

Will REDD+ work? The need for interdisciplinary research to address key challenges

Ingrid J Visseren-Hamakers¹, Aarti Gupta², Martin Herold³,
Marielos Peña-Claros⁴ and Marjanneke J Vijge⁵

In this article, we draw on the contributions to this issue to address the question ‘Will REDD+ work?’. We do so by differentiating between *how*, *where* and *when* REDD+ might work. The article shows how issues of scope, scale and pace of REDD+ are related, and how interdisciplinary research can help to distill the lessons learned from REDD+ efforts currently underway. Important research areas include the drivers of deforestation and forest degradation, monitoring, reporting and verification, co-benefits, governance capacity, linkages with related policies, and the environmental and social impacts of REDD+. In concluding, we highlight the role of interdisciplinary research in supporting the different actors involved in REDD+ to cope with the inherent heterogeneity and complexity of REDD+.

Addresses

¹ Forest and Nature Conservation Policy Group (FNP), Wageningen University and Research Centre (WUR), The Netherlands

² Environmental Policy Group, Wageningen University, The Netherlands

³ Geoinformation Science with Emphasis in Remote Sensing, Wageningen University, The Netherlands

⁴ Forest Ecology and Forest Management Group, Wageningen University, The Netherlands

⁵ Environmental Policy Group (ENP), Wageningen University, The Netherlands

Corresponding author: Visseren-Hamakers, Ingrid J
(ingrid.visseren@wur.nl)

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Edited by **Ingrid J Visseren-Hamakers, Aarti Gupta, Martin Herold, Marielos Peña-Claros and Marjanneke J Vijge**

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Introduction

Reducing emissions from deforestation has received much political and scientific attention since the issue was first placed on the agenda of the United Nations Framework Convention on Climate Change (UNFCCC) in 2005 [1]. The original idea was simple: to contribute to climate change mitigation by creating incentives for developing countries to keep their forests standing, as deforestation is an important cause of carbon emissions. Since then, the scope of the policy

has expanded, and currently encompasses deforestation, forest degradation, conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries, collectively known as REDD+. While REDD+ is being negotiated as part of the UNFCCC’s post-Kyoto agreements, many bilateral and multilateral initiatives are already underway to support developing countries to get ‘ready for REDD+’. These countries are developing national REDD+ strategies through multistakeholder processes and pilot projects that are being implemented to test different approaches. As shown by Murdiyarto et al. [2], many market and civil society actors and the scientific community are actively involved in REDD+ related activities around the world.

With all these actors involved and investments being made in shaping future REDD+ policies and implementation, the question ‘Will REDD+ work?’ naturally arises. Different actors answer this question differently — different countries, local communities, market actors, civil society groups, and scientists have varying interpretations of what REDD+ should become, and of what ‘work’ means. For example, there are starkly different views on what the multiple aims of REDD+ should be (whether emission reductions, conservation of forests and forest biodiversity, or improving livelihoods of local communities), and what kinds of activities REDD+ should prioritize (whether avoiding deforestation, avoiding forest degradation, conservation, sustainable management, or forest carbon stock enhancement) to further its aims.

Moreover, there are also more fundamental questions regarding the desirability of REDD+. Gupta [3] and Houghton [4] stress that some actors question whether the considerable attention to REDD+ is justified, given that deforestation and forest degradation ‘only’ account for around 15–20% of global greenhouse gas emissions, and that the relative contribution of land use to overall emissions is declining. According to such a view, mitigation of climate change might be more effectively pursued by targeting fossil fuel use in developed countries and emerging economies. Gupta [3], Corbera [5], and Gupta et al. [6] also highlight the underlying neoliberal discourses shaping REDD+, as reflected in the creation of forest carbon as a commodity to be traded in markets or compensated as a payment for environmental services.

