Using spatial information to support decisions on safeguards and multiple benefits for REDD+ in Tanzania

Ministry of Natural Resources & Tourism
United Republic of Tanzania

UN-REDD PROGRAMME

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Vision of Tanzania Forest Service: A center of excellence in the conservation of forest and bee resources and sustainable supply of quality forest and bee products and services in Tanzania. Mission of Tanzania Forest Service: To sustainably manage the national forest and bee resources in order to contribute to the social, economic, ecological and cultural needs of the present and future generations.

The UN-REDD Programme is the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD+) in developing countries. The Programme was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally-led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including Indigenous Peoples and other forest-dependent communities, in national and international REDD+ implementation.

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.

ACKNOWLEDGEMENTS

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This report contributes towards Output 2.4 in Tanzania's National REDD+ Programme: "develop national maps to inform the delivery of the REDD+ framework". We would like to thank all those who provided technical input and/or feedback on the draft, including: Nuru Chamuya, Evarist Nashanda, Soren Dalsgaard, Neil Burgess, Roy Gereau, Gino Miceli, Cosimo Togna, Christine Holding, Lauri Tamminen, Ralf Ernst, Philip Platts, Robert Marchant, Han Meng, Megan Albon, Kekilia Namala, Rahima Njaidi, Clara Makenya, Antonia Ortmann, Wilbert Karugaba and Amana Seleman.

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1. Introduction

An estimated 6-17% per cent of all anthropogenic greenhouse gas (GHG) emissions are caused by deforestation and forest degradation, including peatland emissions (van der Werf et al. 2009). The maintenance and careful management of forest carbon stocks can therefore make an important contribution to global climate change mitigation. However, pressure to convert and degrade forests continues to be high, particularly in forest-rich developing nations. Countries through the United Nations Framework Convention on Climate Change (UNFCCC) are preparing to address this issue through REDD+: a climate change mitigation mechanism aiming to significantly reduce emissions from deforestation and forest degradation, and increase removals of carbon dioxide, whilst promoting the sustainable development of the nations involved. REDD+ actions fall under five main activities (see Figure 1).

REDD+ has the potential to contribute to achieving more policy goals than climate mitigation alone. By maintaining and restoring forests, REDD+ could secure the many ecological functions of forests, including biodiversity conservation and the provisioning of a number of ecosystem services that people depend upon, such as water regulation, erosion control and the supply of timber and non-timber forest products. Direct social benefits from national REDD+ implementation are also anticipated, ranging from improved forest governance to direct financial improvements to livelihoods.

The Government of Tanzania expects to attain a range of multiple benefits from implementing its

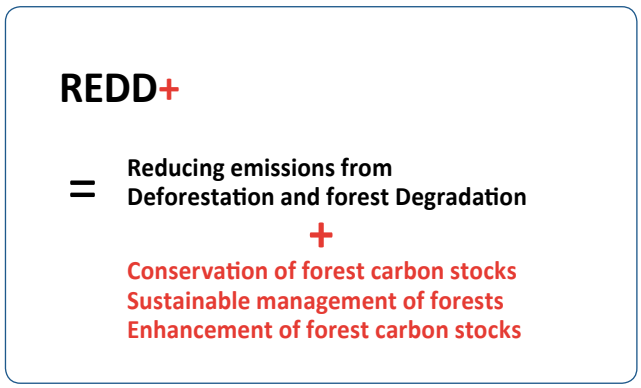

Figure 1: REDD+ activities

REDD+ strategy. To achieve this, the country could develop and employ a suite of approaches to REDD+ implementation to account for the variation in environmental, social and cultural factors in different locations. As stated by the country's REDD+ Strategy:

> *"A properly designed [REDD+] implementation mechanism is expected to contribute to multiple benefits, depending on the location and type of REDD+ activity. These benefits include poverty alleviation, maintenance of forest dependent communities' rights, improved community livelihoods, technology transfer, sustainable use of forest resources and biodiversity conservation."*
> Source: Tanzania Vice President's Office (2013a)

This report presents spatial analyses developed during two working sessions in 2013 with members of the Tanzania Forest Service, Sokoine University of Agriculture, Forestry Training Institute (FTI) Olmotonyi

and the UN-REDD Programme. The maps developed aim to support assessments of the potential for multiple benefits of REDD+ implementation at the national scale in Tanzania, and contribute to REDD+ plans, taking REDD+ safeguards into account. The maps also contribute towards the action in the Tanzania REDD+ Action Plan, which states that the country will: "(1.3) Develop integrated methods to quantify REDD+ and other forest benefits such as biodiversity, ecotourism, and water catchment related to PES [(Payments for Ecosystem Services)]", with a specific activity to "Develop a package of integrated methods for REDD+ co-benefits mapping" (Tanzania Vice President's Office 2013b).

It should be noted that the maps were developed using the best available data at the time, and can be updated when better data become available. To support decision making, the maps will need to be complemented with additional information for each REDD+ action that is being considered, including local data and knowledge. For a more detailed account of the mapping methodology used in this report, please refer to the Tanzania Methodological Brief, available at:http://www.un-redd.org/tabid/1028/Default.aspx.

1.1 Forests in Tanzania

The United Republic of Tanzania is the largest country in East Africa, with a mainland area of 946 270 km^2, and 2 470 km^2 on the islands of Zanzibar (Unguja and Pemba). In 2012, the country had a population of 44.9 million people (Tanzania National Bureau of Statistics 2013). The country's forest ecosystems include humid and evergreen montane and lowland forests, seasonal and semi-evergreen coastal forests and thickets, strongly seasonal and deciduous miombo woodlands, Acacia-Commiphora woodlands and mangroves. These forests provide a range of different goods and services for people, many of whom are forest dependent (Blomley & Iddi 2009). For example, goods include timber and non-timber forest products (NTFPs) such as medicinal plants, and services include water and climate regulation. The forests in Tanzania are also high in biodiversity: aside from a rich fauna, the country contains over 10 000 plant species, hundreds of which are nationally endemic. Of the plant and animal species in Tanzania, 724 species are identified as Threatened in the IUCN Red List, with 276 species classified as Endangered (IUCN 2013).

In 2013, Tanzania, with financial support of the Government of Finland and technical support of the FAO-Finland Forestry Programme, completed its first comprehensive forest inventory – "NAFORMA". It is one of the biggest efforts made to date by a developing country to map its forest resources, and one of the purposes was to help the country meet its requirements under REDD+. The NAFORMA inventory comprised 32 660 ground plots organized in 3 419 clusters, and over 240 000 trees were measured (Ministry of Natural Resources & Tourism 2010; NAFORMA 2013). The biophysical assessment covered not only tree parameters, but also the state of the land and notable features at the plot location, such as land use, vegetation type, soil, shrubs, regeneration, forest management, disturbances, dead wood, stumps, bamboos and forests products and services (Ministry of Natural Resources & Tourism 2010). A new comprehensive land-use land-cover map was also developed from Landsat imagery to be accurate for the year 2010. For this map, vegetation classes were mainly adopted from the Hunting Technical Services (1995) map for the country, with a few modifications to reflect ground conditions (Map 1).

