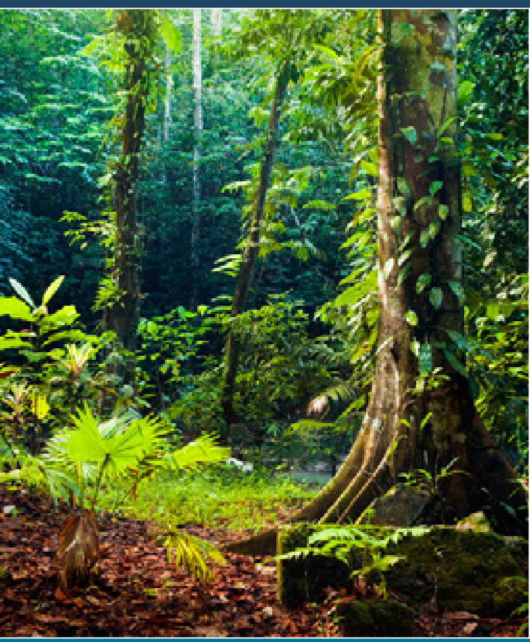
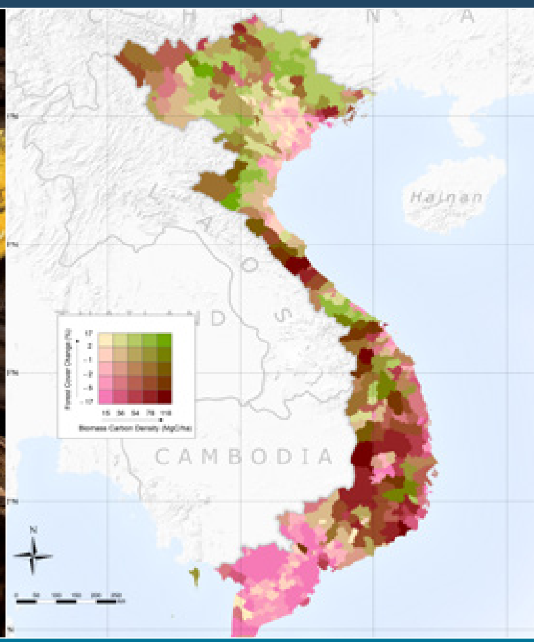
Mapping the potential for REDD+ to deliver biodiversity conservation in Viet Nam

A preliminary analysis





SNV

UNEP WCMC

UNEP World Conservation Monitoring Centre
219 Huntingdon Road
Cambridge, CB3 0DL
United Kingdom
Tel: +44 (0) 1223 277314
Fax: +44 (0) 1223 277136
Email: info@unep-wcmc.org
Website: www.unep-wcmc.org

SNV REDD+ Headquarters
5th Floor, Thien Son Building
5 Nguyen Gia Thieu, District 3
Ho Chi Minh City, Vietnam
Tel: +84 8 39300668
Fax: +84 8 39300668
Email: rmcnally@snvworld.org or akager@snvworld.org
Website: www.snvword.org/redd

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

The SNV REDD+ programme has been established in 2009 and identified three main intervention areas necessary to make REDD+ work, while supporting the poor and enhancing biodiversity. The SNV REDD+ team of experts pilot interventions in these areas in selected countries across Asia and Africa.

ACKNOWLEDGEMENTS

The mapping work summarized in this report was commissioned by SNV – The Netherlands Development Organisation as part of the project '*Exploring Mechanisms to Promote High-Biodiversity REDD+: Piloting in Viet Nam*'. UNEP-WCMC's contribution to the project is part of the REDD-PAC project. Both projects are part of the International Climate Initiative. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety supports this initiative on the basis of a decision adopted by the German Bundestag.

Preliminary spatial analyses were conducted by Green Field Consulting and Development Co., Ltd. in association with the Research Centre for Forest Ecology and Environment (RCFEE), who were responsible for forest biomass carbon estimates. Key Biodiversity Area (KBA) and conservation corridor datasets were provided by Conservation International.

Thanks to Akiko Inoguchi of the Food and Agriculture Organization of the United Nations (FAO), Florian Werner of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Benktesh Sharma who provided comments on a draft version of the report.

DISCLAIMER

CONTRIBUTORS

Hoang Viet Anh and Le Viet Thanh (email: anh.hv@gfd.com.vn), Green Field Consulting & Development, 27 Ly Thai To Hoan Kiem, Hanoi, Viet Nam

Vu Tan Phuong (email: phuong.vt@rcfee.org.vn), Research Centre for Forest Ecology & Environment, Viet Nam Forest Science Institute

Vo Thanh Son (email: thanhson.vo@gmail.com), Centre for Natural Resources & Environmental Studies, Viet Nam National University University, 144 Xuan Thuy Street, Cau Giay, Hanoi, Viet Nam

Steven Swan (email: sswan@snvworld.org), SNV REDD+ Headquarters, 5th Floor, Thien Son Building, 5 Nguyen Gia Thieu, District 3, Ho Chi Minh City, Viet Nam

Rebecca Mant, Monika Bertzky, Corinna Ravilious, Julia Thorley, Kate Trumper and Lera Miles (email: climate@unep-wcmc.org)

UNEP World Conservation Monitoring Centre, 219 Huntingdon Road, Cambridge, CB3 0DL, UK

CITATION

Mant, R., Swan. S., Anh, H.V., Phuong, V.T., Thanh, L.V., Son, V.T., Bertzky, M., Ravilious, C., Thorley, J., Trumper, K., Miles, L. (2013) Mapping the potential for REDD+ to deliver biodiversity conservation in Viet Nam: a preliminary analysis. Prepared by UNEP-WCMC, Cambridge, UK; and SNV, Ho Chi Minh City, Viet Nam.

Available online at: www.carbon-biodiversity.net and www.snvworld.org/redd

Photos: Front and back cover:
Left: © iStock
Centre: *Loepa sikkima*- © Jeremy Holden - SNV
Right: Map of vegetation continuous fields deforestation rates and forest biomass carbon © UNEP - WCMC

UNEP promotes
environmentally sound practices
globally and in its own activities.
This publication is designed for electronic
distribution. Our printing and
distribution policy aims to reduce
UNEP's carbon footprint.

Mapping the potential for REDD+ to deliver biodiversity conservation in Viet Nam

A preliminary analysis

Rebecca Mant, Steven Swan, Hoang Viet Anh, Vu Tan Phuong, Le Viet Thanh, Vo Thanh Son, Monika Bertzky, Corinna Ravilious, Julia Thorley, Kate Trumper and Lera Miles

Contents

1. Introduction

1.1 REDD+: opportunities and risks for biodiversity

REDD+ - *reducing emissions from deforestation and forest degradation, plus conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks in developing countries*[1] – has emerged in recent years as a potential response to tackling greenhouse gas (GHG) emissions arising from the tropical deforestation and land use change. Although primarily intended as a climate change mitigation mechanism, REDD+ also has the potential to provide further benefits through maintenance or restoration of biodiversity and ecosystem services. Depending on how it is implemented, REDD+ can also pose potential risks (see Box 1).

To ensure that these multiple benefits are realized, and that potential risks are minimized, a series of commitments were made in 2010 by the international community – the 'Cancun safeguards' of the United Nations Framework Convention on Climate Change (UNFCCC 2010). Countries seeking to implement REDD+ programmes have agreed to 'promote and support' these safeguards, including that, [REDD+ activities are] '*consistent with the conservation of natural forests and biological diversity, [and] that actions...are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests...*'.

All developing countries pursuing REDD+ are also Parties to the Convention on Biological Diversity (CBD), which adopted a new Strategic Plan for Biodiversity 2011-2020. The Plan establishes five strategic goals and 20 biodiversity 'Aichi Targets' to be met by 2020, including a number of targets relevant to REDD+[2]. In 2012, the Parties to the CBD took note that spatially explicit information on biodiversity priority areas could inform development and implementation of national REDD+ strategies or action plans and compliance with UNFCCC safeguard requirements.

Box 1 Potential benefits and risks to biodiversity from implementing REDD+ activities
Source: Mant et al. 2013

REDUCING DEFORESTATION, FOREST DEGRADATION and CONSERVATION OF FOREST CARBON STOCKS

Benefits - retain the existing biodiversity and ecosystem services of the remaining forest and reduce pressures on biodiversity that are associated with fragmentation and loss of forest area. Decreasing degradation can reduce pressures on forest resources so that forest biodiversity and ecosystem services may recover.

Risks - displace conversion and extractive use pressures to lower carbon forests and to non-forest ecosystems due to continuing need for food crops, pasture or biofuel, thus negatively impacting the biodiversity and ecosystem services these areas provided. Management interventions could have unintended impacts (e.g. fire control could impede natural disturbance processes).

SUSTAINABLE MANAGEMENT OF FORESTS

Benefits - contributes to ensuring the long-term maintenance of forest resources that are already in use, e.g. by controlling how much and from where firewood can be extracted

Risks – depends on the definition of sustainable management, which is not yet characterised in detail by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). REDD+ revenues rewarding this activity could promote harvesting in hitherto unlogged areas.

ENHANCEMENT OF FOREST CARBON STOCKS (afforestation, reforestation and forest restoration)

Benefits - increases the connectivity between patches of intact forest, restoring ecosystem functionality in degraded forests, and reducing pressure on existing forest by providing alternative sources of wood products through plantations.

Risks - could result in low biodiversity, affect ecosystem functioning and promote spread of invasive species if monoculture plantations, non-native species, and unsustainably high inputs (e.g. water, fertiliser, etc.) are used; can harm important non-forest biodiversity and ecosystem services if implemented in places not previously forested

[1] United Nations Framework Convention on Climate Change (UNFCCC) 13th Conference of the Parties (CoP) Decision 1/CP.13 – The Bali Action Plan (2007)

[2] Especially Target 5 (reducing deforestation and degradation); Target 7 (sustainable management of agriculture, aquaculture and forestry); Target 11 (terrestrial protected areas and landscapes); Target 14 (ecosystems services safeguarded); Target 15 (contribution of biodiversity to carbon stocks) (CBD 2010).

1.2 Mapping and REDD+ planning

The success of REDD+ actions in achieving multiple benefits, and ensuring that safeguards are met, will depend to a substantial degree on where different REDD+ activities are implemented. The potential benefits and risks to biodiversity that REDD+ can bring will vary from one location to another depending on a variety of factors from biophysical and geographical to socio-economic and cultural. Spatial information related to these factors can, therefore, help decision makers to plan and prioritise actions and locations as part of national REDD+ programmes.

Maps can be used as a basis for communication with stakeholders as well as for simple visual analysis of the spatial relationship between different themes. High-resolution, accurate and up-to-date spatial information is often limited. In most cases it is necessary to corroborate conclusions reached on the basis of the available spatial datasets, through consulting local knowledge and field observation before making a final decision about the selection of sites for a particular REDD+ action. Mapping cannot cover all factors, such as local governance structures for example, that need to be considered within REDD+ planning processes, but spatial analysis can be a useful decision-support tool, particularly when considering biophysical aspects such as biodiversity importance and conservation value.

REDD+ comprises five activities[3], each of which may present different potential positive and negative impacts on biodiversity (see Box 1). In order to reduce deforestation, for example, understanding and mapping where deforestation has occurred in the recent past can provide an indicator of the potential location of future deforestation, if the drivers of deforestation remain the same (qualitatively and quantitatively). Sustainable management of forests, on the other hand, will be most relevant in locations where forests are currently being used unsustainably, and mapping of production forests in relation to the spatial distribution of forest biodiversity could identify priority locations for this REDD+ activity in relation to the spatial distribution of forest biodiversity.

The maps presented in this summary report have been selected from a range of preliminary GIS[4] outputs produced to illustrate how such mapping can inform REDD+ planning in Viet Nam and contribute to achieving the biodiversity aspects of the National REDD+ Action Programme (NRAP) (see section 1.3). All maps in this report were developed using the best data publicly available at the time, and would need to be updated as more recent and accurate datasets become available. The forest biomass carbon, and forest cover change estimates presented in these maps are not intended to present a definitive statement of REDD+ potential in Viet Nam. The purpose is to show the spatial relationships between *relative* forest biomass carbon densities (and historical changes thereto) and various indicators of biodiversity to illustrate how mapping can be used for planning under the NRAP and stimulate further analysis using better data and refined methods.

1.3 REDD+ readiness efforts in Viet Nam

In the past few years, Viet Nam has emerged as one of Asia's leading countries engaging in REDD+ at a national level in anticipation of a future international GHG emissions reduction compliance regime negotiated under the UNFCCC. Near-term financing opportunities, such as the Forest Carbon Partnership Facility's (FCPF) Carbon Fund, or bilateral partnerships such as that recently agreed between Norway and Viet Nam[5].

Since the 2007 Bali Action Plan, Viet Nam has embarked on a number of official development assistance (ODA) and grant-funded 'REDD+ readiness' programmes and demonstration projects, including submission of a Readiness Preparation Proposal (R-PP) in 2010 and implementation of the first phase of a UN-REDD national programme (2009-2012).

These preparatory REDD+ investments have permitted Viet Nam to experiment with some elements of national REDD+ programme development and achieve a partial foundation of readiness for future 'results-based actions'. Some notable achievements include, *inter alia*:

- an institutional framework for designing and operating a national REDD+ programme
- stakeholder engagement through a national network, working groups and website
- reference emission level (REL) and forest reference level (FRL) modelling
- GHG emissions measurement, reporting and verification (MRV) framework design
- preliminary mainstreaming of REDD+ into non-forestry policy frameworks
- policy research on benefit distribution system (BDS) design options

[3] The five REDD+ activities are: reducing deforestation; reducing forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (UNFCCC, 2007).