In addition, REDD+ can be expected to ‘work’ only if the activities it promotes and their impacts on forest carbon are measured and made equivalent with other carbon units to be potentially traded or compensated. Thus, the need for robust and efficient measuring and monitoring principles and techniques both requires and receives considerable attention. Besides being discussed in the respective technical communities (see e.g. De Sy et al. [7] and Mohren et al. [8]), Gupta et al. highlight that measurement and monitoring techniques and practices are also receiving attention in terms of their social impacts and risks [6]. While the development of monitoring, reporting and verification (MRV) systems is often framed as a neutral scientific activity, in practice it calls for many politically fraught decisions, and can further the interests of certain actors involved in forest governance while excluding others [6,9,10,11].

Finally, REDD+ is also critiqued as a step back in the history and evolution of forest policies. Forest policies have developed from an initially monofunctional perspective that focused on timber production, to a multifunctional and multiactor perspective that highlights the different services being provided by forests to a large and diverse group of producers and users. Critics of REDD+ thus highlight that, with its focus on carbon, REDD+ risks viewing forests once again as monofunctional. Others see its carbon-centered focus as a logical consequence of the fact that REDD+ is a climate change mitigation mechanism. Bridging such views, and analyzing how multifunctional benefits can still be derived from REDD+ thus necessarily requires a broader interdisciplinary debate.

In line with this need for interdisciplinarity, we draw on the contributions in this issue to synthesize *how, where* and *when* REDD+ will work. Our aim is to present an interdisciplinary perspective on REDD+ by integrating insights from the diverse natural and social science studies, which together address ecological, technical, political and economic aspects, and highlight roles, responsibilities and (dis)incentives of the different actors involved. This perspective leads to an interdisciplinary research agenda for REDD+ that, we hope, contributes to further scientific understanding of what is needed to make REDD+ work.

Complexity versus simplicity: how will REDD+ work?

Many discussions on whether REDD+ will work are in essence deliberations on whether REDD+ should be kept simple or whether there are aspects that need to be included as prerequisites for its success — the question of complexity versus simplicity.

An important issue here is the necessary scope of REDD+. There are, broadly speaking, two main scope-related

debates. The first relates to whether REDD+ should focus on reducing carbon emissions only, or whether it should also aim to conserve biodiversity and improve the livelihoods of and empower local communities. The second scope debate centers around the forest and land-use change activities to be included within REDD+.

With regard to the first, some argue that REDD+ should focus on carbon while avoiding harm to other forest-related services by introducing ‘safeguards’. This view is justified by noting that REDD+ is an UNFCCC-driven process and thus will by definition focus on carbon and climate issues. Proponents of such a view also highlight that REDD+ should be treated as driver and catalyst for change rather than a holistic solution to all forest-related issues and challenges. Others call for taking advantage of the opportunities for synergies by incorporating noncarbon ‘co-benefits’ into the design and compensation mechanisms of REDD+. Early thinking in the conservation community assumed that REDD+ would ‘automatically’ also serve biodiversity conservation goals. Over the years, this presumption has been nuanced to the current scientific consensus that biodiversity synergies can be better attained, and negative impacts avoided, if REDD+ is purposefully designed to do so [12,13,14,15]. Consequently, Pant [16], Phelps et al. [15], and Visseren-Hamakers et al. [17] argue for a new definition of REDD+ success, to include climate, biodiversity and livelihood goals.

A similar shift is evident with regard to the social dimensions of REDD+, with the focus moving away from how REDD+ can avoid harm to how it can bring about positive social change [18]. Some highlight that REDD+ will simply not work if alternative livelihood opportunities for forest-dependent communities are not considered, since the expansion of small-scale subsistence agriculture, for example, is an important cause of deforestation and forest degradation [4,17]. Others note the crucial need for secure land rights for indigenous communities to prevent land grabs [3,5]. Here, one of the main questions is how REDD+ can be designed and implemented in an equitable manner [3]. At the local and national level, land and land-use rights need to be clarified for REDD+ payments to work and to be appropriately and fairly allocated [3,17–20]. Yet these issues are highly contentious and political and have dominated forest governance debates for decades. The addition of carbon rights and the expectation of payments further increase the stakes and the complexity of these issues. As a result, many scholarly and policy analyses now highlight the multiple governance challenges that might stymie REDD+ [21].