The biophysical assessment in NAFORMA was complemented by a socioeconomic survey, aiming to collect data on land uses from the local users, to support national decision making on improved land-use policies that takes into account people's reality and needs. Socioeconomic data was collected from 3 500 household and 1 100 key informant interviews. In total, over 200 parameters[1] were recorded in the interviews.

The first analysis of the NAFORMA field inventory by FAO estimates 51 per cent of Tanzania's land area to be woodland and 4 per cent to be forest, including humid montane and lowland forest, and mangroves.


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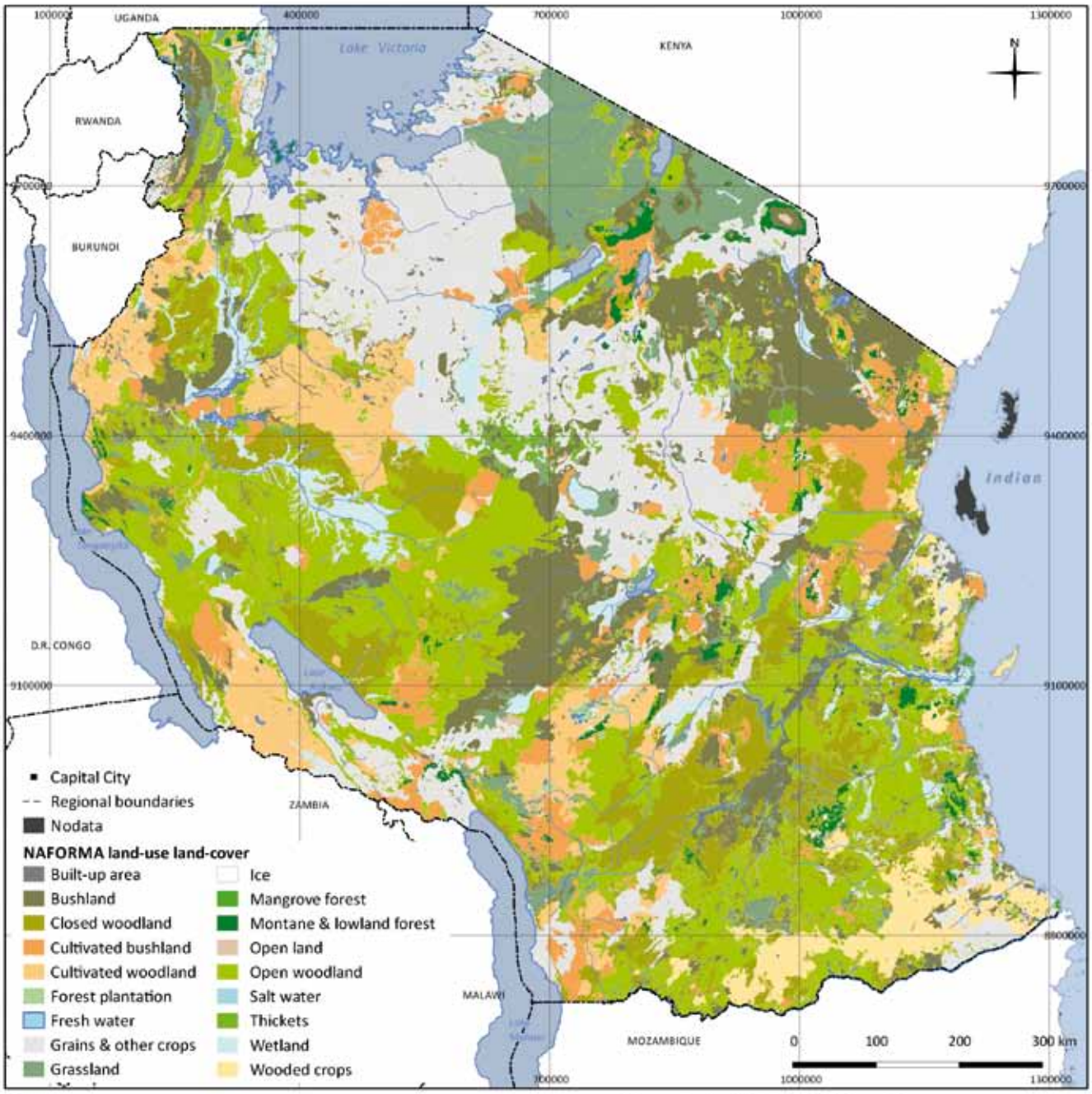
[1] Parameters recorded included: household income sources; food security including use of wild food plants; harvesting of forest products including charcoal, fuelwood and honey by zone and region; household perception of user rights and local rules with regard to the harvesting of forest products; household energy; awareness and participation of key informants and household respondents in PFM; forest disturbance and governance.

The mean density of growing stock in Tanzania is low, on average 34 m^3/ha for all land covers. NAFORMA plots show higher woody volumes in remote areas due to inaccessibility and thereby document a substantial human impact. Forest in protected areas, where harvesting is not allowed, holds about half of the woody biomass volume in the country.

The main direct causes of uncontrolled deforestation and forest degradation in Tanzania's forests include: small-scale agricultural expansion, human settlements and population increase, firewood and charcoal production, uncontrolled fires (especially June - October), timber extraction, overgrazing, development of infrastructure, industry and mining, and introduction of large-scale agriculture. Together, these drivers contribute towards an annual deforestation rate of between 130 000 and 500 000 ha per annum (FAO 2010).

Map 1: NAFORMA land-use land-cover (LULC) map for Tanzania

This map shows broad land-use and/or land-cover classes in Tanzania (excluding Zanzibar).



Data sources:
NAFORMA. 2013. NAFORMA land-use land-cover map 2010.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

1.2 REDD+ implementation and safeguards in Tanzania

In 2008, Tanzania received bilateral financial support from Norway to start the Tanzania REDD+ Initiative. In addition, multilateral support from the UN-REDD Programme enabled the launch of Tanzania's UN-REDD National Programme in 2009, now scheduled to conclude in 2013.

In March 2013, the Government endorsed the National REDD+ Strategy and its Action Plan. It is anticipated that there will be changes to legal frameworks that regulate incentives, rights, financing options and practices as a result of REDD+. The REDD+ Strategy recognizes that this does not automatically ensure that there will be no negative impacts on the environment or livelihoods and the rights of communities (Tanzania Vice President's Office 2013a), and affirms that the implementation of REDD+ activities will be done in accordance with the Cancun REDD+ Safeguards[2].

