**Operating Costs** – the average cost to ensure operation of an activity (conventional or solution) which is measured in 2014$US/**Functional Unit**. This is needed to estimate how much it would cost to achieve the adoption projected when compared to the **REF Case**. Note that this excludes **First Costs** for implementing the solution.

**Payback Period** – the number of years required to pay all the **First Costs** of the solution using **Net Operating Savings**. There are four specific metrics each with one of **Marginal First Costs** or **First Costs** of the solution only combined with either discounted or non-discounted values. All four are in the model. Additionally, the four outputs are calculated using the increased profit estimation instead of **Net Operating Savings**.

**PDS/ Project Drawdown Scenario** – this is the high growth scenario for adoption of the solution

**PPB/ Parts per Billion** – a measure of concentration for atmospheric gases. 10 million PPB = 1%.

**PPM/ Parts per Million** – a measure of concentration for atmospheric gases. 10 thousand PPM = 1%.

**REF/ Reference Scenario** – this is the low growth scenario for adoption of the solution against which all **PDS scenarios** are compared.

**Regrets solution** has a positive impact on overall carbon emissions being therefore considered in some scenarios; however, the social and environmental costs could be harmful and high.

**Replacement Time**- the length of time in years, from installation/acquisition/setup of the solution through usage until a new installation/acquisition/setup is required to replace the earlier one. This is calculated as the ratio of **Lifetime Capacity** and the **Average Annual Use**.

**TAM/ Total Addressable Market** – represents the total potential market of functional demand provided by the technologies and practices under investigation, adjusting for estimated economic and population growth. For this solutions sector, it represents world and regional total addressable markets for electricity generation technologies in which the solutions are considered.

**Total Emissions Reduction** – the sum of grid, fuel, indirect, and other direct emissions reductions over the analysis period. The emissions reduction of each of these is the difference between the emissions that would have resulted in the **REF Scenario** (from both solution and conventional) and the emissions that would result in the **PDS Scenario**. These may also be considered as “emissions avoided” as they may have occurred in the REF Scenario, but not in the PDS Scenario.

**Transition solutions** are considered till better technologies and less impactful are more cost effective and mature.

**TWh/ Terawatt-hour** – A unit of energy equal to 1 billion kilowatt-hours

1. This study defined “strictly protected areas” as those that “discourage consumptive resource use or even physical access” and “sustainable use areas” as those that “allow for controlled resource extraction, land use change, and in many instances human settlements” (Soares-Filho et al. 2010). [↑](#footnote-ref-1)
2. For example, In Tanzania, a 2002 law allowing formalization of Community Forests from communal lands created 2.345 Mha of community-owned and community-managed forests by 2008 (Alden Wily). In the Gambia, communities secured ownership of their forest resources through long leases granted to community-elected Community Forest Committees although the total land area of these Community Forests amounts to less than 45,000 hectares. [↑](#footnote-ref-2)
3. For most results, only the differences between scenarios, summed over 2020-2050 were presented, but for the net first cost, the position was taken that to achieve the adoptions in 2020, growth must first happen from 2015 to 2020, and that growth comes at a cost which should be accounted for, hence net first cost results represent the period 2015-2050. [↑](#footnote-ref-3)
4. <https://rightsandresources.org/en/publication/at-a-crossroads-trends-in-recognition-of-community-based-forest-tenure-from-2002-2017/#.XW67hChKg2w> [↑](#footnote-ref-4)
5. In some cases, the low boundary is negative for a variable that can only be positive, and in these cases the lowest collected data point is used as the “low” boundary. [↑](#footnote-ref-5)