With regard to the second set of scope debates relating to land use and land-use changes to be incorporated into a REDD+ mechanism, much attention has focused on the

opportunities and challenges posed by the shift from RED to REDD+ [1]. The debate on the appropriate scope of REDD+ has recently been even further expanded. As shown by Houghton [4], Visseren-Hamakers et al. [17] and Olander et al. [22], current discussions also focus on whether and how the main driver for deforestation and forest degradation, that is agricultural expansion, can be addressed through REDD+. In terms of scope, REDD+ is thus becoming increasingly complex. This also makes the 'REDD+ community' more heterogeneous, since not only climate actors, but also the conservation, development, agricultural and food security communities are involved.

The broadened scope of REDD+ has also significantly increased the complexity of measuring and monitoring REDD+ activities [22,23]. While deforestation is relatively straightforward to monitor, monitoring forest degradation is much more difficult [24]. De Sy et al. [7] show how, in the latest thinking on MRV, different technologies and monitoring mechanisms for forest carbon are combined. From a critical social science perspective, Gupta et al. [6] argue that the expanded REDD+ MRV challenge requires a form of 'carbon accountability' that acknowledges diverse on-the-ground forest realities and empowers nonexpert forms of knowledge.

If safeguards and co-benefits are to be incorporated in MRV systems as well, these would become even more complicated. Monitoring of co-benefits for REDD+ is still in its infancy, especially compared to monitoring of forest cover and carbon stock [25]. Developing capacities for the monitoring of forest carbon stock already accounts for a large part of countries' REDD+ readiness activities [26], and additional resources available for the development of co-benefits monitoring is likely smaller. As argued by Dickson and Kapos [25], in the case of biodiversity monitoring for REDD+, countries can partly overcome this by using and combining existing biodiversity and forest cover monitoring programs, techniques and databases, though the quality and scope of these programs vary greatly among countries. Also, the identification of priority areas can significantly help to make the measurement of biodiversity safeguards and co-benefits in REDD+ more feasible [17,25]. Apart from what to monitor, another question is who to include in monitoring. Many advocate involving local communities in monitoring forest carbon stock and co-benefits on the ground. Some see such local involvement as vital to increasing the quality of data and (cost-)efficiency, improving governance, empowering local communities, and generating local employment opportunities [21]. Larrazábal et al. [27] not only agree, but also point to the challenges of reconciling locally generated data with the potentially stringent MRV standards and requirements demanded internationally.

Another aspect of the complexity versus simplicity question is whether, for REDD+ to work optimally, it needs to be linked to other policies [3,17,22]. For example, REDD+ payments may not be enough to compete with the returns from alternative land uses, and payments for different ecosystem services may need to be combined [19]. Equally important are links between climate change and forest governance. Strengthening these linkages could enable synergies between climate and forest policies, and may help REDD+ to take on board the lessons learned from decades of forest policy. Especially synergies with existing forest certification and legality schemes should be pursued [28,29]. Finally, REDD+ as a climate mitigation instrument needs to be linked to climate adaptation efforts, since forests have an important role in both mitigation and adaptation [22,30].

The discussion above highlights that with many aspects of REDD+, choices have to be made between simplicity versus complexity. A balance needs to be sought between assuring success and feasibility: when complexity is needed, and where synergies can easily be obtained. Such political and societal choices, which can be supported by interdisciplinary research, need to be made at all levels where REDD+ is being discussed, from the international to the national and local levels [28]. We turn to these challenges of scaling REDD+ below.

Scaling REDD+: where will REDD+ work?

A crucial element in discussing where REDD+ will work relates to the countries that it might be most suited for. Different priorities can be distinguished from international and national perspectives. From a perspective aiming to maximize global carbon emission reductions, focusing on a few large countries with high deforestation rates and thus large REDD+ potential, such as Brazil or Indonesia, would be a logical choice. From a national perspective, more countries would like to benefit from REDD+. The expansion of the number of activities under REDD+ has thus been strongly influenced by countries' interests to be included. A related issue is the fact that countries with high rates of deforestation and forest degradation are also often those with various policy failures (such as corruption and weak law enforcement), unclear land tenure, and low levels of MRV capacity. This makes the implementation of REDD+ more challenging [5,18].