[4] Geographic information system.

[5] Joint Declaration between the Socialist Republic of Viet Nam and the Kingdom of Norway on REDD+, signed 5 November 2012.

Annamitc Rain Forest Vietnam © Jeremy Holden, SNV

In 2012, the Prime Minister approved a National REDD+ Action Programme: 2011-2020 (NRAP)[6]. Together with reduction of GHG emissions through efforts to mitigate deforestation and forest degradation, biodiversity conservation is included as part of the NRAP's overall objective. Conservation of biodiversity, and diversification and improvement of livelihoods of forest owners, comprise specific objectives for the 2016-2020 period of NRAP implementation. Development of a national environmental and social safeguards information system (SIS) is also indicated as an element of NRAP activities in the initial period of implementation (2011-2015).

Despite these advances during the past three years of intensive REDD+ readiness efforts, Viet Nam is only now beginning to consider coherent policy responses in addressing and respecting environmental and social safeguards. At the same time, processes are underway in Viet Nam to start piloting sub-national demonstration activities under the NRAP[7]. Maps, such as those presented in this preliminary report, can inform both national safeguard policy processes and sub-national planning processes, in which economic, environmental and social trade-offs are negotiated among stakeholders to realise the multiple benefits of REDD+ (Dickson *et al.* 2012).

1.4 Changes in quality and quantity of Viet Nam's forests

Forest cover in Viet Nam has changed dramatically since the second half of the 20th century. Four decades (1941-1976) of conflict devastating the national economy, followed by a further two decades (1976-1996) of economic and political isolation, drove forest cover from 43 % in 1943 to a low of 27 % in 1990. Extensive application of herbicides by the United States Air Force, over a decade-long period (1961-1971) during the Second Indochina War affected a significant area (2.4 million ha) of forest land in the south of the country (VDR 2010).

Since the last decades of the 20^{th} century, agricultural expansion for cultivation of cash crops by the lowland ethnic majority Kinh people, migrating into forested areas, has been the major direct cause of deforestation. An exacerbating factor accompanying the expanding agricultural frontier was timber and firewood collection by the new settlers (De Koninck 1999). The most extensive losses of forest cover were

[6] Prime Ministerial Decision 799/QD-TT, dated 27 June 2012, on Approval of the National Action Program on Reduction of Greenhouse Gas Emissions through Efforts to Reduce Deforestation and Forest Degradation, Sustainable Management of Forest Resources, and Conservation and Enhancement of Forest Carbon Stocks: 2011 – 2020.

[7] Under a number of bi- and multilateral REDD+ readiness initiatives, such as the second phase of the UN-REDD National Programme in Viet Nam, and the Forest Carbon Partnership Facility (FCPF).

in the Central Highlands, central coastal provinces, and the eastern part of the southern region (MARD, 2008). The loss of mangrove forests has been particularly acute – 85 % reduction in extent in the past 60 years (from 400,000 ha in 1943 to less than 60,000 ha in 2008)[8].

By the mid-1990s, severe depletion and degradation of the forest estate precipitated an abrupt policy change: logging bans followed by two decades of ambitious reforestation programmes, to 're-green the bare hills', have reversed the decline in forest cover. The most recent forestry sector programme set the target of five million hectares of reforestation to bring Viet Nam back to pre-war levels of forest cover. At the close of the programme, in December 2010, forest cover in Viet Nam had attained nearly 40 %[9] (see Figure 1). Consequently, Viet Nam is unique in Southeast Asia, but in harmony with neighbouring China, in achieving net afforestation/ reforestation for nearly two decades (VDR 2010; MARD 2011).

Gains in forest quantity, however, have not been mirrored in terms of forest quality. Most of the reforestation effort in Viet Nam comprises monoculture plantations of fast-growing exotic species, such as hybrid *Acacia* and *Eucalyptus*, and reforested areas are of low biodiversity and ecosystem service value (BCA, 2009). Degradation of natural forests continues largely unabated. Lucrative trade in timber and processed wood products to expanding domestic and export markets continues to degrade the nation's (and neighbouring countries') remaining natural forests (VDR 2010; MARD 2011). The current major direct causes of residual localized deforestation, and more pervasive forest degradation in Viet Nam, are identified as: (i) conversion to agriculture (particularly perennial cash crops); (ii) illegal logging; (iii) infrastructure development; and (iv) forest fires. Invasive species, mining, biofuels and a changing climate are currently implicated as minor drivers of deforestation and forest degradation, but with potential to intensify in the future (MARD, 2011).

2. Developing maps of forest biomass carbon, forest cover change and biodiversity

2.1 Mapping forest cover and carbon density

The GHG emissions reduction/enhanced removal potential of forests depends on the biomass carbon present within these forests; understanding the distribution of forest biomass carbon, therefore, is an important part of national REDD+ planning.

A map of above and below ground forest biomass carbon in Viet Nam for 2005 (Map 1 - **NFIMAP forest biomass carbon map**) was prepared on the basis of the 2005 Viet Nam forest cover map produced

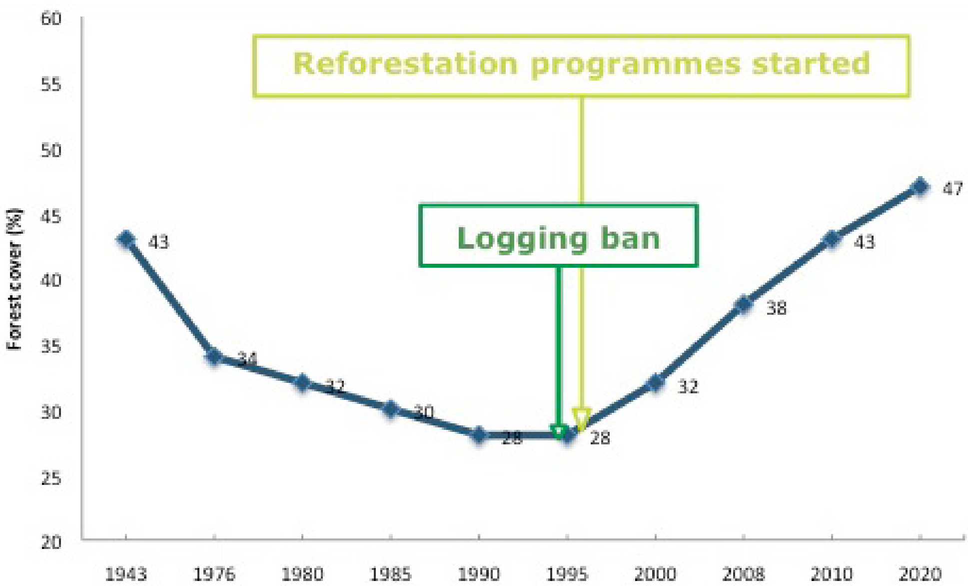


Fig 1 Forest cover of Viet Nam from 1943 to 2010 and projection to 2020 (Source: Adapted from VNFOREST 2013)

[8] Ministry of Agriculture & Rural Development Decision No. 1267/QĐ-BNN-KL, dated 04.05.09, Announcing the Current Forest Resource Management of the Country.

[9] A total of about 13.4 million ha, comprising 10.3 million ha of natural forest (77 %) and 2.9 million ha of plantation (23 %) (FAO 2010).

by the third cycle of the National Forest Inventory, Monitoring and Assessment Programme (NFIMAP III)[10].

In Map 1, biomass carbon is classified into five area-based classes in which each class contains approximately one fifth of the area of Viet Nam. The average forest biomass carbon stock for Viet Nam in 2005, estimated from this map, is about 106 tC ha^{-1}, about 33 % higher than the 72 tC ha-1 reported in the 2010 Global Forest Resources Assessment (GFRA; FAO 2010). One potential reason for underestimation in GFRA report is assumed growing stock volume of 78 m^3 ha^{-1}, a value from year 2000, while the forest monitoring plot-based estimate from NFIMAP III (2005) showed an average growing stock volume of 99 m^3 ha^{-1}.

Comparison was also made with an alternative above and below ground forest biomass carbon map, a global map of forest carbon stocks in tropical regions *c.* 2000[11](Saatchi *et al.* 2011). The map of Viet Nam's biomass carbon (Map 2) extracted from this global benchmark map gives significantly higher estimation of average forest *and non-forest* biomass carbon density for Viet Nam, 257 tC ha^{-1}, more than two and a half times the value obtained from using national standing volume and forest cover data (NORDECO 2010). The value of the global carbon biomass data, and the reason it was explored in this high-biodiversity mapping exercise, is that they are accompanied by an estimate of uncertainty for above-ground biomass potentially caused by use of coarse imagery at 1-km pixel resolution, which for Viet Nam are between 26 to 54 % with a mean of 36 %.

NFIMAP III data do not have such estimates of uncertainty, but field verification of NFIMAP IV (2010) inventory data conducted in 2011, indicates underestimation of standing timber volume (from which biomass estimates are derived) – the number of trees measured in permanent plots in natural forests was underestimated by 21 % on average (JICA & VNFOREST, 2012). It is beyond the scope of this preliminary study to investigate and evaluate the underlying cause of the differences between biomass carbon estimates and the degrees of uncertainty associated with these datasets. The existence of different estimates of forest biomass carbon stocks, with high degrees of uncertainty over their precision, however, illustrates the importance of improving national data quality and the need for field-based verification as the basis of REDD+ planning and results-based financing.

While there is a substantial difference in *absolute* forest biomass carbon density estimates, what is relevant to this exploration of spatial relationships between forest carbon and biodiversity is that the *relative* spatial pattern of biomass carbon distribution is similar between the two datasets: the Mekong delta and Red river deltas have low carbon density; the upland areas of the North and Central Highlands have relatively high carbon density; and the Northwest and Northeast share similar patterns of carbon distribution in both maps.

This study also explored global soil carbon datasets as a contribution to forest carbon stock estimates for Viet Nam. Land clearance or unsustainable forest management often lead to a significant release of soil carbon to the atmosphere; soil carbon data, therefore, would be valuable additions to REDD+ planning processes. However, accurate spatial data on soil carbon is scarce, and for Viet Nam the available global data (Scharlemann *et al.* in prep.) are very coarse. As the resolution of the forest biomass carbon data is higher than that of the soil carbon dataset, it can be advisable for planning at finer scales to use only biomass carbon maps. Ignoring the benefits that REDD+ actions create in terms of soil carbon, however, may reduce potential income from REDD+ payments. A global map of terrestrial soil carbon stocks (Scharlemann *et al.* in prep.), based on up-to-date composite datasets summarized in the Harmonized World Soil Database, was reviewed but not incorporated with forest biomass carbon maps for Viet Nam under this study, since the coarse resolution of the global soil data would have obscured the detailed spatial pattern for biomass carbon distribution obtained from the national data NFIMAP III data.

2.2 Mapping deforestation

In order to reduce deforestation and pressure for forest conversion it can be useful to identify where deforestation has occurred in the past as a possible indication of future deforestation. Proximity to zones where deforestation took place in the past may indicate a higher threat of deforestation in the future if the same factors continue to drive deforestation at similar rates. Therefore, recent deforestation is also presented on the '**NFIMAP forest biomass carbon map**' Map 1. Deforested areas were located by identifying areas which had forest cover in the NFIMAP II forest map produced in 2000 but were non-forested in the NFIMAP III forest cover map of 2005. Although, Viet Nam has reported a net gain in forest cover from 2000 (11.3 million ha) to 2005 (12.6 million ha), localized deforestation has occurred throughout the country in a pattern of small-scale mosaic encroachment (Map 1).

In addition to presenting the deforestation in the NFIMAP data, a previous study conducted by

[10] At the time of producing the forest biomass carbon maps, the NFIMAP IV (2010) cycle had been completed, but was not publically available and remains subject to internal review process within the MARD.

[11] Biomass measurements used to produce the Saatchi et al. (2011) map were made after 1995 and before 2005.

SNV (Holland and McNally 2009) used Vegetation Continuous Fields (VCF) data, provided by Global Land Facility, to map Viet Nam's deforestation rate between 2000 and 2005. Elaborating on this work, the '**VCF deforestation map**' (Map 3) presents the percentage of deforestation in an area in the context of the forest carbon densities of the NFIMP III data.

It should be noted that although the official NFIMAP II and III data indicate a net gain of 1.35 million ha (11.5 %) in forest cover during 2000-2005, the VCF data suggest a slight decrease of 1.8 % of forest cover during this period. The NFIMAP follows specific definition of 'forestland' (which includes areas forested to varying degrees) and forest types to meet planning and management needs of the national forest estate. VCF on the other hand is a global index mainly designed to map coverage of vegetation. Because of its coarse resolution (500 m), VCF may have tended to overlook young plantations where the tree canopy has not yet formed a closed and homogeneous layer thereby underestimating the forest cover. These young stands, however, are detectable in the NFIMAP using higher resolution imagery (such as SPOT and Landsat). The VCF data also exhibit a large degree of variation in localized forest cover change throughout the country, indicating that: 20 % of forested districts in Viet Nam experienced a reduction in forest cover by more than 10 % between 2000 and 2005.

Despite the positive trend in forest cover change for Viet Nam over the 2000-2005 period, resulting from afforestation and reforestation as indicated by the NFIMAP data, significant loss continues in rich natural forests. The 2010 GFRA documents a 51 % reduction in Viet Nam's highly fragmented residual primary forest cover from 185,000 ha in 2000 to 85,000 ha in 2005 (FAO 2010). The rate of deforestation decelerated between 2005 and 2010, but still 5,000 ha or 6.2 % of primary forest was lost from the national estate during this period (FAO 2010), raising serious concern about the ecological integrity of Viet Nam's remaining natural forest and its associated biodiversity conservation value.