The REDD+ Strategy also states that a system for providing information on safeguards is to be developed that is consistent with the Cancun Safeguards, and in line with World Bank policies on Environmental Assessment, Natural Habitats, Forests, Involuntary Resettlement, and Indigenous Peoples. The Strategy further states "this system will require spatial monitoring information that is: (...) consistent with the conservation of natural forests and biological diversity" (Tanzania Vice President's Office 2013a). The Measuring, Reporting and Verification (MRV) System is to be integrated with the REDD+ Safeguards Information System.

At the time of writing, Tanzania has a draft REDD+ Safeguards document (dated June 2013), which constitutes the national interpretation of the Cancun Safeguards in accordance with the country's REDD+ Strategy. The draft may still change substantially, as it is being subjected to several stakeholder consultations and drafting rounds during 2013.

On environmental aspects, the draft REDD+ Safeguards document states that the REDD+ Programme will maintain and enhance conservation of Tanzania's biodiversity and other ecosystem services, considering the needs of forest dependent communities and appropriate management and utilization methods (see Table 1). It specifies that REDD+ activities are to be designed to maintain and enhance biodiversity and

Table 1: Excerpt from the June 2013 version of the draft Tanzania REDD+ Safeguards: Principle 7 (Tanzania Vice President's Office 2013c). Other parts of the document are also relevant to the topics covered in this publication, but key text for biodiversity and ecosystem services are included under Principle 7.

Principle 7: REDD+ Programme maintains, promotes and enhances the conservation of the country's natural forests for their biodiversity and other ecosystem services (co-benefits) while meeting the needs of forest dependent communities.	
Criteria	**Indicators**
7.1 The REDD+ initiative analyses the possible impacts on biodiversity and other ecosystem services when considering options for REDD+ actions	7.1.1 The national MRV system incorporate the assessment of biodiversity and other ecosystem services 7.1.2 Positive and negative impacts of REDD+ on Biodiversity and other ecosystem services identified and analyzed in a transparent and participatory way using available scientific methods 7.1.3 Scientifically sound assessment frameworks for analyzing impacts of REDD+ on biodiversity and other ecosystems services are in place and utilized 7.1.4 Mechanisms to address negative and promote positive impacts of biodiversity and ecosystems services as a result of REDD+ programme in place and implemented
7.2 REDD+ initiative maintains and enhances the conservation of biodiversity and other ecosystem services and considering the needs of forest dependent communities and appropriate management and utilization methods.	7.2.1 Additional resources to maintain and enhance biodiversity and other ecosystem services are generated by the REDD+ initiative 7.2.2 Species or ecosystems that are rare, endemic or threatened with extinction are identified, protected and monitored. 7.2.3 REDD+ activities are designed to maintain and enhance biodiversity, ecosystem services and forest dependent community needs 7.2.4 Monitoring plan for the impacts/outcomes of REDD+ activities on biodiversity and ecosystems is developed and implemented 7.2.5 Biodiversity and other ecosystem services research and information dissemination plan developed and implemented to improve biodiversity conservation and management 7.2.6 Biodiversity and other ecosystem services conservation and management guidelines developed and incorporated in forest management plans in REDD+ sites
7.3 The REDD+ programme protects natural forests from degradation and conversion to other land uses including forest plantations	7.3.1 REDD+ actions that protect natural forests from conversion are identified, prioritized and implemented 7.3.2 Monitoring of impacts of REDD+ actions on natural forests is done in a transparent and participatory way 7.3.3 REDD+ activities are designed to maintain and enhance protection of natural forests
7.4 The REDD+ Programme ensures restoration of degraded areas using indigenous species.	7.4.1 The REDD+ activities promotes and uses indigenous species to restore degraded areas 7.4.2 Mechanisms to monitor the use of indigenous species in the restoration of degraded areas are in place and utilized

[2] Annex 1 of UNFCCC Decision 1/CP.16

ecosystem services, and that species or ecosystems that are rare, endemic or threatened with extinction should be identified, protected and monitored. It implies that the REDD+ Programme will protect natural forests from degradation and conversion to other land uses, including to forest plantations, and that it shall also promote and use indigenous species to restore degraded areas. Furthermore, it states that the REDD+ Programme shall analyse the possible impacts on biodiversity and other ecosystem services when considering options for REDD+ actions.

2. Planning for REDD+ multiple benefits and safeguards

When identifying potential zones for REDD+ action, several considerations are likely to be relevant (Figure 2). First, the goals of REDD+: to reduce forest carbon emissions, maintain or enhance forest carbon stocks, as well as to deliver the other benefits that REDD+ is expected to bring. The aim is to achieve an overall reduction in forest carbon stock losses and overall gain in carbon stocks compared to those in an anticipated non-REDD+ future; whilst applying the agreed safeguards for REDD+. This means that, second, the drivers of forest loss and degradation need to be tackled in order to avoid leakage and ensure persistence of the achieved results. This implies an identification of the pressures that forests may be subject to in future, and the vulnerability of forest carbon stocks to those pressures. Third, decision-makers will need to consider feasible actions that can be used to achieve the goals, and evaluate them in terms of what benefits they can provide, under what conditions they will be effective, and what risks they may carry. These actions and their effects should be consistent with the REDD+ safeguards. For example, the draft Tanzania REDD+ Safeguards expect the REDD+ Programme to analyse the possible impacts on biodiversity and ecosystem services when considering options for REDD+ actions.

The maps in section 2 of this report aim to assist decision-makers in this process of identifying potential zones for REDD+ action. Some relevant themes are also identified for which spatial information is not yet available.

2.1 Biomass carbon stocks of Tanzania

The central value that REDD+ is intended to protect and enhance is forest carbon, in biomass and potentially also soils. Spatial planning for REDD+ implementation therefore needs to include a consideration of existing carbon stocks and their rate of loss; to inform decisions on which stocks will be maintained, which will be enhanced, and which may be lost even in the context of REDD+ implementation.

The NAFORMA inventory has resulted in a new, field-based map of woody biomass for Tanzania, at 5 km resolution. Another, higher resolution map which will account for all above ground biomass is in preparation by NAFORMA, building on a multi-source approach, combining the field based survey and remote sensing. This map will be available in late 2013.