Another discussion on the question where REDD+ will work focuses on the potential of REDD+ to negatively impact ongoing positive forest governance trends, arguing that it might reverse the decentralization underway in many countries [18,31,32]. Such analyses thus emphasize the need for a 'nested' approach to REDD+, one that links multiple scales of forest governance, also through translocal and transnational networks [18,33].

A third important issue of scale relates to the sovereignty of countries to develop safeguard policies for REDD+ at the national level. The UNFCCC has developed broad and, according to some, rather unspecific safeguards guidelines that countries can use in developing their REDD+ national strategies. Voluntary REDD+-related initiatives, however, have developed more detailed safeguards and co-benefits policies. The World Bank's Forest Carbon Partnership Facility (FCPF), for example, has its own safeguards policy and requires participating countries to perform a Strategic Environmental and Social Assessment (SESA); UN-REDD has developed social and environmental principles and criteria; and the Climate Community and Biodiversity Alliance (CCBA) has incorporated biodiversity and social concerns in its standard [17,25]. This highlights an important dynamic in current REDD+ developments: while voluntary initiatives set conditions at the international level for actors participating in REDD+ (as do other forest management initiatives, such as certification), the UNFCCC emphasizes the sovereignty of countries with regard to national REDD+ safeguard policies. Which of these approaches will best ensure a working REDD+ requires not only continued political negotiations, but also interdisciplinary research.

The issue of monitoring and estimating the impacts of REDD+ is linked to scales as well [34]. REDD+ incorporates implementation and activities at the local level, and the estimation and reporting of the impacts of these local activities at the national level. This link between local implementation and national reporting (for carbon and co-benefits) remains one of the main technical and institutional challenges facing REDD+ [7,17,28]. It includes, among others, the discussion about the appropriate level at which reference levels for REDD+ should be set. A reference level is in theory needed for the local, national and global level. However, the choice of the appropriate scale of the reference level depends on which outcomes of REDD+ are prioritized [17,25]. Thus, here, the debates on scope and scale merge, as with many other dimensions of REDD+. For example, at the global level, the question is whether REDD+ has a positive net effect as a climate change mitigation activity. The national level needs to be more concerned with the (carbon) impacts and (co-)benefits of REDD+ policies and strategies, and needs to ensure that compensations are verifiable and ideally also verified. The local level is by nature much more concerned with co-benefits and less so with carbon impacts, although, as argued by Putz and Romero [28], it is at this level that many of the decisions influencing the outcomes of REDD+ are taken.

The REDD+ choices made and the activities implemented at the various scales thus influence each other. Coordination, rather than conflict, across scales is thus an essential prerequisite to making REDD+ work. These

scaling issues are also integrally related to the previously discussed scope issues. Consequently, these interactions of levels and scales and their implications remain a vital area for future interdisciplinary research.

Pacing REDD+: when will REDD+ work?

Alongside debates about the complexity of REDD+ at multiple levels, and the design issues yet to be resolved, the question arises when REDD+ is likely to become a reality, and whether it will do so in time. Since deforestation continues with an annual rate of 13 million hectares per year [35], there is an urgent need for effective measures.

Whereas the momentum in early negotiations on REDD+ was high, it has slowed down in recent years [1]. This tempered pace can be partly explained by the high complexity of the issue, but it also reflects diverging views among UNFCCC Parties on the desirability and design of REDD+, and the relatively low political will to effectively combat deforestation and forest degradation. REDD+ is also to a large extent dependent on the success of the post-Kyoto negotiations. If these fail to yield agreements, there may be no REDD+ in the context of the UNFCCC in the short term [3]. Yet even if an international REDD+ mechanism under the auspices of the UNFCCC fails to materialize, voluntary public and private REDD+-related initiatives might still continue to develop, although the pace at which they will do so will become more uncertain.

In addition to these political considerations, knowledge gaps and limited capacities inhibit the timely and large-scale implementation of REDD+. Large data and capacity gaps need to be addressed before REDD+ outcomes can be measured, reported on and verified (MRV'd). Finally, a fuller and more interdisciplinary understanding of the multidimensional drivers of deforestation and forest degradation is needed to ensure a workable and sustainable REDD+ [4,7], an issue now receiving attention in international policy debates.