2.3 Mapping forest management functions

Understanding which forests are managed for which purposes will be essential in planning for REDD+ to meet both climate change mitigation and biodiversity objectives of the NRAP (Map 4). In Viet Nam, forests are classified into three management types:

- Special-use forests - where the primary function is conservation of nature, cultural and sites of historical importance, recreation and tourism (i.e. synonymous with 'protected areas' in a generic global sense)
- Protection forests - which are maintained for catchment protection, hydrological cycle maintenance, soil conservation and land stabilization in coastal areas
- Production forests - which are managed primarily for timber and non-timber forest products (NTFPs) production and, more recently, 'forest environmental services' provision.

Official government statistics[12] indicate that by the end of 2011 Viet Nam had 2.0 million ha of special-use forest (15 % of the total national forest estate), 4.6 million ha of protection forest (34 %) and, 6.7 million ha of production forest (59 %). Special-use and protection forests can be very important in limiting deforestation, forest degradation and conserving forest carbon stocks, whereas production forests are most relevant to the REDD+ activity of sustainable management of forests. Map 4 presents the NIFMAP III forest biomass carbon map overlaid with the spatial distribution of the **three forest management types** in Viet Nam. This map indicates that production forests store 0.56 Gt of carbon accounting for 47 % of Viet Nam's total forest biomass carbon stock, suggesting that sustainable management of forests may be an important REDD+ activity in Viet Nam. A large proportion of forest within all three management categories is 'natural forest'[13](Figure 2), which is important for consideration of the Cancun Agreements, which emphasise natural forest protection through REDD+[14]. In 2005, around half of production forests (43.7 %) and protection forests (55.5 %) are classified as natural forest.

It is necessary to note that the total amount of biomass carbon in the three forest management types only accounts for 87.3 % of the estimated total forest biomass carbon stock in Viet Nam. The difference is due to the 'shrub land' category (7.7 million ha) which is recognized in the forest cover map (Map 1) but is not classified and mapped as forest in the three types of forest management map (Map 4).

It is also important to consider that special-use forests (protected areas) will only secure carbon stocks and conserve biodiversity if they are effectively managed. There are several cases in Viet Nam where national parks have been affected by infrastructure development including power generation. Examples of such cases are: the Krong Kmar hydroelectric plant (12 MW) built in Chu Yang Sin national park in 2005, and the Road No. 645 from Dak Lak province to Phu Yen province that goes through Ea So natural reserve (Cao Thi Ly *et al.*, 2009).

[12] MARD Decision No. 2089, dated 30.08.12, on the Declaration of National Forest Status, 2011.

[13] Defined as '*forest existing in nature or restored through natural regeneration* [comprising] *primary and secondary* [restored and post-harvest] *forests*', following MARD Circular No. 34, dated 10.06.09, Regulating the Criteria for Defining and Classifying Forests

[14] [REDD+] '*Actions are consistent with the conservation of natural forests and biological diversity, ensuring that* [REDD+] *actions…are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services…*'

© Jeremy Holden, SNV

2.4 Mapping forest biodiversity

Areas of REDD+ activities may be selected for multiple benefits in addition to climate change mitigation. The conservation of biodiversity is explicitly cited as an objective of Viet Nam's NRAP (Section 1.3). Ideally locally generated data on local biodiversity priorities would be used for identifying key areas for conservation efforts. Such detailed local data are not always available. Viet Nam has no national system of biodiversity monitoring. Therefore, the spatial distribution of biodiversity was assessed using a number of indicators including:

- Key Biodiversity Areas and Conservation Corridors (BirdLife International *et al.* 2013)
- Terrestrial vertebrate[15] species richness (IUCN 2011)
- Threatened terrestrial vertebrate species richness (i.e. the subset of terrestrial vertebrate species listed in the IUCN Red List of Threatened Species)

Mapping biodiversity with areal data

Key Biodiversity Areas (KBAs) (Map 5) are internationally recognised areas of importance for species diversity. KBAs are identified at the national, sub-national or regional level by local stakeholders using the two widely accepted criteria for biodiversity importance: vulnerability and irreplaceability.

- ***Vulnerability:*** areas where there is regular occurrence of significant (exceeding a threshold) population of a globally threatened species (according to the IUCN Red List) at the site.
- ***Irreplaceability:*** areas that hold a significant proportion of a species' global population at any stage of the species' lifecycle.

Therefore, KBAs can be used as a proxy to assess the location of areas important for biodiversity and how this relates to the spatial distribution of forest carbon stocks and changes in those stocks. In Viet Nam, there are 104 KBAs covering an area of 3.35 million ha, accounting for 10 % of country's terrestrial area (BirdLife *et al.* 2013). KBAs are not only important for biodiversity, but also for carbon storage. In terms of forest biomass carbon, KBAs in Viet Nam contain more than one fifth (0.37 Gt) of the country's total forest carbon stocks. In some places, KBAs are included as part of special-use forests (protected areas), and so are already under some form of conservation management, but not always. In general, KBAs are larger in size than individual special-use forests.

KBAs do not cover all areas important for biodiversity conservation. Depending on what aspect of biodiversity conservation is considered, different areas could be highlighted as priorities. One effort in the Indochina region identifies **conservation corridors**, on behalf of the Critical Ecosystem Partnership Fund (BirdLife *et al.* 2013). Conservation corridors are centred around KBAs (core areas), with the remainder comprising either areas that have the potential to become KBAs in their own right (through management or restoration) or areas that contribute to the ability of the conservation corridor to support biodiversity in the long term (CEPF, 2012). Prioritizing conservation corridors as well as KBAs could help ensure connectivity between habitats which can increase the resilience of forests to climate change. In total, this preliminary study indicated that combined, conservation corridors store more than half (0.76 Gt C) of all forest biomass carbon stocks in Viet Nam.

For both biodiversity conservation and climate change mitigation objectives, it is not just the total forest carbon stored in these forests that is important to Viet Nam, but also the quality of these natural forests and how that biomass carbon is spatially distributed. Viet Nam's natural forest cover is highly fragmented (Map 1), and such a patchy (and degraded) natural forest estate presents a major challenge to conserving biodiversity[16] and maintaining forest ecosystem services[17]. This challenge is likely to be exacerbated by a changing

[15] Amphibians, reptiles, birds and mammals.
[16] Particularly wide-ranging forest-obligate conservation flagship species, such as tiger, elephant and wild cattle species.
[17] As mandated by national Decree No: 99 on the Policy for Payment for Forest Environmental Services.

climate, inducing shifts in species' distributions (CEPF 2012). Prioritisation of conservation corridors for forest landscape restoration under the NRAP is a possible example of the potential to apply REDD+ to meet multiple national policy objectives and deliver of multiple benefits: biodiversity conservation and climate change mitigation.

Mapping biodiversity with species distribution data
IUCN species range data (IUCN 2011) can also be used to quantify biodiversity indices including potential species richness and threatened taxa. The distribution of species richness can give an indication of the potential of REDD+ to affect species diversity (only an indication, because some species are restricted to less rich areas). Within the IUCN Red List process, all known mammal, bird and amphibian species have been assessed worldwide, as well as some reptiles, plants and invertebrates. Since species richness data from only available vertebrate classes are used in this preliminary mapping exercise[18], this exercise does not make a complete assessment for all the species in Viet Nam. However, this richness data is likely to provide a relatively reliable indication of the total richness of all species in Vietnam's forests[19](Map 6).

The distribution of certain groups of species may be particularly important for ecological, cultural or economic reasons at national or local scale. Understanding the spatial distribution of these species in relation to forest biomass carbon can help to select areas where REDD+ may yield greater biodiversity benefits, as required under Vietnam's NRAP objectives.

For ecological reasons, amphibians make 'good' indicators of ecosystem health, the spatial distribution of biodiversity and conservation importance as a consequence of their higher sensitivity to environmental change (Gardner 2001). The distribution of amphibian species richness is highlighted here as an example of using a particular taxonomic group as a proxy for the spatial distribution of biodiversity that could inform planning of national and sub-national REDD+ programmes (Map 7).

The IUCN Red List also assigns threat status categories to species. Here, we define species as threatened with extinction when they fall into the IUCN categories of Vulnerable, Endangered, Critically Endangered and Data Deficient). The number of threatened species in an area can indicate areas of priority for conservation investment, which a national REDD+ programme could contribute to (Map 8).

3. Synthesis maps and REDD+ planning

Combining the different data layers discussed above can aid REDD+ planning to achieve multiple benefits from REDD+ by communicating the spatial relationships between forest carbon and forest biodiversity. One potentially valuable use of maps in REDD+ planning is for the selection of pilot areas. Priority site selection, for emissions reduction potential and biodiversity conservation value, can be done at different scales: prioritizing landscapes, provinces, districts and down to local project sites. The scale of planning objectives - national, subnational, local - demands data and resultant maps of different resolutions. Data at a coarse resolution, as used in this preliminary analysis, can be suitable for selecting priority provinces, but finer resolution data would be required for spatial planning for REDD+ at the local level. In order to generate synthesis maps for REDD+ planning, it is necessary to decide on criteria for selecting areas and how these criteria can be represented in synthesis overlays.

Some REDD+ activities will be more appropriate in some places, and others in other places. The multiple benefits that could be achieved will depend on both the location and approach. Different areas will be suitable for reducing deforestation, reducing forest degradation, conservation of forest carbon stocks, sustainable management of forests and enhancement of carbon stocks. Different analyses will be appropriate for identifying areas in which each of these types of activity could be undertaken. Here, by way of worked examples, maps have been developed for the potential to reduce emissions (i) from deforestation and (ii) through sustainable forest management.

When considering the potential for REDD+ measures to reduce deforestation, it might be appropriate to consider both the areas at high risk of deforestation and areas with the highest carbon densities in order to gain substantial emissions reductions. If there is also a biodiversity conservation objective, as there is in the case of the Viet Nam NRAP, spatial information about biodiversity in forests is critical to this analysis. It is possible to map proxy indicators for all three factors: deforestation risk, carbon density and biodiversity. Areas of past deforestation can be an indicator of areas where future deforestation may occur (if the drivers of deforestation remain the same), forest biomass carbon can indicate likely magnitude of emissions from deforestation, and the

[18] A grid of 100 km^2 hexagons where overlaid on top of the distribution maps of each species from the IUCN RED List database (IUCN 2011). A spatial query was used to read species information and count the number of species that occurred within each hexagon. The result of this process are hexagon grid maps with each hexagon containing the number of total species per given taxonomic group (e.g. amphibians) and/or extinction threat category (e.g. Critically Endangered).

[19] The relationship between taxonomic groups in terms of species richness, while never perfect, tends to be positive, and practical conservation planning based on data for well-known taxonomic groups can cautiously proceed under the assumption that it represents species in less well-known taxa, at least within the same biome (Rodrigues & Brooks 2007).

number of threatened species is an indicator of the biodiversity conservation value of an area[20]. These indicators can be presented together in a **summary map of potential areas for reducing deforestation** at an appropriate resolution for decision-making. The provinces with the highest levels of forest loss, highest carbon densities and number of threatened terrestrial vertebrate species, identified from this initial analysis are Da Nang, Dak Lak, Dak Nong, Gia Lia, Lam Dong, Quang Binh and Quang Nam (Map 9). An estimate of the likely cost of reducing deforestation in the different areas could be used to further refine the prioritisation.

Decreasing carbon emissions from timber production falls under the 'Sustainable management of forests' REDD+ activity. This activity should be confined to forests already dedicated to timber production, for example by assessing the impacts of harvest regimes on forest carbon stocks and applying reduced-impact logging techniques. Bringing new forests into production would not normally be considered as a REDD+ activity (unless it were an alternative to anticipated deforestation). As for deforestation, it might be appropriate to consider which areas dedicated to timber production have high carbon densities, along with spatial information about forest biodiversity. A **synthesis map of potential areas for sustainable management of forests** can be produced by comparing: 1) percentage of production forest in an administrative area; 2) forest biomass carbon densities; and 3) threatened species as an indicator of biodiversity. This preliminary map suggests that the provinces with the highest levels of production forest, highest carbon densities and number of threatened species are Dak Nong, Gia Lia, Kon Tum, Lam Dong, Nghe An and Quang Binh (Map 10).
Selecting areas for "reducing degradation" requires the identification of areas where degradation is currently occurring, which is challenging and requires extensive field monitoring. "Enhancement of forest carbon stocks" may involve reversing degradation, which would require the same information, or may involve reforestation. Here, it would be necessary to identify areas where forest had been lost, where the overall benefits of reforestation would be greater than those delivered through the current land use.

Comparing several of these synthesis maps may help in identifying areas that have greatest potential for delivering both carbon and non-carbon benefits from REDD+. It is encouraging to see that Lam Dong province, the focus of REDD+ pioneering activities in Viet Nam to date, is highlighted in both example maps given above (i.e., Map 9 and 10): the province has relatively high forest biomass carbon densities; a high proportion of production forest; high historical rates of deforestation and high numbers of threatened species.

Pleione Orchid in Moss Forest © Jeremy Holden, SNV

However, these maps alone cannot determine the selection of priority sites to achieve multiple benefits under the NRAP. Other factors to be considered in elaborating the NRAP's implementation include the opportunities to collaborate with existing land use programmes and policies; costs (particularly opportunity costs) of emission reductions; risk of domestic leakage (displacement rather than reduction of deforestation); and local stakeholder capacity to implement REDD+ activities. During these initial years of REDD+ demonstration activity, there may also be value in selecting areas to test a range of approaches to REDD+ implementation and generate a diversity of learning experiences.