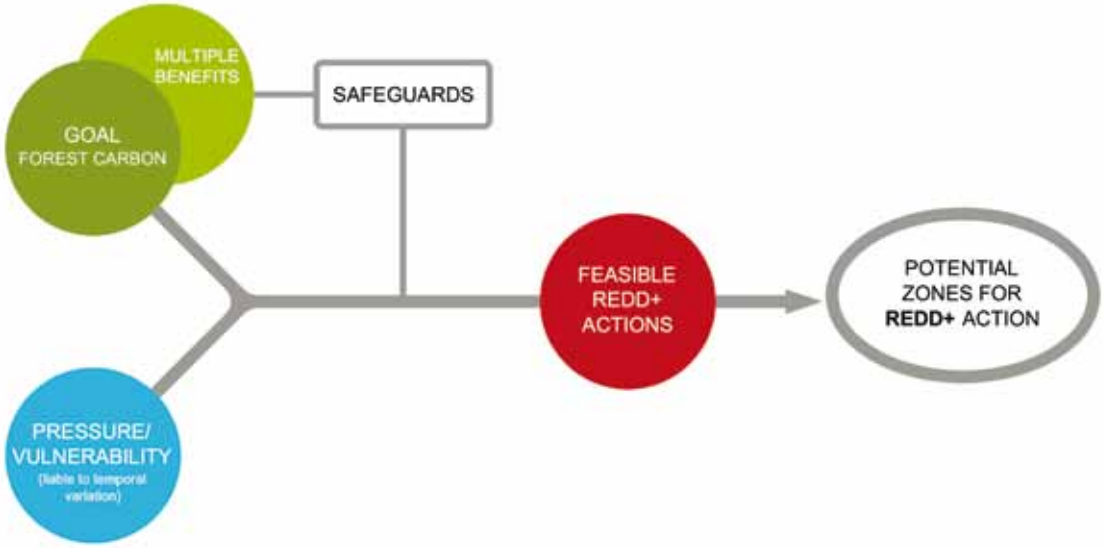


Figure 2: When identifying potential zones for REDD+ action, several factors are likely to be relevant. Identifying the current and desired spatial distribution of forest carbon stocks and multiple benefits (the goals of REDD+) is a first consideration. Current and future pressures on forests determine what additional value REDD+ actions can bring. Feasible actions in different locations is a third consideration. These actions should be consistent with the REDD+ safeguards, which intend to ensure that REDD+ actions promote multiple benefits and avoid harm.

When the NAFORMA woody biomass carbon map is compared with two other datasets on above-ground biomass carbon developed for the tropical regions of the world (Saatchi et al. 2011; Baccini et al. 2012), differences in the pattern of biomass distribution are notable (Map 2). Furthermore, the field plot-based mapping methodology applied here results in lower biomass estimates than reported in Saatchi et al. (2011) and Baccini et al. (2012). Some of these differences can be explained by differences in the definition. While above-ground biomass consists of all living biomass (including stem, stump, branches, bark, seeds and foliage), the applied definition of woody biomass in the initial NAFORMA analysis refers to the stems of the trees only. However, as the tree stems constitute the major part of above-ground biomass carbon in the dominating Tanzanian vegetation types, the differences observed here are larger than expected.

In addition to the carbon stored in biomass, there is a pool of carbon stored in the soil. Removing vegetation can cause the release of soil carbon stocks. In some cases it may therefore be important to take soil carbon stocks into account in forest land-use planning. Map 3 shows soil organic carbon down to 1 m depth in Tanzania, and is based on a global dataset (Scharlemann et al. in prep). A national soil carbon map for Tanzania is being developed based on the NAFORMA field inventory and sources of soil data, and can replace Map 3 when it becomes available. In addition, Map 4 shows a sum of woody biomass carbon, below ground biomass and soil organic carbon to illustrate the combined amounts of carbon in these different pools.

Deciding which carbon map is most appropriate to use for decision making depends on what REDD+ action is under consideration, and what carbon pools it will influence. For example, where the aim is to reduce forest clearing or unsustainable forest management, which can lead to release of soil carbon, a combined map of biomass and soil carbon can be useful for understanding where soil carbon stocks will significantly influence emissions. The maps in this report that include a carbon layer use the NAFORMA woody biomass map, because it is the most recent dataset available, and because the inclusion of soil carbon stocks in all analyses may lead to an over-estimate of the likely impacts of REDD+. Furthermore, the accuracy of national scale soil carbon assessments is much lower than equivalent assessments for above-ground biomass.

2.2 Natural forest

The definition of *forest* in the first negotiations on REDD under the UNFCCC did not distinguish between natural and plantation forest. This led to the concern that REDD could result in the conversion of natural forests to plantations or other non-forest systems, such as agroforestry (Harvey et al. 2010). To address this, the Cancun Safeguards[4] defined at the UNFCCC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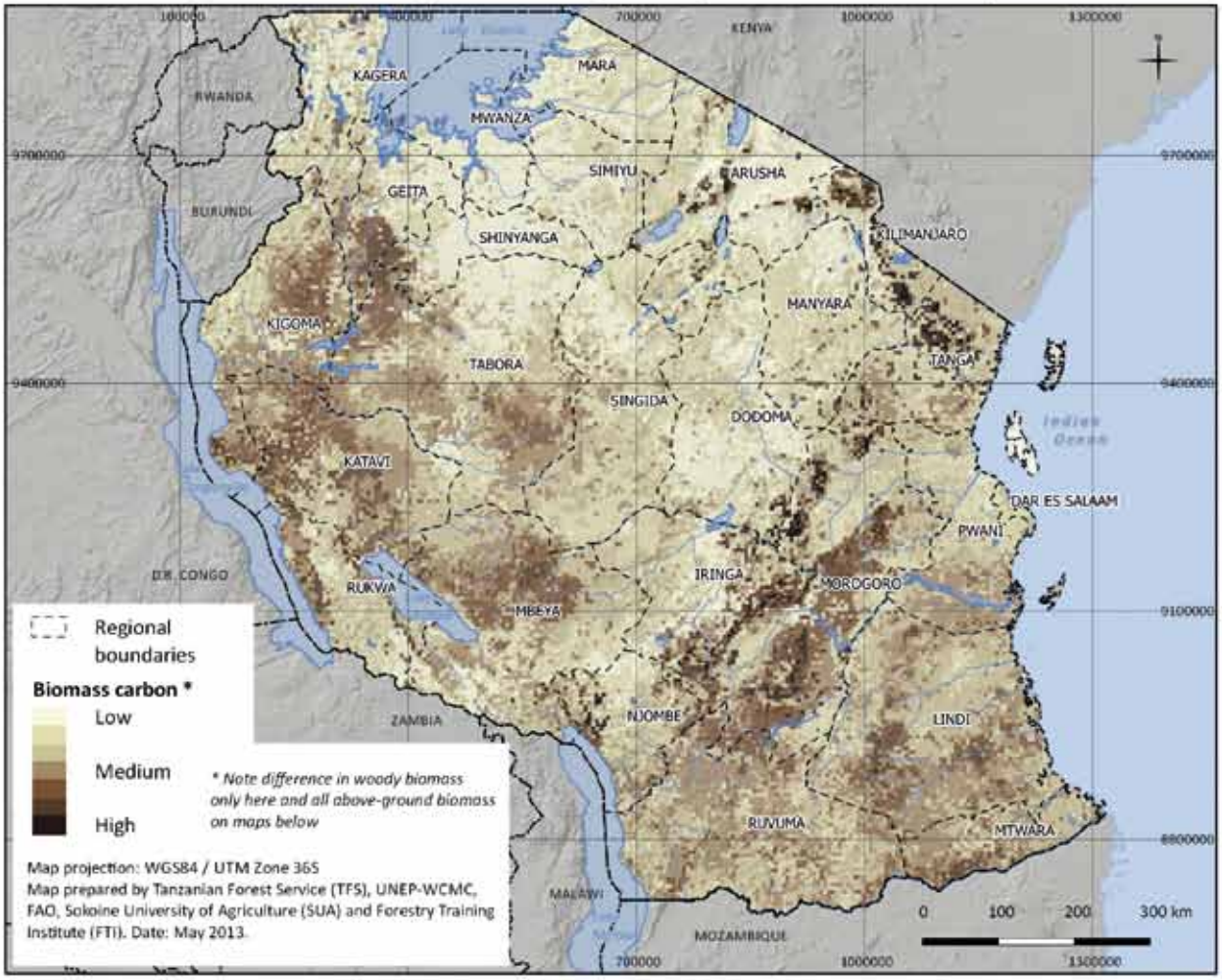
Map 2: Woody biomass carbon compared with above-ground biomass carbon (three different datasets)