Progress in REDD+ development and implementation will be in phases that are also part of the UNFCCC negotiations. Countries are expected to move from strategy formulation, to policy reform and demonstration activities, and eventually to results-based actions and compensation [36]. This 'step-wise' nature is now prominent in many aspects of REDD+ and emphasizes that it will become more of a learning-by-doing process [37]. This allows for studying and monitoring progress and failures, leaves sufficient room to develop country capacities, and for interdisciplinary science to accompany the process with dedicated research [31,38].

Finally, the question of when REDD+ will work depends to a large extent on the provision of reliable and sufficient

funding, both in the short term to make countries 'ready' for REDD+, as well as in the medium to long term to secure sufficient and sustainable payments for carbon credits. Since most countries are not yet ready to receive compensations for REDD+ at the national level, most funding currently consists of short-term, so-called 'fast-start' finance aimed at capacity-building and the development of national strategies and action plans. A multitude of financing mechanisms now exists, whether multilateral or bilateral, fund-based or market-based, direct or indirect, and public or private, as shown by the overview by Streck [31]. Negotiations on REDD+ financing have, however, not resulted in any agreements on an international funding mechanism, and it is still unclear how much funding is needed to make REDD+ work in the long term. While the earliest debates on REDD+ within the UNFCCC focused both on funding and on scope and design issues, much policy attention in recent years has focused on the latter set of issues, with funding relegated to the background and only now re-emerging as a key policy agenda item [1]. Whether and how sufficient and durable funding will become available depends not only on the carbon price and the economic situation at large, but also on the political commitment of countries and private actors to invest in REDD+ in the long term [31,39].

Conclusions an interdisciplinary research agenda

In this article, we reflected on the question 'Will REDD+ work?' from an interdisciplinary perspective. While we organized our discussion around the questions *how*, *where* and *when* REDD+ will work, these questions are necessarily related. Regarding safeguards and co-benefits, for example, the success of REDD+ is highly dependent on its ability to compensate forest dependent communities for using forests in a sustainable manner. This can only be done if tenure rights are clarified — something that is not achieved overnight, especially given the contentiousness of the issue. Also, since land rights are a national responsibility, only voluntary guidelines can be developed at the international level. This example reveals how the complexity, multilevel character and pace of REDD+ are related. It also highlights how REDD+ touches upon core issues in forest governance that the international forest and conservation community have not yet been able to solve. REDD+ can thus only work if it successfully addresses these difficult issues.

This content-driven complexity of REDD+ is exacerbated by the complexity caused by the fact that so many different governmental, market and civil society actors from different sectors, such as climate, forest, conservation, and community rights, and scientists from different disciplines are involved in developing and implementing REDD+ mechanisms at different levels. This makes identification of common priorities extremely difficult,

given the very different views on what REDD+ should become. The necessary complexity of REDD+ thus influences the pace of its development and implementation. At the same time, however, a broadened scope of REDD+ can also increase the chance that REDD+ will become a viable climate mitigation tool. Perceiving REDD+ as a governance system, with at the international level a UNFCCC core surrounded by other initiatives, such as the FCPC, UN-REDD and the Convention on Biological Diversity (CBD), could help unravel the inter-relationships between and contributions of the different instruments.

So, the question 'Will REDD+ work?' is considerably less straightforward than it sounds. Given the experience with earlier policy efforts to combat deforestation and forest degradation, REDD+ will most likely work better in certain contexts and less so in others. The chance that it will become the 'one size fits all' global solution to deforestation and sustainable forest use is highly unlikely. Efforts should thus focus on making REDD+ work as much as possible. Interdisciplinary research can support these efforts by advancing our understanding of how, where and when REDD+ might work, and identifying when (and what kind of) complexity is necessary.