Whilst it is not possible to map all of the factors that need to be considered in REDD+ planning, maps such as the examples presented in this summary report offer a convenient starting point to narrow down candidate locations of high multiple benefit potential. Synthesis maps will be most useful where they include as many of the key factors that should influence the decision as possible. Different synthesis maps can be created depending on the criteria agreed for selecting areas and the available data. Criteria could be developed for each of the REDD+ activities (or more specific policies and measures), with related synthesis maps.

Once areas have been selected at a coarse scale, for example particular provinces, selecting locations at the local scale requires detailed local information and maps. These maps need to cover the local priorities for REDD+ actives which are going to be undertaken.

[20] If national biodiversity priority areas, or priority species are defined, the indicator could draw on these as well.

4. Conclusions

Mapping indicators of the potential for multiple benefits, such as biodiversity conservation value, can help in REDD+ planning, informing the selection of locations for REDD+ activities. This report provides worked examples showing how multiple benefits can be incorporated into spatial planning for REDD+ at the national level in the specific case of Viet Nam. The maps illustrating this summary report were selected from a series of over 40 maps produced by the study. The maps presented here are made available to national and international stakeholders for immediate use in planning for REDD+ demonstration activities at the sub-national level. It is hoped that the example maps presented here stimulate further analysis in support of the NRAP with more up-to-date national and local data sets[21], and refined methods, to produce more accurate estimates of the spatial distribution of forest biomass carbon density, biodiversity and other indicators of non-carbon benefits of REDD+.

Maps can also aid stakeholder engagement in REDD+ strategy consultations. International and national policy commitments, together with near-term financing opportunities, present existing goals and possible incentives for the consideration of broader environmental and social benefits from REDD+. Stakeholders, from local communities to international bodies involved in emissions reductions from forest and land use management, want to see more than just carbon performance returns from their investments and foregone opportunities. Spatial analysis of the relationships between carbon and non-carbon benefits can be a powerful analytical, communications and decision-support tool among various stakeholders.

Selecting specific locations and particular REDD+ activities to promote the multiple benefit potential of REDD+ is likely to benefit from a nationally owned consultative process, building upon these initial map products, and applying the best available data. Refined data layers will be needed to inform sub-national planning processes, for both forestry and other land use sectors, which will be essential in operationalizing the National REDD+ Action Plan (NRAP). In Viet Nam, the immediate application of such sub-national multiple benefit mapping exercises will be to inform Provincial REDD+ Action Plan processes under pilot demonstration activities such as those supported by the VNFOREST-led UN-REDD Programme (Phase 2)[22], and LEAF[23] and MB-REDD[24] projects.

The following recommendations outline some of the direction and applications for further mapping work under the NRAP and their relevance to other policy processes in Viet Nam, such as informing national biodiversity policy and planning.

5. Recommendations

1. Identify and use the most up-to-date and highest resolution data available for any new mapping work

New forest biomass carbon and deforestation maps could be produced immediately using the 2010 NFIMAP IV forest cover and standing timber volume data unavailable to this study. Above-ground biomass estimations could be further refined by applying improvements in tree allometry at the global level (e.g. Chave *et al.* 2005), or better still, at the national level (*cf.* recently developed allometric equations for estimation the major forest ecoregions of Viet Nam) (Vu Tan Phuong *et al.* 2012).

Identifying or developing data and indicators for forest degradation and forest landscape restoration potential is important in planning for enhancement of forest carbon stocks, which is a highly relevant REDD+ activity for Viet Nam. Indicators of multiple benefits should draw on existing in-country datasets of potential environmental and social 'performance indicators' for REDD+.

Exploring indicators of other potential multiple benefits from REDD+, beyond the biodiversity indicators used in this report would extend the utility and value of the synthesis maps. Building on this initial work, future spatial analysis could explore a broader scope and include ecosystem services in addition to carbon sequestration, such as those regulated under national PFES policy[25].

Mapping social economic parameters and REDD+ potential would also make a valuable contribution to REDD+ planning for multiple benefits. Indicators such as household poverty levels aggregated by

[21] Notably application of NFIMAP IV data on forest cover and standing timber volumes for more accurate biomass estimations.
[22] Proposed UN-REDD Viet Nam Phase II Programme: Operationalising REDD+ in Viet Nam, 2013-2016.
[23] Lowering Emissions in Asia's Forests project, 2011-2016.
[24] Delivering Multiple Benefits from REDD+ in South East Asia project, 2011-2016
[25] Decree No: 99/2010/ND-CP, dated 24.09.10, on the Policy for Payment for Forest Environmental Services. The types of forest environmental services stipulated in this Decree include: a) soil protection and reduction of erosion; b) regulation and maintenance of water sources; c) forest carbon sequestration and reduction of emissions of GHGs; d) protection of natural landscapes and conservation of biodiversity; e) provision of spawning grounds, sources of feeds, and natural seeds, for aquaculture

administrative unit (district or commune) in the context of REDD+ potential would be relatively straight forward. Mapping of forest governance types – State forest management boards, community forestry management, smallholder household leases, etc. - in relation to changes in forest carbon stocks would be more challenging, but a potentially valuable tool in prioritizing and locating REDD+ policies and measures under the nascent NRAP's implementation.

2. Use new REDD+ multiple benefit maps to aid decision making as a contribution to achieving NRAP objectives and broader goals for forestry

Improved forest biomass carbon density maps could form the basis of innovative mapping techniques to assess REDD+ activity potential beyond the illustrative examples of reducing deforestation and sustainable management of forests given in this summary report. Most challenging, but most pertinent to Viet Nam, would be attempts to map and visualize reduced emissions from avoided forest degradation. Mapping of multiple benefits could also contribute to the refinement of proposed REDD+ benefit distribution systems, such as the 'R-coefficient' (Pham Minh Thoa *et al.* 2012)[26].

Extending mapping to cover ecosystem services would be particularly relevant for planning in Viet Nam, which is a regional pioneer in 'payment for forest environmental services' (PFES). National policy[25] identifies five such services to be regulated by the State for the purposes of generating revenue and incentives for improved forest protection and development. Mapping of multiple forest ecosystem services could help explore possibilities of 'bundling'[27] or 'stacking'[28] service payments.

At a sub-national level, improved multiple benefit mapping could be immediately employed to inform the development of Provincial REDD+ Action Plans (PRAP), notably under the UN-REDD Viet Nam Phase II Programme's support to six proposed pilot provinces (Lam Dong, Ca Mau, Binh Thuan, Ha Tinh, Bac Kan and Lao Cai), in addition to other provinces[29] supported by other development partners' pilot REDD+ interventions. Provincial maps of cadastral layers (statutory forest land tenure), forest cover, forest types, biomass carbon densities, drivers of deforestation and degradation, forest reforestation/restoration potential, biodiversity conservation value and poverty levels would serve as valuable decision support and stakeholder communication tools for these projects.

3. Explore the application of web-based GIS platforms to maintain and display maps of REDD+ multiple benefits as part of a national forest monitoring system

Following the preliminary recommendations of the Measurement, Reporting and Verification (MRV) Framework Document for Viet Nam (UN-REDD 2011), a web-based GIS platform, such as the evolving Viet Nam Forestry Information Portal (FORMIS – www.formisvietnam.com), could display and maintain multiple benefit REDD+ maps and associated spatial data. Information platforms, such as FORMIS, could further contribute to development of geo-referenced national forest monitoring systems that incorporate multiple benefit mapping as an information service to REDD+ stakeholders. Maps like those produced in this preliminary study, presented through GIS over the Internet, could make a useful contribution to a baseline for the *national system for providing information on how safeguards are being addressed and respected throughout implementation of* [REDD+] *activities'*[30] (See section 1.1)

4. Explore broader national policy applications of forest biodiversity and ecosystem mapping beyond planning for REDD+ to facilitate more integrated planning across ministries/sectors at the national level

In addition to facilitating inclusion of multiple benefit considerations into REDD+ planning, improved mapping and spatial analysis of forest carbon and non-carbon values could also be applied to the consideration of REDD+ opportunities and risks (Section 1.1) in national biodiversity policy making and planning. Preliminary dialogue with Vietnam's Biodiversity Conservation Agency has suggested a number of potential applications for mapping biodiversity and ecosystem services, e.g. National Biodiversity Strategy & Action Plan revision; national biodiversity master planning and biodiversity corridor development.

[26] The R-coefficient' is payment coefficient for REDD+ activities, being explored under the UN-REDD programme in Viet Nam as a mechanism to deliver REDD+ multiple benefit. The R-coefficient introduces a weighting of REDD+ performance-based payments which would favour sharing of benefits accrued through a national REDD+ programme in accordance with various social, environmental and geographical considerations.

[27] Single payment covering provision of multiple services.

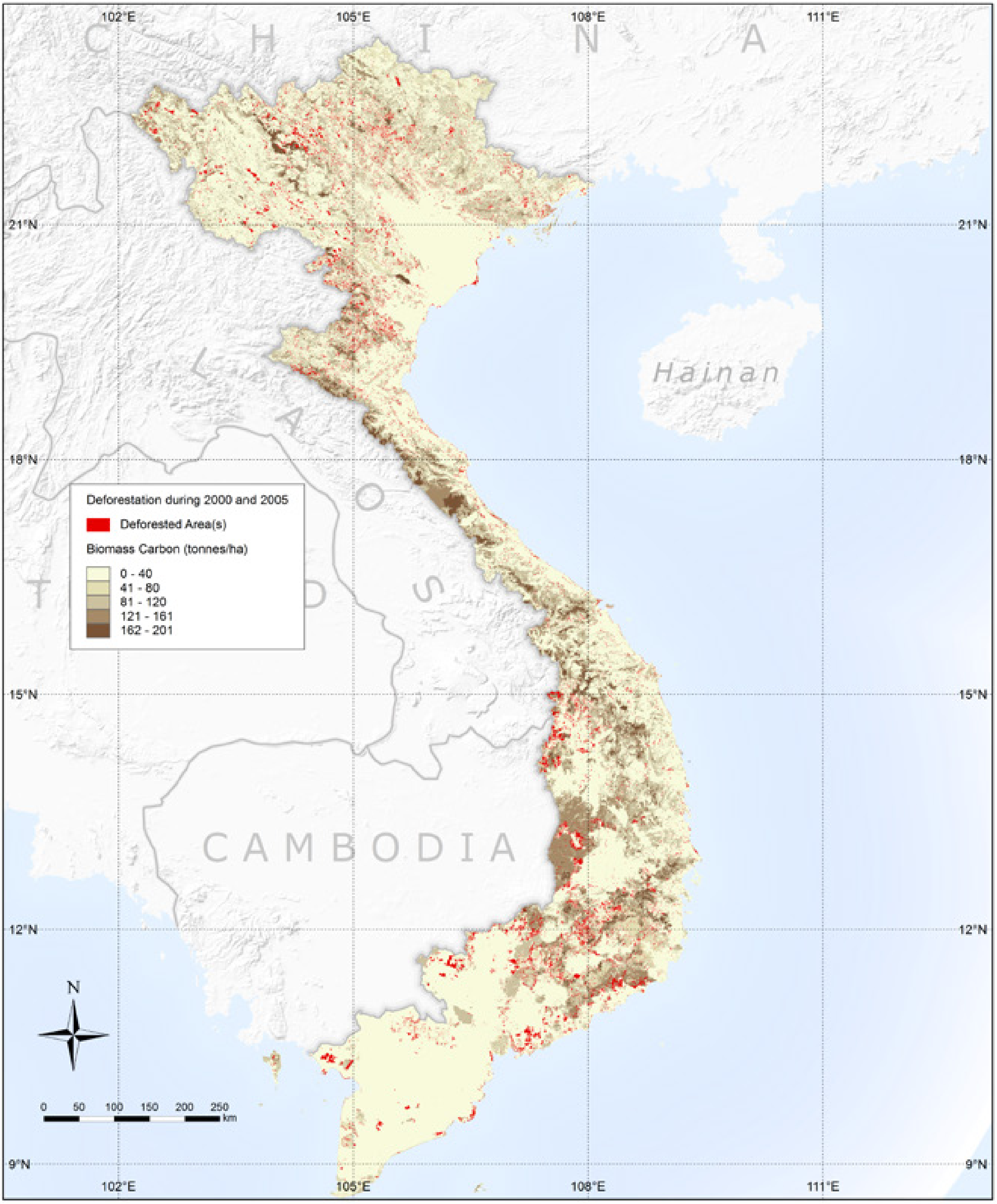
[28] Package of individual payments for provision of individual services.

[29] Dien Bien, Kon Tum, Nghe An, Quang Binh, Quang Nam, Thanh Hoa and Thua Thien–Hue.

[30] UNFCCC CoP16 Decision 1 /CP.16, paragraph 71

Map 1 - National Forest Inventory, Monitoring and Assessment forest biomass carbon and deforestation

The levels of GHG emissions from forests, and the potential for REDD+, are influenced by the biomass carbon present and rates of change in these carbon densities with changing forest management and land use practices. This map shows forest biomass carbon density estimates for 2005, based on national forest inventory data, together with areas deforestation that took place between 2000 and 2005. As such, this map gives an indication of the potential for reducing emissions from deforestation (assuming constant drivers of deforestation), conservation of forest carbon stocks and enhancement of stocks through reforestation of denuded areas.