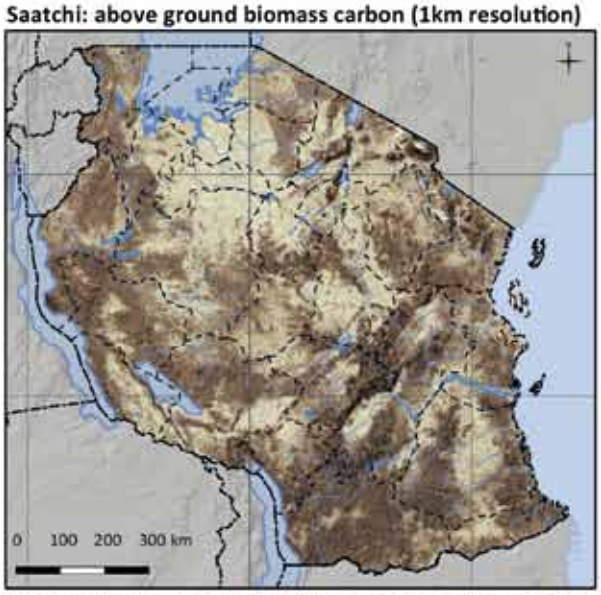
This map shows the NAFORMA woody biomass carbon map (top), compared with above-ground biomass carbon maps based on data from Saatchi et al. (2011) (below left) and Baccini et al. (2012) (below right). The maps are displayed using the same carbon value categories, and are therefore comparable. Current carbon stocks will be needed to inform many decisions in spatial REDD+ planning. For many REDD+ decisions, above-ground biomass is the most important carbon pool (woody biomass constituting the bulk of this).

NAFORMA: Woody biomass carbon only (5km resolution preliminary dataset based on field data)



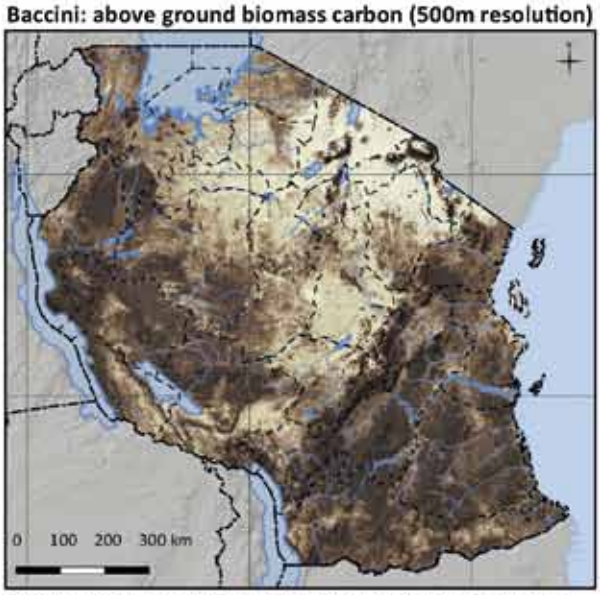
Data sources: Woody biomass carbon: NAFORMA. 2013. NAFORMA woody biomass. 5km preliminary dataset based on field data. Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Saatchi: above ground biomass carbon (1km resolution)



Data source: Saatchi S, Harris NL, Brown S, Lefsky M, Mitchard ET, Salas W, Zutta BR, Buermann W, Lewis SL, Hagen S, Petrova S, White L, Silman M, Morel A. 2011. Benchmark map of forest carbon stocks in tropical regions across three continents. Proceedings of the National Academy of Sciences USA. Jun 14;108(24):9899 -904.

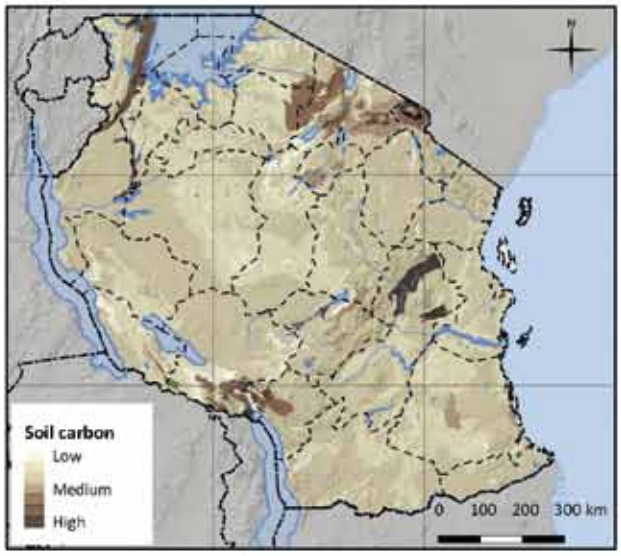
Baccini: above ground biomass carbon (500m resolution)



Data source: Baccini, A., Goetz, S.J., Walker, W.S., Laporte, N.T., Sun, M., Sulla-Menashe, D., Hackler, J., Beck, P.S.A., Dubayah, R., Friedl, M.A., Samanta, S., Houghton, R.A. 2012. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. Nature Climate Change 2 182-185.

Map 3: Soil organic carbon

This map shows soil organic carbon to a depth of 1 metre. Soil carbon stocks can be relevant to account for in some REDD+ decisions.