REDD+ research remains, to date, quite monodisciplinary insofar as REDD+ is being analyzed from separate natural and social sciences perspectives. The only recent multidisciplinary evaluation by Angelsen et al. [40••] argues that REDD+ as an idea is a success story and a catalyzer of transformational change, but that it still faces many challenges. Their policy and research suggestions include identifying and focusing on key bottlenecks impeding progress, and shifting emphasis to cross-scale and jurisdictional-level REDD+ efforts. Other detailed analyses of REDD+, including earlier journal special issues [41,42], have focused on specific dimensions, such as the governance challenges and/or the international politics of REDD+. These studies also call for more integrated multilevel analysis of REDD+ design and implementation prospects. An important need is to avoid REDD+ becoming a victim of a 'hype cycle' [42], whereby the initially high attention declines as it becomes evident that REDD+ is difficult to operationalize. It is also important, however, to avoid the opposite problem: that REDD+ is widely embraced and promoted because it can mean almost anything to anyone.

Building on the above insights, we conclude by outlining here the elements of a timely and supportive interdisciplinary REDD+ research agenda. Given the complexity of the issue, REDD+ could become a catalyst for forest-related research to become more interdisciplinary. This provides a great opportunity that should not be bypassed. Also, the fact that REDD+ negotiations have slowed down provides a unique chance for research to accompany

the process of step-wise progress and synthesis. In this process, interdisciplinary research can help refine how, where and when REDD+ could work. With this, scientists also have an important role to play in capacity building, by providing the needed knowledge for multiple actors in different contexts and at different steps of the process. Concretely, interdisciplinary research can synthesize important lessons from countries' readiness processes for addressing the complexities of REDD+.

While monodisciplinary approaches have provided important insights, current questions on several key REDD+ issues need to draw on combined social and natural science perspectives. These include: whether and how MRV systems can include co-benefits; strengthening countries' technical and governance capacity for REDD+; defining preconditions for successfully incorporating co-benefits into REDD+; linking REDD+ to other policy areas such as forest management certification and timber legality; and identifying and managing the environmental and social impacts of varied REDD+ activities.

The issue of drivers of deforestation and degradation is perhaps the most relevant yet most understudied theme requiring interdisciplinary analysis [43,44]. Since there is an urgent need to better understand the links between land-use change processes, their drivers, the involved actors, the related carbon emissions and impacts, and the necessary REDD+ activities, the study of drivers of deforestation and degradation will certainly benefit from an interdisciplinary approach [4].

Finally, studies to address the multilevel nature of REDD+ are also essential. Themes include the link between international negotiations, national policies and local REDD+ activities; and the links between REDD+ monitoring objectives, approaches and impacts at different levels.

In conclusion, interdisciplinary research can help to distill the lessons learned from REDD+ efforts currently underway and can provide concrete recommendations for improving the impacts of REDD+. As shown in the synthesis above, REDD+ is complex and multidimensional, and interdisciplinary scientific understanding is essential in supporting the different actors involved in REDD+ to cope with this inherent heterogeneity and complexity.

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References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as:

- of special interest
 - of outstanding interest
1. Pistorius T: **From RED to REDD+: the evolution of a forest-based mitigation approach for developing countries.** *Curr Opin Environ Sustain* 2012, **4**:638-645.
 2. Murdiyasar D, Brockhaus M, Sunderlin W, Verchot L: **Lessons learned from the first generation of REDD+ activities.** *Curr Opin Environ Sustain* 2012, **4**:678-685.
 3. Gupta J: **Glocal forest and REDD governance: win-win or lose-lose.** *Curr Opin Environ Sustain* 2012, **4**:620-627.
 4. Houghton R: **Carbon emissions and drivers of deforestation and forest degradation.** *Curr Opin Environ Sustain* 2012, **4**:597-603.
 5. Corbera E: **Seeing REDD+ through the lens of political ecology.** *Curr Opin Environ Sustain* 2012, **4**:612-619.
 6. Gupta A, Lövbrand E, Turnhout E, Vijge M: **In pursuit of carbon accountability: the politics of REDD+ measuring, reporting and verification systems.** *Curr Opin Environ Sustain* 2012, **4**:726-731.
 7. De Sy V, Herold M, Achard F, Asner GP, Held A, Kellndorfer J, Verbesselt J: **Synergies of multiple remote sensing data sources for REDD+ monitoring.** *Curr Opin Environ Sustain* 2012, **4**:696-706.
 8. Mohren F, Hasenauer H, Nabuurs G-J: **Forest inventories for carbon change assessments.** *Curr Opin Environ Sustain* 2012, **4**:686-695.
 9. Boyd W: **Ways of seeing in environmental law: how deforestation became an object of climate governance.** *Ecol Law Q* 2010, **37**:843-916.
- Discusses the processes of classification, calculation and commensuration that are necessary for forests to be seen and governed as carbon sinks.
10. Bumpus AG: **The matter of carbon: understanding the materiality of tCO₂e in carbon offsets.** *Antipode* 2011, **43**:612-638.
- Argues that the 'spatial abstraction' of carbon for the global carbon market runs the risk of downplaying the local context within which carbon credits are generated.
11. Lovell H, Liverman D: **Understanding carbon offset technologies.** *New Polit Econ* 2010, **15**:255-273.
- Analyses the production of credits in carbon offset projects using a critical social science perspective.
12. Siikamäki J, Newbold SC: **Potential biodiversity benefits from international programs to reduce carbon emissions from deforestation.** *AMBIO* 2012, **41**:78-89.
 13. Gardner TA, Burgess ND, Aguilar-Amuchastegui N, Barlow J, Berenguer E, Clements T, Danielsen F, Ferreira J, Foden W, Kapos V et al.: **A framework for integrating biodiversity concerns into national REDD+ programmes.** *Biol Conserv* 2011.
- Develop a framework for facilitating the integration of biodiversity concerns into REDD+ strategic planning and assessment processes, and propose applying a 3-tiered approach for biodiversity assessments.
14. Busch J, Godoy F, Turner WR, Harvey CA: **Biodiversity co-benefits of reducing emissions from deforestation under alternative reference levels and levels of finance.** *Conserv Lett* 2011, **4**:101-115.
 15. Phelps J, Friess DA, Webb EL: **Win-win REDD+ approaches belie carbon-biodiversity trade-offs.** *Biological Conservation* 2012, **154**:53-60.
 16. Pant P: **Carbon, conservation, communities under sustainability (C3S) paradigm for forests.** In *The Economic, Social and Political Elements of Climate Change*. Edited by Filho WL. Springer-Verlag; 2011.
 17. Visseren-Hamakers IJ, McDermott C, Vijge M, Cashore B: **Trade-offs, co-benefits and safeguards: current debates on the breadth of REDD+.** *Curr Opin Environ Sustain* 2012, **4**:646-653.