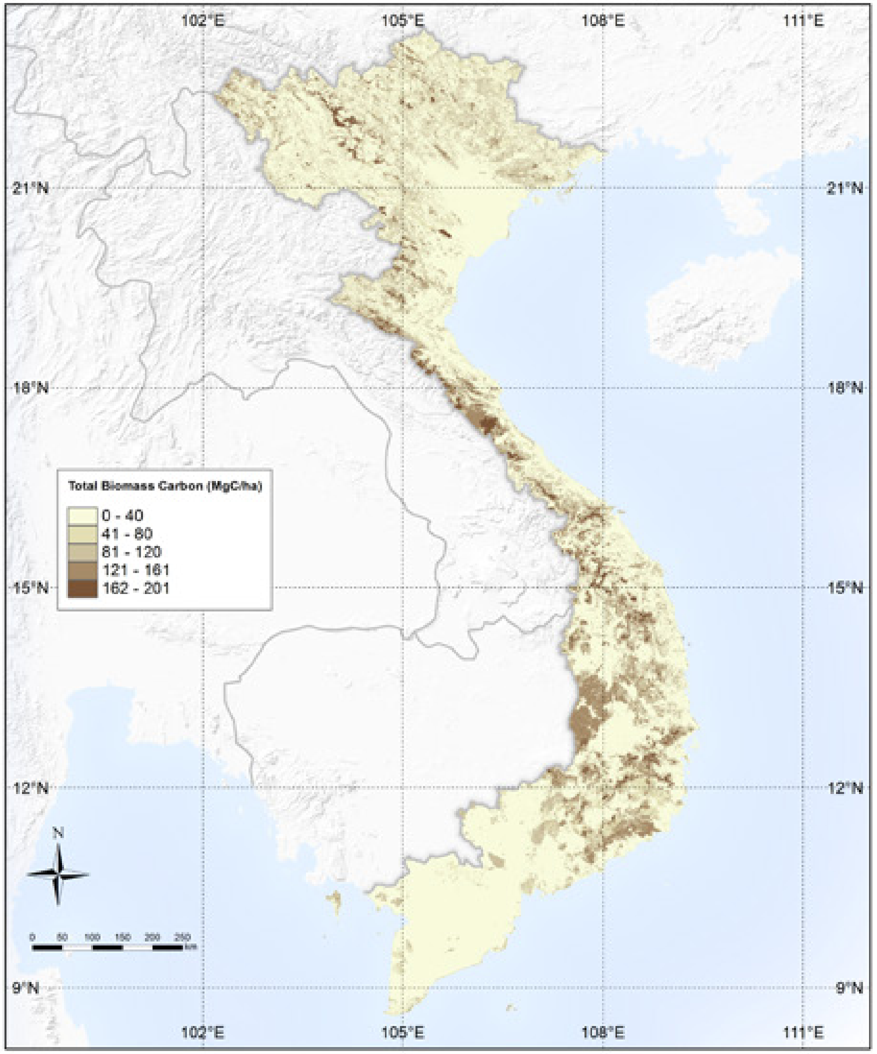


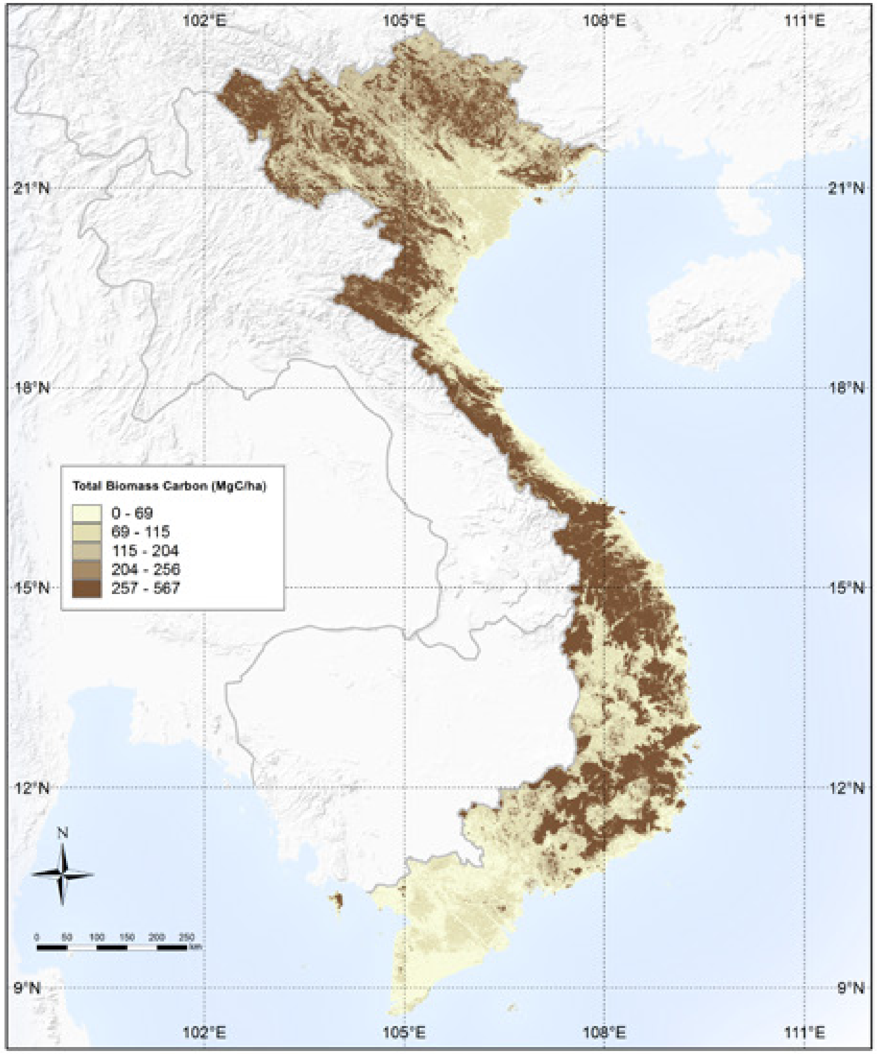
Method and data sources:
Forest biomass carbon is based on the 2005 Viet Nam forest cover map produced by the third cycle of the National Forest Inventory, Monitoring and Assessment Programme (NFIMAP III), Forest Inventory and Planning Institue (FIPI), Hanoi, Viet Nam. Forest biomass carbon values for 12 forest types applied in NFIMAP III were generated from; verified and aggregated standing wood volume data from NFIMAP III (NORDECO 2010), published generic wood density estimates for tropical trees (Reyes et al. 1992), published generic biomass expansion factors for tropical forests (Brown et al. 1989) and published default values for above to below ground biomass ratios (FAO 2008). Deforestation is shown as areas in the NFIMAP II forest map produced in 2000 which were no longer forest in 2005.

UNEP WCMC SNV

Map 2 - Comparison of forest biomass carbon maps generated using global (Saatchi et al 2011) and national NFIMAP datasets

Biomass carbon can be calculated in a variety of different ways. This preliminary study explored two datasets to obtain forest biomass carbon estimates for Vietnam; from Saatchi et al (2011) on the right and NFIMAP III on the left. The Saatchi map gives significantly higher estimation of average forest and non-forest biomass carbon density for Viet Nam (257 tC ha-1) – more than two and a half times the value obtained from using NFIMAP III data (see text for discussion). The Saatchi data, unlike the national data, has added value in that they are accompanied by uncertainty estimates, which for Viet Nam are between 26 to 54 % with a mean of 36 %. What is important, in terms of exploring the spatial relationship between forest carbon and forest biodiversity, is that the carbon maps produced using the NFIMAP and Saatchi datasets, are similar in relative distribution of carbon densities, if not absolute values. Upon these different forest biomass carbon maps can be overlaid multiple datasets of biodiversity and other REDD+ multiple benefits (see Maps 5-10).



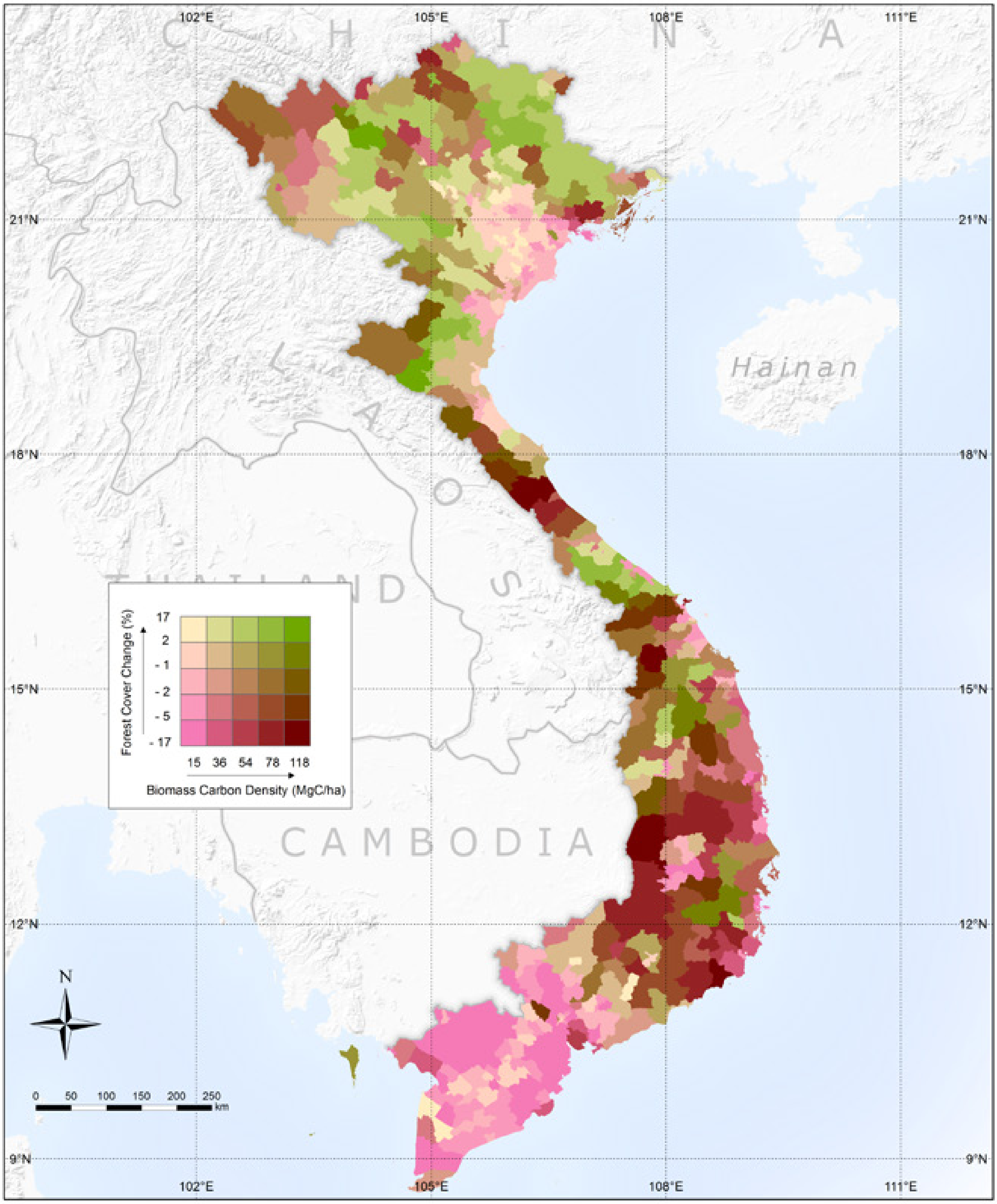


Method and data sources:
The carbon map on the right shows forest and non-forest biomass carbon density for Viet Nam from Saatchi, et al. (2011); produced. by using Lidar data on NASA's ICESat satellite in combination with information on the height of treetops from more than 3 million measurements and corresponding reference ground data, from which they calculated the amount of above-ground biomass carbon. The result is then extrapolated to cover varying landscape to produce seamless map, using a number of satellite imagery. The final result has spatial resolution of 1 km. The carbon map on the left shows forest biomass carbon, from Map 1, which is based on the 2005 Viet Nam forest cover map produced by the third cycle of the National Forest Inventory, Monitoring and Assessment Programme (NFIMAP III), Forest Inventory and Planning Institue (FIPI), Hanoi, Viet Nam.