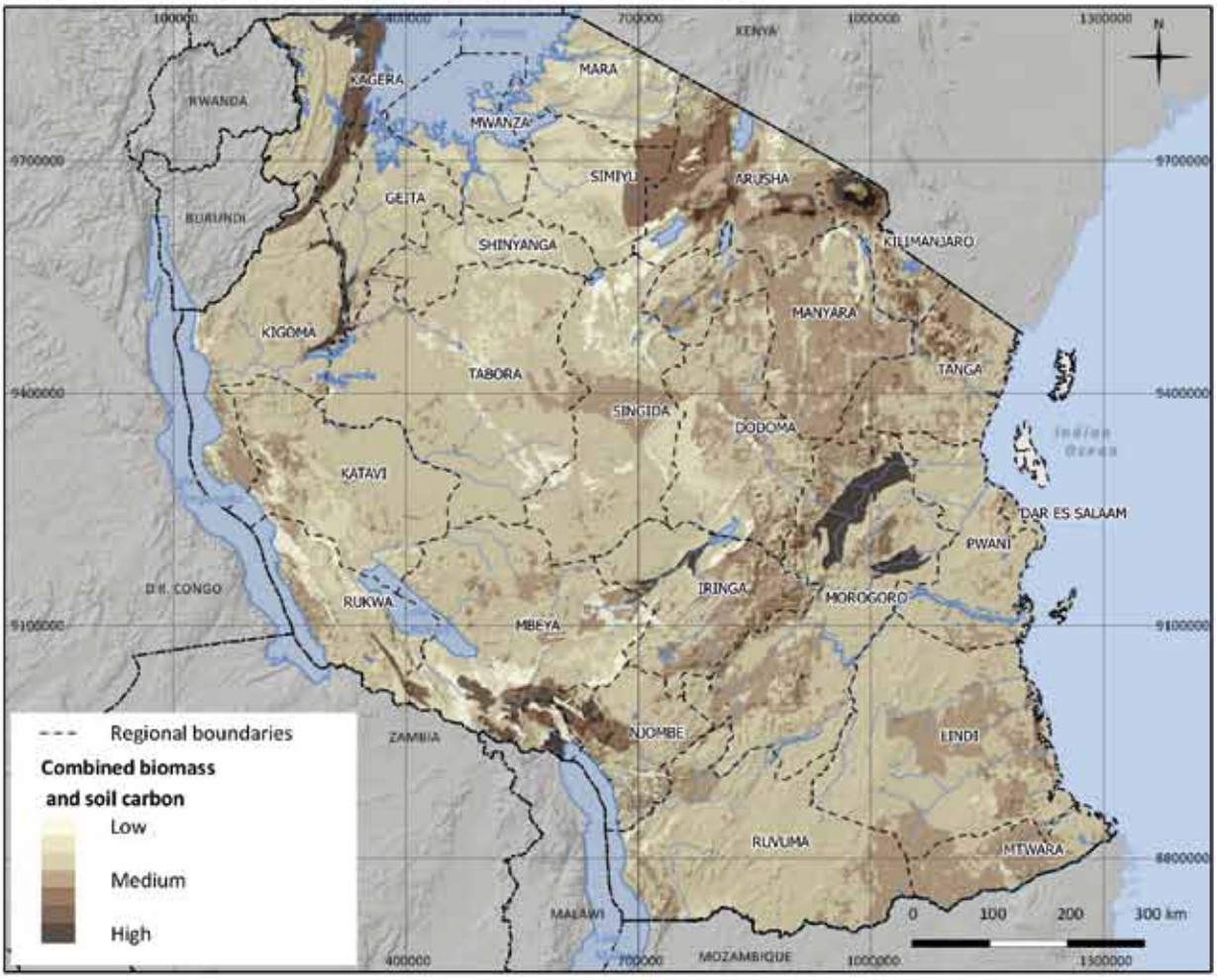
Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

Data sources:
Woody biomass carbon: NAFORMA. 2013. NAFORMA woody biomass only. 5km preliminary dataset based on field data.
Below ground biomass conversion factors: IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 4 Agriculture, Forestry, and Other Land Use. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).
Published: IGES, Japan. Accessed: March 2013 at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html
Ecological zones: FAO. 2001. Global Forest Resources Assessment 2000. FAO Forestry Paper 140. Food and Agriculture Organization of the United Nations, Rome, Italy.
Soil organic carbon: Scharlemann JPW, Hiederer R & Kapos V. in prep. Global map of terrestrial soil organic carbon stocks. A 1-km dataset derived from the Harmonized World Soil Database. UNEP-WCMC & EU-JRC, Cambridge UK.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. Surveys and Mapping Division. Administration Map of Tanzania. Dar es Salaam Tanzania, 2011

Methods:
Above ground woody biomass was taken from NAFORMA (2013). Ecosystem-specific conversion factors (IPCC 2006) were used to add below-ground biomass, with the factors allocated to FAO ecological zones (FAO 2001). Where an ecological zone was not listed in IPCC 2006, the tropical shrubland factor was used. These values were multiplied by 0.5 to convert from biomass to carbon. This was added together with soil carbon (Map 3) to form the combined carbon map (Map 4).

Map 4: Combined carbon map

This map shows the sum of above-ground woody biomass carbon, below-ground carbon and soil organic carbon. In some cases it may be preferable to base REDD+ decisions on a combination of carbon pools, rather than only above-ground or woody biomass.



Conference of Parties in 2010 state that REDD+ actions should be: "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, and to enhance other social and environmental benefits". The Government of Tanzania, through its draft REDD+ Safeguards document, has identified the protection of natural forests from degradation and from conversion to other land uses (including plantations) as a priority.

Since no common definition of natural forest has yet been agreed under the UNFCCC, a national definition of natural forest is useful in this context. The Tanzania REDD+ Strategy defines natural forest as: "Forest composed of indigenous trees, not planted by man". This further requires a definition of forest, and Tanzania is currently using multiple definitions of forest in parallel. The REDD+ Strategy and NAFORMA follows the FAO Forest Resources Assessment (FRA) definition, which defines forests as "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use." (FAO 2010). The Tanzanian Government has also submitted a national definition of forest to the Clean Development Mechanism (CDM) under the UNFCCC, defining forest as having a minimum tree crown cover value of 10 per cent, a minimum land area value of 0.05 ha, and a minimum tree height value of 2 metres. If the CDM definition is applied, bushland and thicket vegetation could in many cases fall under the definition of forest, while these land cover categories are likely to be excluded using the FAO/REDD+ Strategy/NAFORMA definition. Including thickets and bushlands as forest, could expand the area of natural forest by as much as 38 per cent (an additional 6 369 000 ha), and hence also the areas that are covered by draft safeguard 7.3 (Table 1).