18. Chhatre A, Lakhanpal S, Larson A, Nelson F, Ojha H, Rao J: **Social safeguards and co-benefits in REDD+: a review of the adjacent possible.** *Curr Opin Environ Sustain* 2012, **4**:654-660.
 19. Hein L, Van der Meer P: **REDD+ in the context of ecosystem management.** *Curr Opin Environ Sustain* 2012, **4**:604-611.
 20. Phelps J, Guerrero MC, Dalabajan DA, Young B, Webb EL: **What makes a 'REDD' country?** *Global Environ Change* 2010, **20**:322-332.
 21. Danielsen F, Skutsch M, Burgess ND, Jensen PM, Andrianandrasana H, Karky B, Lewis R, Lovett JC, Massao J, Ngaga Y *et al.*: **At the heart of REDD+: a role for local people in monitoring forests?** *Conserv Lett* 2011, **4**:158-167.
 22. Olander L, Galik CS, Kissinger GA: **Operationalizing REDD+: scope of reduced emissions from deforestation and forest degradation.** *Curr Opin Environ Sustain* 2012, **4**:661-669.
 23. Herold M, Skutsch M: **Monitoring, reporting and verification for national REDD+ programmes: two proposals.** *Environ Res Lett* 2011, **6**.
 24. Herold M, Román-Cuesta RM, Hirata Y, Van Laake P, Asner G, Souza C, Avitabile V, Skutsch M, MacDicken K: **Options for monitoring and estimating historical carbon emissions from forest degradation in the context of REDD+.** *Carbon Balance and Management* 2011, **6**.
 25. Dickson B, Kapos V: **Biodiversity monitoring for REDD+.** *Curr Opin Environ Sustain* 2012, **4**:717-725.
 26. Romijn JE, Herold M, Kooistra L, Murdiyasar D, Verchot L: **Assessing capacities of non-Annex I countries for national forest monitoring in the context of REDD+.** *Environ Sci Policy* 2012, **20**:33-48.
 27. Larrazábal A, McCall M, Mwampamba T, Skutch M: **The role of community carbon monitoring in REDD+: a review of experiences.** *Curr Opin Environ Sustain* 2012, **4**:707-716.
 28. Putz FE, Romero C: **Helping curb tropical forest degradation through linking REDD+ with other conservation interventions: a view from the forest.** *Curr Opin Environ Sustain* 2012, **4**:670-677.
 29. Ochieng RM, Visseren-Hamakers IJ, Nketiah KS: **Interaction between the FLEGT-VPA and REDD+ in Ghana: recommendations for interaction management.** *Forest Policy Econ* 2012:661-669.
 30. Somorin OA, Brown HCP, Visseren-Hamakers IJ, Sonwa DJ, Arts B, Nkem J: **The Congo Basin forests in a changing climate: policy discourses on adaptation and mitigation (REDD+).** *Global Environ Change* 2012, **22**:288-298.
 31. Streck C: **Financing REDD+: matching needs and ends.** *Curr Opin Environ Sustain* 2012, **4**:628-637.
 32. Sandbrook C, Nelson F, Adams WM, Agrawal A: **Carbon, forests and the REDD paradox.** *Oryx* 2010, **44**:330-334.
 33. Sikor T, Stahl J, Enters T, Ribot J, Singh N, Sunderlin W, Wollenberg L: **REDD-plus, forest people's rights and nested climate governance.** *Global Environ Change* 2010, **20**:423-425.
 34. Lövbrand E, Stripple J: **The climate as political space. On the territorialization of the global carbon cycle.** *Rev Int Stud* 2006, **32**:217-235.
 35. FAO: *Global Forest Resources Assessment 2010.* Rome: FAO; 2010.
 36. Visseren-Hamakers IJ, Verkooijen P: **The practice of interaction management: enhancing synergies among multilateral REDD+ institutions.** In *Forest and Nature Governance: A Practice-based Approach.* Edited by Arts B, Behagel J, Bommel Sv, Koning Jd, Turnhout E. Springer; 2012:133-149. World Forests.
 37. Herold M, Angelsen A, Verchot LV, Wijaya A, Ainembabazi JH: **A stepwise framework for developing REDD+ reference levels.** In *Analysing REDD+: Challenges and Choices.* Edited by Angelsen A, Brockhaus M, Sunderlin WD, Verchot LV. Center for International Forestry Research (CIFOR); 2012.
 38. Angelsen A, Brown S, Loisel C, Peskett L, Streck C, Zarin D: *Reducing Emissions from Deforestation and Forest Degradation (REDD): An Options Assessment Report.* Meridian Institute; 2009.
 39. Isenberg J, Potvin C: **Financing REDD in developing countries: a supply and demand analysis.** *Clim Policy* 2011, **10**:216-231.
 40. Angelsen A, Brockhaus M, Sunderlin WD, Verchot (Eds): **Analysing REDD+: Challenges and choices.** Bogor, Indonesia: Center for International Forestry Research (CIFOR); 2012.
- Based on CIFOR's large-scale, comparative study of REDD+, this report takes stock of the current status of REDD+, and the key institutions, interests, ideas and information currently shaping REDD+ activities.
41. Corbera E, Schroeder H: **Governing and implementing REDD+.** *Environ Sci Policy* 2011, **14**:89-99.
 42. Skutch M, McCall M: **Reassessing REDD: governance, markets and the hype cycle: an editorial comment.** *Clim Change* 2010, **100**:395-402.
 43. Kissinger G, Herold M, De Sy V: *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers.* Vancouver, Canada: Lexeme Consulting; 2012.
 44. Hosonuma N, Herold M, De Sy V, De Fries RS, Brockhaus M, Verchot LV, Angelsen A, Romijn JE: **An assessment of deforestation and forest degradation drivers in developing countries.** *Environ Res Lett* 2012, **7**.