UNEP WCMC SNV

Map 3 - Vegetation Continuous Fields deforestation rates and forest biomass carbon

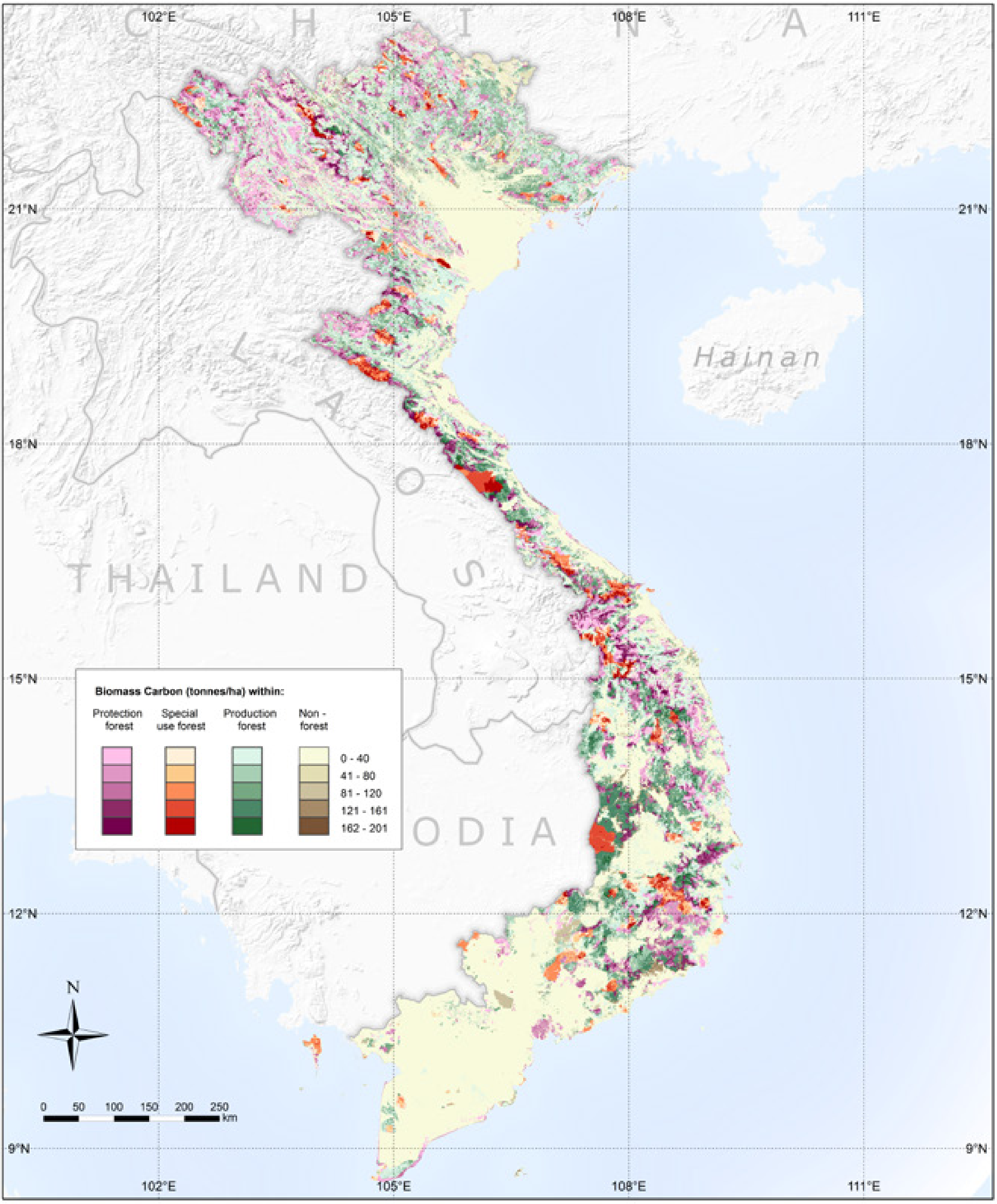
Districts which have lost a high proportion of their forest in the past may be at risk of future deforestation if the pressures driving deforestation have not changed. Sustained high levels of loss within areas of high biomass carbon density will have the largest emissions reduction potential. This map shows districts with historical (2000-2005) deforestation rates and forest biomass carbon density; another means of visualizing REDD+ potential, with the exception of reducing emissions from avoided forest degradation, sustainable management of forests, and carbon stock enhancement through forest landscape restoration ('reverse degradation').



Method and data sources:
The carbon density in this map was produced using the NFIMP data, Forest Inventory and Planning Institue (FIPI), Hanoi, Viet Nam (see map 1). However, the levels of forest change were calculated using Vegetation Continuous Fields (VCF) data. Following on from a previous study conducted by SNV (Holland and McNally 2009), where VCF data, provided by Global Land Facility, were used to map Viet Nam deforestation rate between 2000 and 2005. Because of its coarse resolution (500 m) VCF tends to underestimate the young plantation where the tree canopy is not yet formed a closed and homogeneous layer.

Map 4 - Three types of forest management

This map shows forest biomass carbon density as distributed over the three types of forest management category regulated by the State in Viet Nam: production, protection and special-use (see section 2.3). Different REDD+ activities will be eligible in different forest management types: production forests may be the focus of suitable management of forests, protection forests in upper catchments could benefit from carbon stock enhancement through restoration of degraded forests, special-use forests (protected areas) would apply forest carbon conservation actions, and so forth.

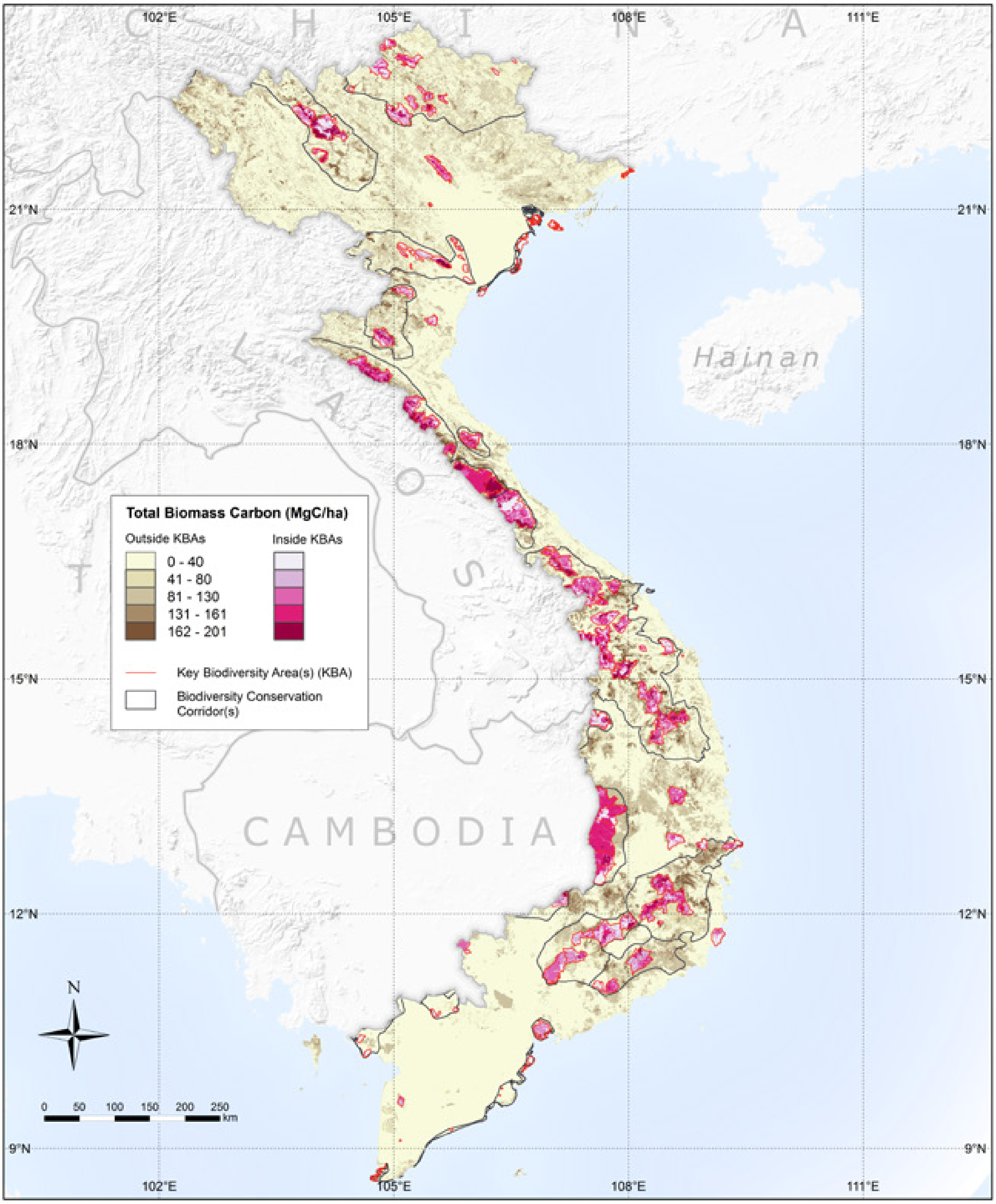


Method and data sources:
The the location of different types of forest was derived from data provided by the Ministry of Agriculture and Rural development,Viet Nam, 2008. Including: Special-use forests - where the primary function is conservation of nature, cultural and sites of historical importance, recreation and tourism, Protection forests - which are maintained for catchment protection, hydrological cycle maintenance, soil conservation and land stabilization in coastal areas; and Production forests - which are managed primarily for timber and non-timber forest products (NTFPs) production and, more recently, 'forest environmental services' provision. The carbon layer present in the map is from the NIFMAP III forest biomass carbon map (see map 1). It is necessary to note that the total amount of biomass carbon in the three forest management types only accounts for 87.3 % of total forest biomass carbon stock in Viet Nam, due to the 'shrub land' category which is recognized in the forest cover map but is not classified and mapped as forest in the three types of forest management.

UNEP WCMC SNV

Map 5 - Forest biomass carbon, Key Biodiversity Areas and conservation corridors

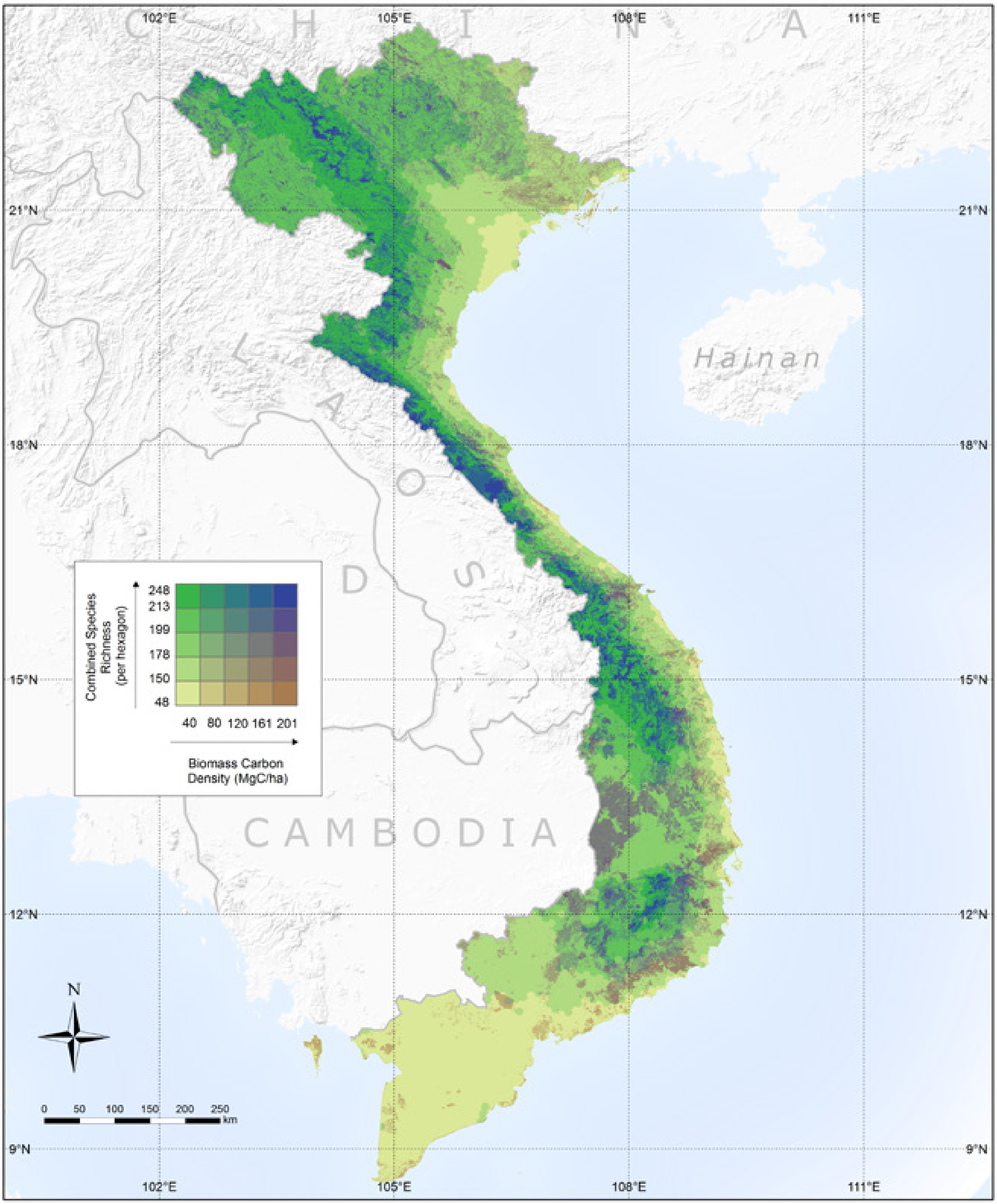
Location of REDD+ activities may be selected for multiple, not just climate change mitigation, benefits. Targeting areas that are important for forest biodiversity and carbon can allow multiple benefits to be achieved. This map is an example overlay of priority biodiversity conservation areas over a forest carbon map for Vietnam. Prioritising KBAs and associated conservation landscapes, or corridors, under the NRAP would result in disproportionately high biodiversity benefits from REDD+.



Method and data sources:
The KBA and condervation corridor datasets were provided by BirdLife and Conservation International. KBAs are internationally recognised areas of importance for biodiversity. They are identified at the national, sub-national or regional level by local stakeholders using the two widely accepted criteria for biodiversity importance: vulnerability and irreplaceability. Additionally, in Viet Nam the Critical Ecosystem Partnership Fund (CEPF) has identified conservation corridors that cover areas that have the potential to become Key Biodiversity Areas in their own right (through management or restoration) and areas that contribute to the ability of the conservation corridor to support all elements of biodiversity in the long term (CEPF, 2012). The Forest biomass carbon is based on the 2005 Viet Nam forest cover map produced by the third cycle of the National Forest Inventory, Monitoring and Assessment Programme (NFIMAP III), Forest Inventory and Planning Institue (FIPI), Hanoi, Viet Nam (see Map 1).

Map 6 - Forest biomass carbon and terrestrial vertebrate richness

The richness of species in an area provides one indicator of biodiversity drawing on readily available global datasets, which can be improved upon with development of national biodiversity databases, as is the case currently in Viet Nam. This map shows the spatial relationship between carbon density species richness irrespective of the conservation importance of those constituent species.