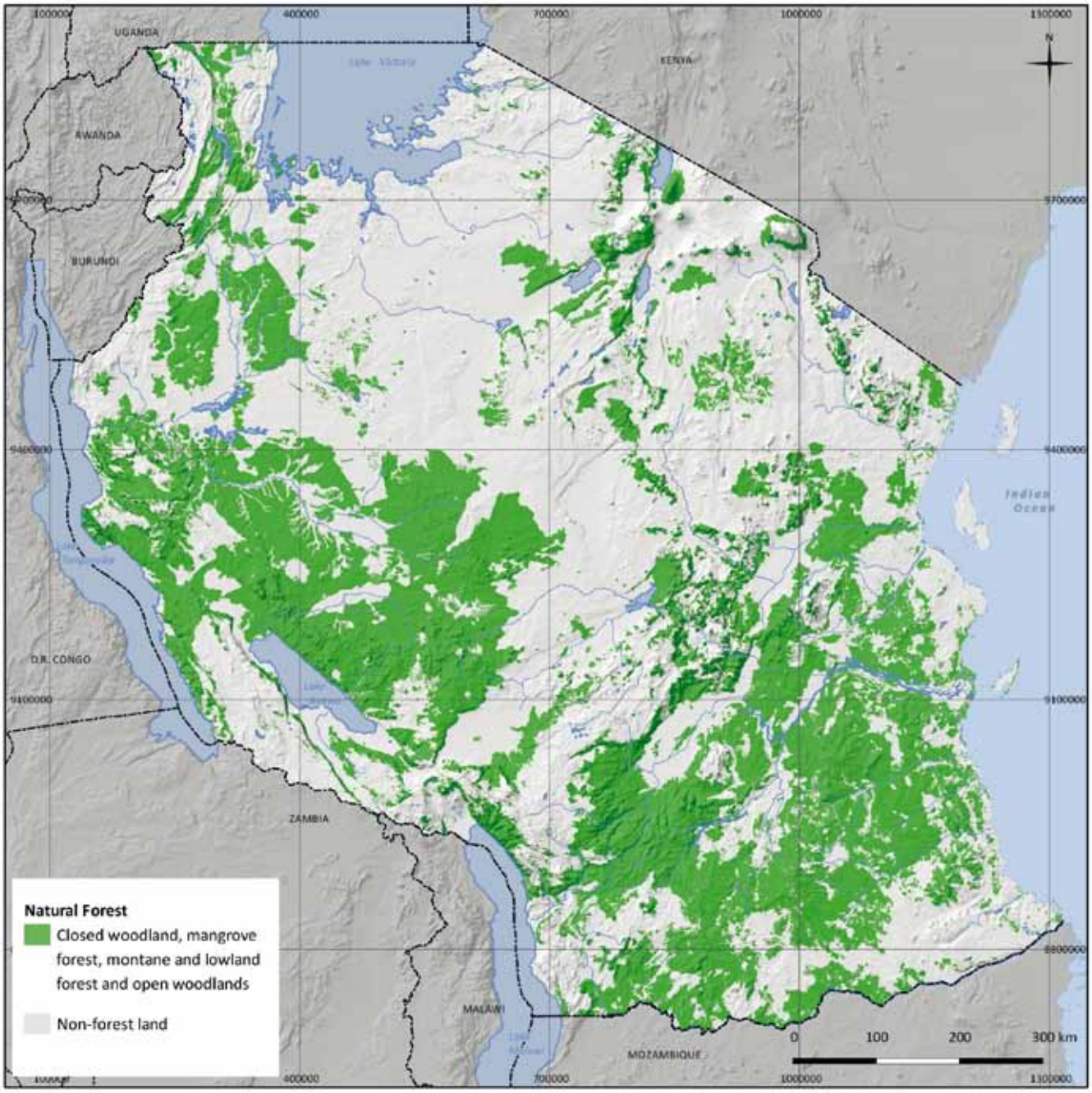
Map 5 shows an estimate of the difference between these two forest definitions, based on the categories in the NAFORMA land-use land-cover map. Whilst the map is not a perfect representation of the two definitions, it does show that definitions of forest and natural forest can have a strong influence on the extent of the area to which the safeguard would apply. Some of the limitations of this map are: first, the vegetation classification used to produce the remote sensing-based land-use land-cover map may include stands shorter than the 2 m or 5 m minimum tree height in various forest definition categories, which would hence not fit the forest definition. Second, a strict interpretation of the natural forest definition would exclude areas that have been invaded by (or deliberately planted with) non-native species. This possibility is not accounted for in these maps. Third, that same strict interpretation could also exclude high carbon forests where enrichment plantings have been carried out in the past; these are also not distinguished on the maps.

The national natural forest definition applied to REDD+ is likely to be important, as it on the one hand places constraints on the areas that might be available for specific REDD+ actions, for example the development of plantations; but on the other hand also provides an important safety mechanism to protect natural forest.

[4] FCCC/CP/2010/7/Add.1 Appendix I

Map 5: Natural forest estimations based on the NAFORMA land-use land-cover map.

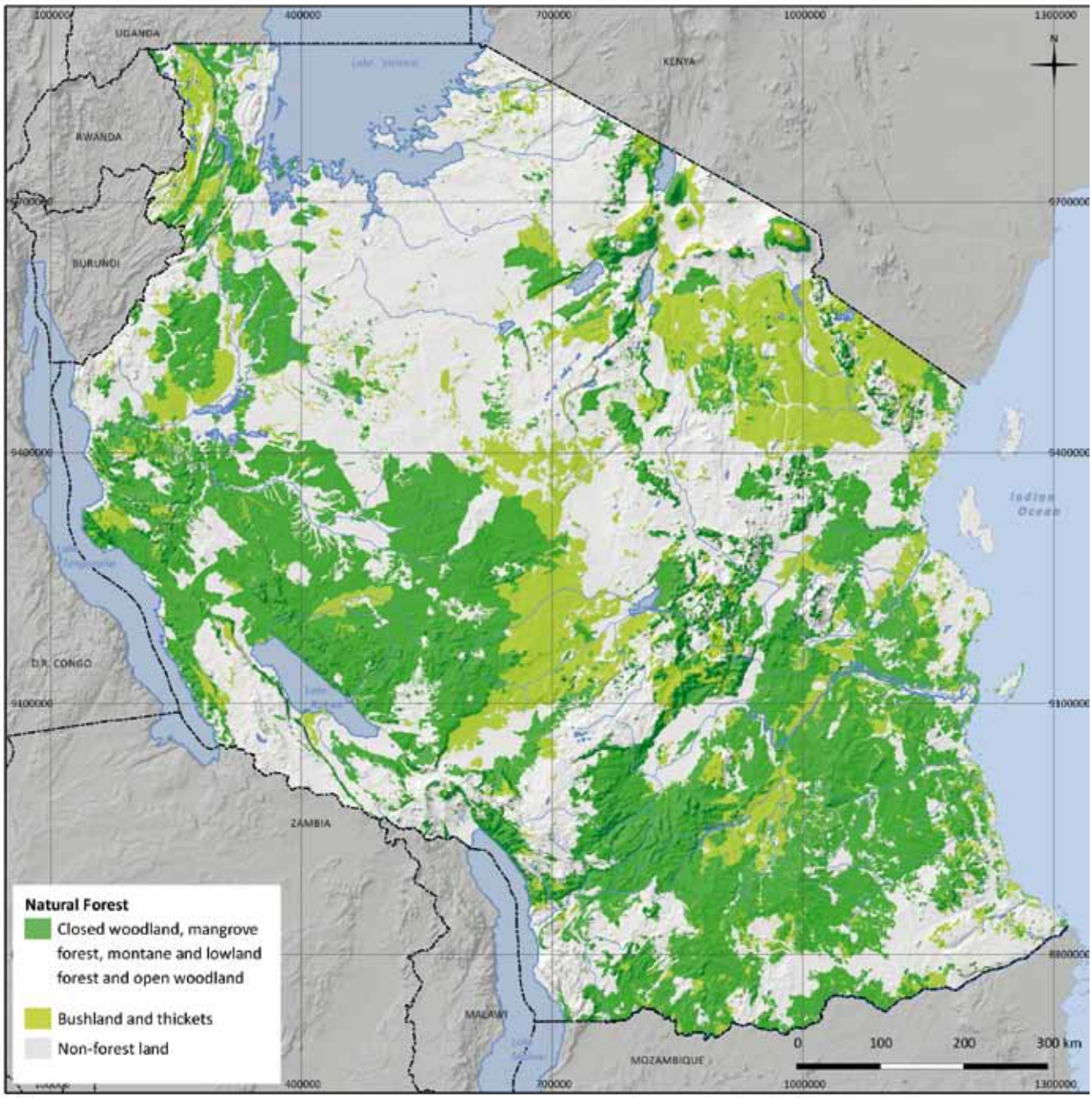
Defining natural forest is necessary to be able to apply key parts of the REDD+ safeguards, which state that "the REDD+ programme [should] protect natural forests from degradation and conversion to other land uses including forest plantations" (draft safeguard 7.3 in table 1). In Tanzania, different definitions of natural forest are possible, as the country has several definitions of 'forest' in use. Two key examples are: (1) The REDD+ Strategy/NAFORMA/ FAO FRA definition: minimum tree crown cover of 10 per cent, minimum land area of 0.5 ha and minimum tree height of 5 meters. (2) The national UNFCCC CDM definition: minimum tree crown cover of 10 per cent, minimum