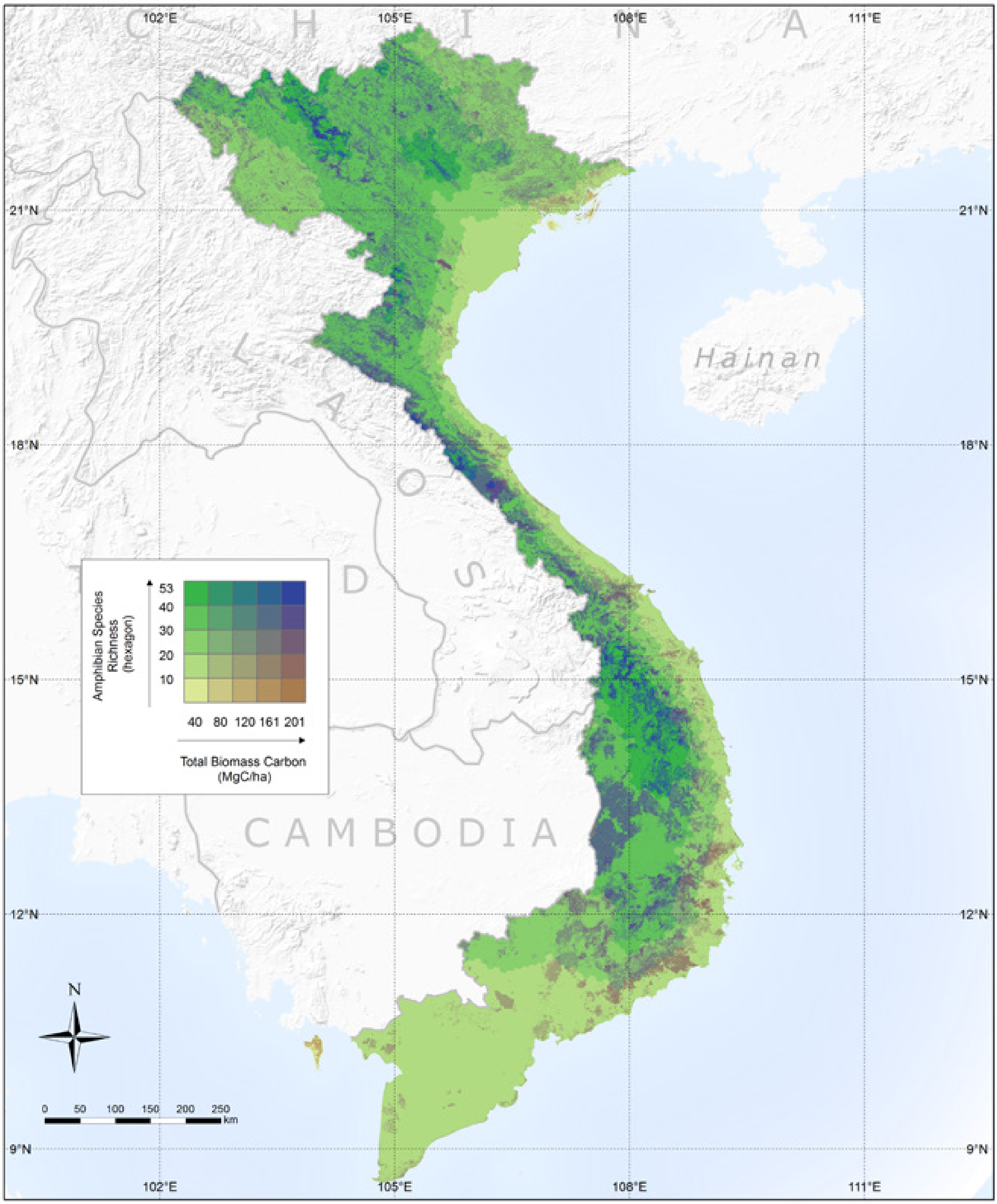


Method and data sources:
Species range data produced by the IUCN Red List enables an indication of species richness to be overlaid onto the forest carbon biomass base map produced from NFIMAP III data (Map 1). Within the IUCN Red List, all known mammal, bird and amphibian species have been assessed, but, not all reptiles. Species richness data from all these vertebrate classes are used in this preliminary mapping exercise, but it will still not form a complete list of all species in Viet Nam. However, this richness is likely to provide a relatively reliable indication of the total richness of all species in Vietnam's forests.

UNEP WCMC SNV

Map 7 - Forest biomass carbon and amphibian species richness

The distribution of certain groups of species may be particularly important within a country or region due to, for example, ecological, cultural or economic reasons. From the aggregated species richness data for four terrestrial vertebrate classes presented in Map 6, amphibian species distributions are extracted to present an alternative indicator of biological diversity against forest carbon in Viet Nam. Amphibians are selected as an indicator for this example map because their sensitivity to environmental change. Vietnam, with broad altitudinal and latitudinal range, is known for its high diversity of amphibians.

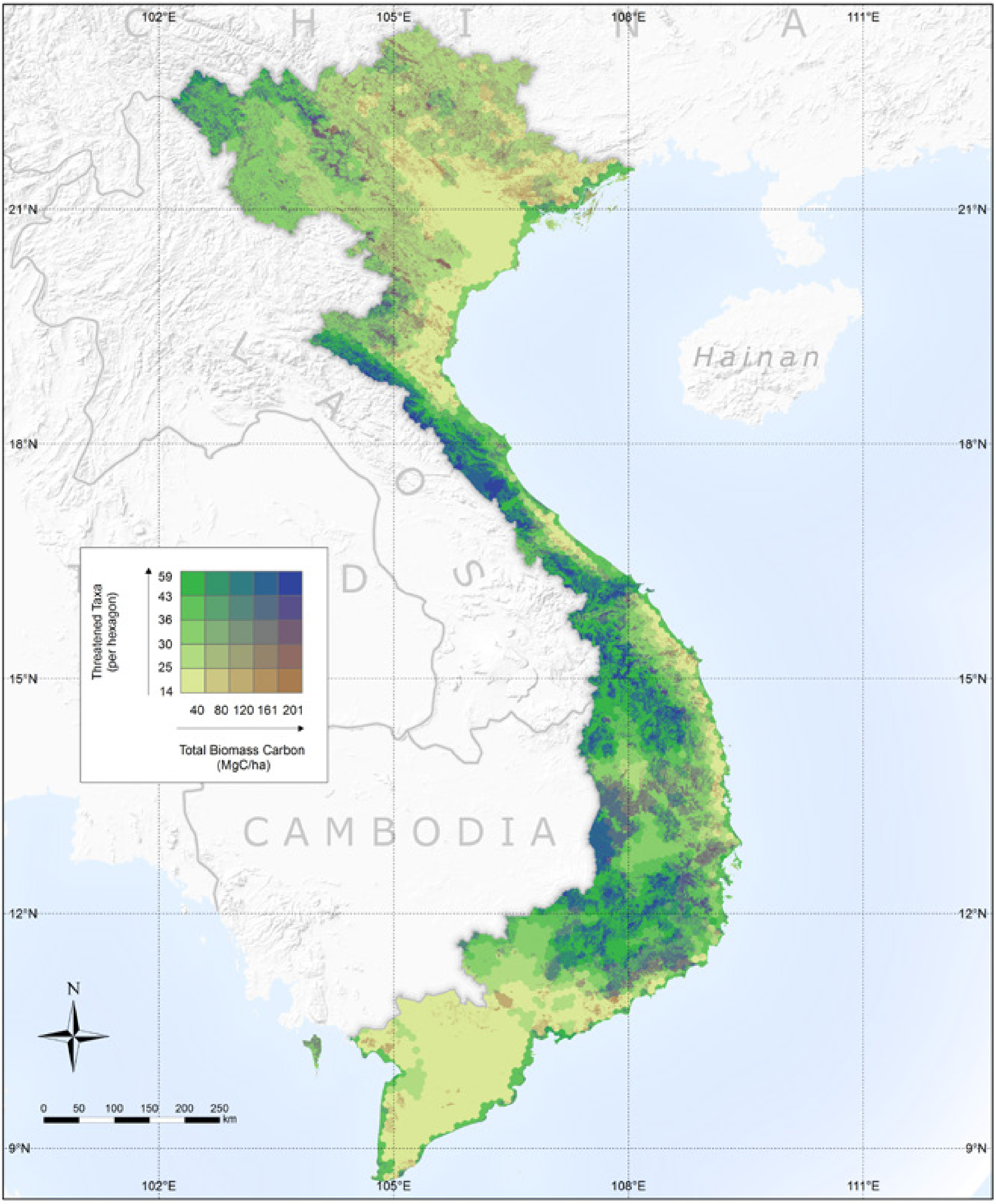


Method and data sources:
The amphibian data have been selected from the species range data within the ICUN Red List, 2011, and superimposed on the NFIMAP III forest carbon biomass map (Map 1).

UNEP WCMC SNV

Map 8 - Forest biomass carbon and threatened species richness

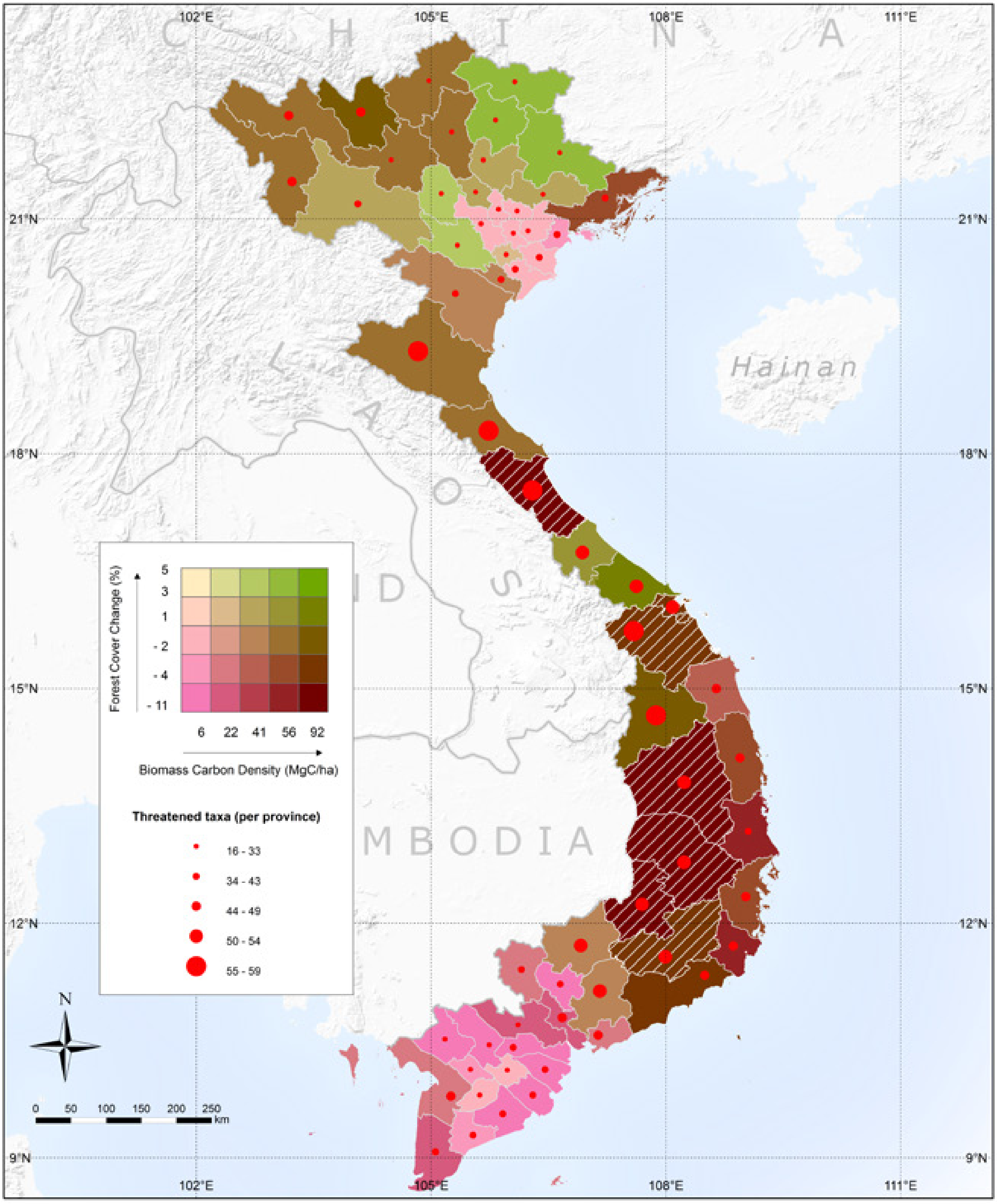
Species threatened with extinction are priorities for conservation investments and action, and REDD+ activities have the potential to help conserve these threatened species. In displaying threatened species richness, this map indicates, not just levels of biodiversity in Viet Nam in relation to forest biomass carbon density estimate, but also the potential conservation priority areas.



Method and data sources:
Threatened speiceis were identified as those listed as Critically Endangered, Endangered, Vulnerable, or Data Deficient within the IUCN Red List, 2011. The base carbon density map is that derived from the NFIMAP III data (see Map 1).

Map 9 - Forest biomass carbon, forest cover change, and threatened species richness

Areas of past deforestation can be an indicator of where future deforestation may occur, forest carbon biomass can indicate likely emissions during deforestation and the number of threatened species is an indicator of the biodiversity conservation value of an area. This synthesis map attempts to visualize these four attributes – carbon, loss of carbon, biodiversity and conservation value – as an example of displaying multiple factors for consideration in REDD+ planning processes. If areas and administrative units with high forest biomass carbon density, high historical rates of deforestation and high threatened species richness, are prioritized for actions to reduce emissions from avoided deforestation, it could make a significant contribution to the NRAP objective of 'reduction of GHG emissions through efforts to mitigate deforestation and…biodiversity conservation…'. Provinces which are high in all three are highlighted.

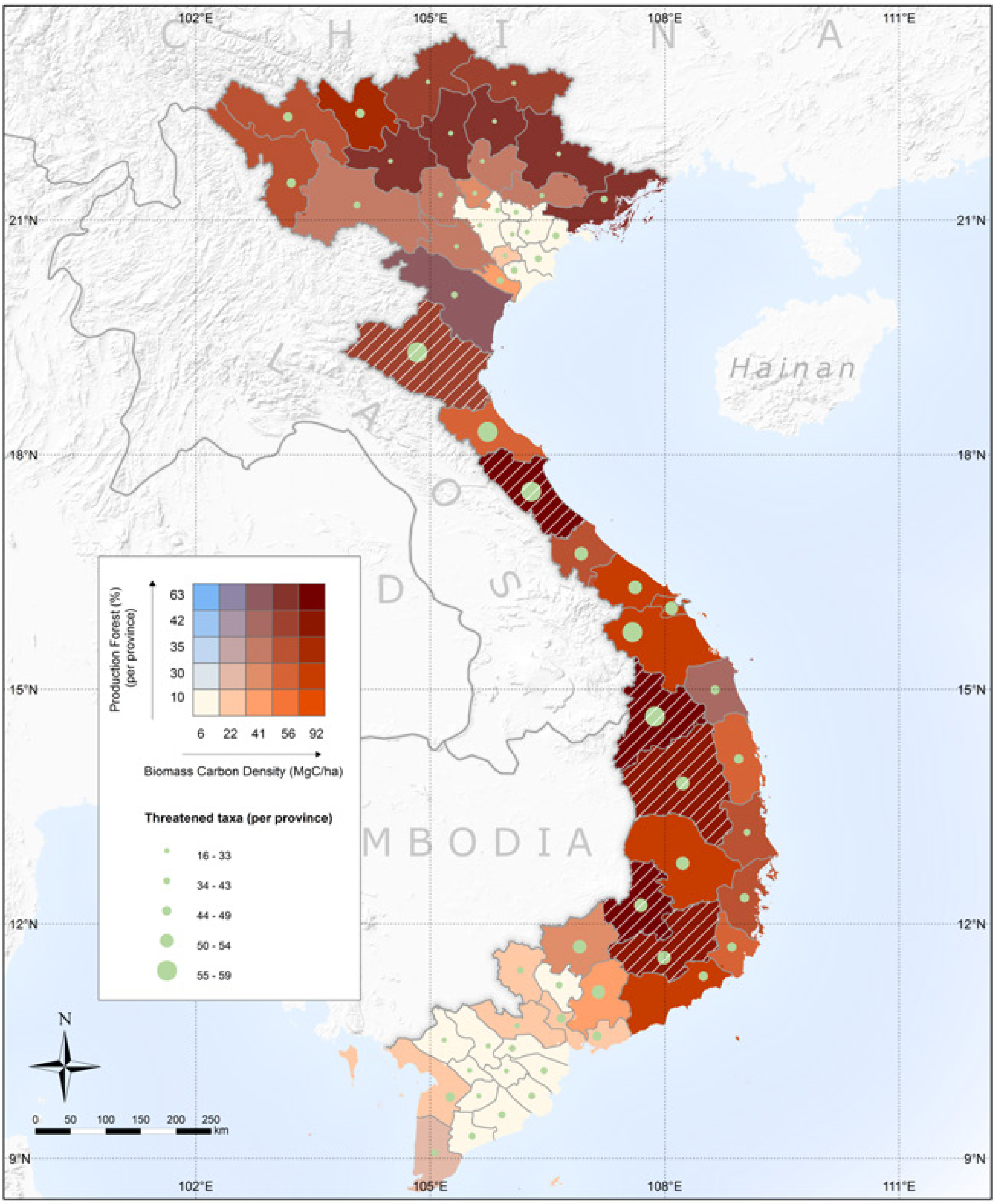


Method and data sources:
The average forest carbon biomass data is from the NFIMAP III 2005 data (Map 1). The deforestation layer is produced from the Vegetation Continuous Fields (VCF) data on percentage of forest cover change (Map 3); and the number of threatened taxa is taken from the IUCN Red List, 2011 (Map 8).

UNEP WCMC SNV

Map 10 - Forest biomass carbon density, percentage production forest, and threatened species richness

Carrying out the sustainable management of forests under a national REDD+ programme is relevant where forests are managed for timber production. In Viet Nam, these are the production forests. This synthesis map is another example of visualizing forest carbon stock distribution (from NFIMAP III), biodiversity and conservation importance (from the IUCN RED List), together with REDD+ activity potential (in this case potential for sustainable management of forests as represented by the percentage of forestland in a province assigned to the production forest category). As a contribution to State Forest Company reform, in addition to meeting national and international biodiversity policy commitments, the NRAP might prioritise those provinces with high biomass carbon, high threatened species richness and large areas of production forest for sustainable forest management activities. Provinces with all three are highlighted.



Method and data sources:
Production forest currently allows use for timber production, the amount of production forest in each province is taken from data provided by the Ministry of Agriculture and Rural development, 2008 (Map 4). The average forest carbon biomass data is from the NFIMAP III 2005 data (Map1) and the number of threatened taxa is taken from the IUCN Red List data (Map 8).

UNEP WCMC SNV

References

BCA (2009) Report - *Gap Analysis of Terrestrial Protected Areas System in Vietnam.* Vietnam Environment Administration, Biodiversity Conservation Agency (BCA), Hanoi.

BirdLife International, Conservation International, & the Critical Ecosystem Partnership Fund (2013) *Key Biodiversity Areas of Vietnam.* BirdLife International, Cambridge, and Conservation International, Arlington.

Brown, S., Gillespie, A.J.R. & Lugo, A.E. (1989). Biomass estimation methods for tropical forests with applications to forest inventory data. *Forest Science* 35: 881-902.

Brown, S. 1997. Estimating Biomass and Biomass Change of Tropical Forests: a primer. FAO Forestry Paper 134. FAO, Rome.

Cao Thi Ly, Nguyen Quoc Binh & Nguyen Thi Thuy Phuong (2009) *Key Stakeholder Involvement in Protected Forest Area Management in Viet Nam: Status and Trends.* Southeast Asian Network for Agroforestry Education (SEANAFE), Los Banos and The Center for People and Forests (RECOFTC), Bangkok.

CBD (2010) *Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets: Living in Harmony with Nature.* Secretariat to the Convention on Biological Diversity, Montreal.

CEPF (2012) *Ecosystem Profile Indo-Burma Biodiversity Hotspot: 2011 Update. Critical Ecosystem Partnership Fund* (CEPF).

J. Chave, Andalo, C., Brown, S. Cairns, M.A., Chambers, J.Q., Eamus, D., Folster, H., Fromard, F., Higuchi, N., Kira, T., Lescure, J.P., Nelson, B.W., Ogawa, H., Puig, H., Rie´ra, B. & Yamakura, T. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia* (2005) 145: 87–99

De Konnick, R. (1999) *Deforestation in Viet Nam.* International Development Research Centre (IDRC), Ottawa.

Dickson, B., Bertzky, M., Christophersen, T., Epple, C., Kapos, V., Miles, L., Narloch, U., & Trumper, K. (2012). *REDD+ Beyond Carbon: Supporting Decisions on Safeguards and Multiple Benefits.* UN-REDD Programme Policy Brief 02. The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), Geneva.

FAO (2010) *Global Forest Resources Assessment 2010: Main Report.* Food and Agriculture Organisation of the United Nations, Rome.

Gardner, T. (2001) Declining amphibian populations: a global phenomenon in conservation biology. A*nimal Biodiversity and Conservation* 24(2):25-44

Holland, T. & McNally, R. (2009). *Mapping Potential for REDD in Vietnam: Forest Cover, Forest Cover Change and Forest Carbon Density.* SNV – The Netherlands Development Organisation, Hanoi.

JICA & VNFOREST (2012) *Final Report: the Study on Potential Forests and Land Related to "Climate Change and Forests".* Japan International Cooperation Agency (JICA) & Vietnam Administration of Forestry (VNFOREST), Hanoi.

IUCN (2011) IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org/technical-documents/spatial-data>. Accessed on 8 August 2011.

Mant, R., Swan, S., Bertzky, M. & Miles, L. (2013) *Participatory biodiversity monitoring: considerations for national REDD+ programmes.* Prepared by UNEP-WCMC, UN-REDD Programme, Cambridge and SNV REDD+, Hanoi.

MARD (2008) *Forest Carbon Partnership Facility Readiness Plan Idea Note.* Ministry of Agriculture & Rural Development (MARD), Socialist Republic of Vietnam, Hanoi.

MARD (2011) *Forest Carbon Partnership Facility Readiness Preparation Proposal: Socialist Republic of Vietnam.* Ministry of Agriculture & Rural Development (MARD), Socialist Republic of Vietnam, Hanoi.

NORDECO (2010) Technical Assistance in the Development of the National REDD Programme of Vietnam. Component of Collecting Information and Analyzing Trends of Forest Resources and Forest Carbon Stock for Establishment of the Interim Baseline Reference Scenarios. Nordic Agency for Development and Ecology (NORDECO), Copenhagen.

Pham Minh Thoa, Phung Van Khoa, Enright, A., Nguyen Thanh Trung, Nguyen Truc Bong Son (2012) *Final report on a Pilot to Establish R-coefficients for REDD+ Benefit Distribution in Di Linh District, Lam Dong Province, Viet Nam.* The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) Viet Nam National Program, Hanoi.

Reyes, G., Brown, S., Chapman, J. & Lugo, A. E. (1992) Wood densities of tropical tree species. *General Technical Report SO-88.* USDA Forest Service, Southern Forest Experiment Station, New Orleans, Louisiana, USA.

Rodrigues, A.S.L. & Brooks, T.M. (2007) Shortcuts for biodiversity conservation planning: the effectiveness of surrogates. *Annu Rev Ecol Evol Syst* 38:713-737

Saatchi, S., Harris, N., Brown, S., Lefsky, M., Mitchard, E., Salas, W., Zutta, B., Buermann, W., Lewis,S., Hagen, S., Petrova, S., White, L., Silman, M., and More, A. (2011), Benchmark map of forest carbon stocks in tropical regions across three continents, Proc. Natl. Acad. Sci. U. S. A., 108: 9899–9904.

Scharlemann, J.P.W, Hiederer, R., Kapos, V. In prep. *Global map of terrestrial soil organic carbon stocks.* UNEP-WCMC & EU-JRC, Cambridge, UK.

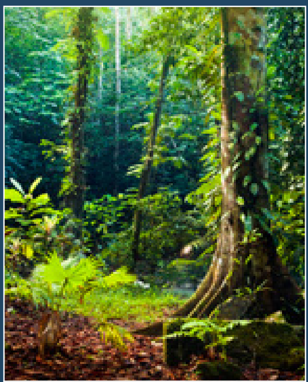
UNFCCC (2010) Conference of the Parties Decision 1/CP.16: Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention. Secretariat to the United Nations Framework Convention on Climate Change, Bonn.

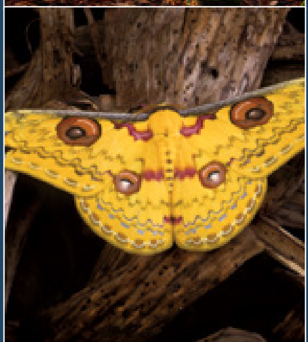
UN-REDD (2011) *Measurement, Reporting & Verification Framework Document with reference to Safeguards Information and Monitoring of Policies & Measures under the Viet Nam National REDD+ Program.* The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) Viet Nam National Program, Hanoi.

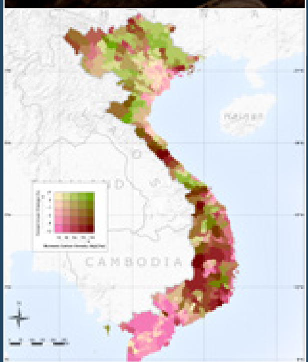
VDR (2010) *Vietnam Development Report 2011: Natural Resources Management.* Joint Development Partner Report to the Vietnam Consultative Group Meeting, 7-8 December, 2010 Hanoi.

VNFOREST (2013) Viet Nam Forestry: Introduction to the Forests and Forest Sector of Viet Nam. Viet Nam Administration of Forestry (VNFOREST), Hanoi.

Vu Tan Phuong, Inoguchi, A., Birigazzi, L., Henry, M., Sola, G. (2012) *Tree Allometric Equation Development for Estimation of Forest Above-Ground Biomass in Viet Nam Part A - Introduction and Background of the Study.* The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) Viet Nam National Program, Hanoi.







REDD+ aims to incentivise Reducing Emissions from Deforestation and forest Degradation, as well as the conservation of forest carbon stocks, sustainable management of forests and the enhancement of forest carbon stocks. Such activities can potentially provide biodiversity benefits, but there is also a need to avoid any risks of environmental harms from REDD+. Here we present selected results of spatial analyses to explore biodiversity benefits and risks from REDD+ in Viet Nam.

Contact:
UNEP World Conservation Monitoring Centre
219 Huntingdon Road
Cambridge, CB3 0DL, United Kingdom
Tel: +44 1223 814636
Fax: +44 1223 277136
E-mail: climate@unep-wcmc.org
www.unep-wcmc.org

SNV REDD+ Headquarters
5th Floor, Thien Son Building,
5 Nguyen Gia Thieu, District 3
Ho Chi Minh City, Vietnam
Tel: +84 8 39300668
Fax: +84 8 39300668
E-mail: rmcnally@snvworld.org or akager@snvworld.org
www.snvworld.org/redd

UNEP WCMC

SNV

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the Parliament of the Federal Republic of Germany