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013

land area of 0.05 ha and minimum tree height of 2 meters. The REDD+ Strategy/NAFORMA/FAO FRA definition includes the vegetation categories montane and lowland forest, open and closed woodlands, and mangroves, but excludes thickets and bushlands (the map on the left). The CDM definition is also likely to include thickets and bushlands in addition to the other vegetation categories (the map on the right). Including thickets and bushlands may expands the area of natural forest by up to 38 per cent (an additional 6 369 000 ha), and hence also the areas that are covered by draft safeguard 7.3.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013

2.3 Biodiversity

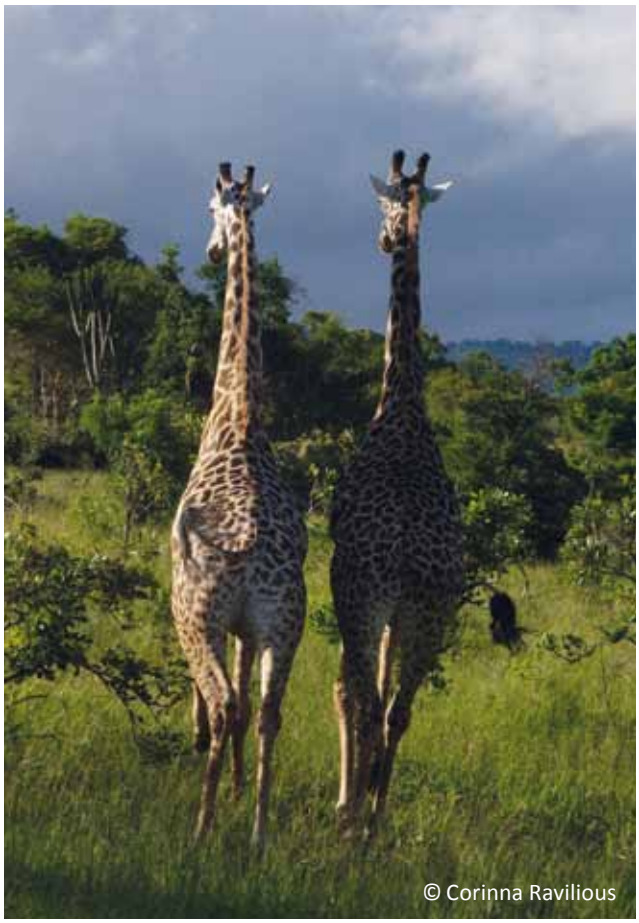
Biodiversity is not distributed evenly across space, and because of its complexity, is difficult to capture in a single indicator. For this reason, different approaches for identifying areas of importance for biodiversity exist. To examine key aspects of biodiversity for Tanzania, and how these relate to the distribution of biomass in-country, a number of datasets were used for this report.

First, an analysis of tree species diversity using the NAFORMA inventory was undertaken, to investigate the spatial distribution of tree species richness (Map 6), and the NAFORMA inventory clusters where threatened tree species were observed (Map 7). It should be noted, however, that the NAFORMA survey was not designed to accurately sample rare phenomena tree species diversity, and so may not give a representative result. Still, the threatened tree species identified in the survey were largely found in the Eastern Arc Mountains, which is a known global plant biodiversity hotspot (Mittermeier et al. 2004), in coastal forest and in remote locations of the miombo woodlands. For further details on mapping tree species richness and threatened tree species, including on the methodology employed, please refer to Annex I of this report.

Map 8 presents the distribution of animal species richness (mammals, birds and amphibians), and threatened species of the same categories. This information has been combined with woody biomass carbon to allow for identification of areas that are high in both carbon and animal species richness. The compilation of maps in Map 9 shows the same type of information but separated for the different taxa. 'One map show the frequency of threatened species and the other frequency of all assessed species, including species that are not considered threatened. These maps have been developed based on extent of occurrence[5] data from the IUCN Red List of Threatened Species (IUCN 2013). As can be seen from both Map 8 and Map 9, the Eastern Arc Mountains stand out as being among the few areas that have particularly high values of both threatened species richness and carbon. Such forests may be appropriate for REDD+ actions to conserve natural forests, and reduce human disturbances.

Map 10 shows the location of major wildlife corridors in Tanzania, and how they relate to protected areas and natural forest. Wildlife corridors are vital for the long term viability of wildlife populations and stability of protected ecosystems, but are in many cases subject to pressures such as forest degradation or land-use change (Jones et al. 2012). If wildlife corridors were to become the subject of forest rehabilitation or increased protection under REDD+, carbon stocks could be enhanced at the same time as benefiting key areas for biodiversity.

Together, maps 6-10 provide a range of biodiversity information that can be considered for different REDD+ purposes. REDD+ actions to maintain natural forest could provide additional benefits for biodiversity if they were implemented in areas that have high biodiversity values, or areas that have such values nearby and could serve as buffer zones. Forest areas which have been degraded but still hold high biodiversity values, or land that function as a wildlife corridor, could be appropriate for forest restoration using appropriate methods.

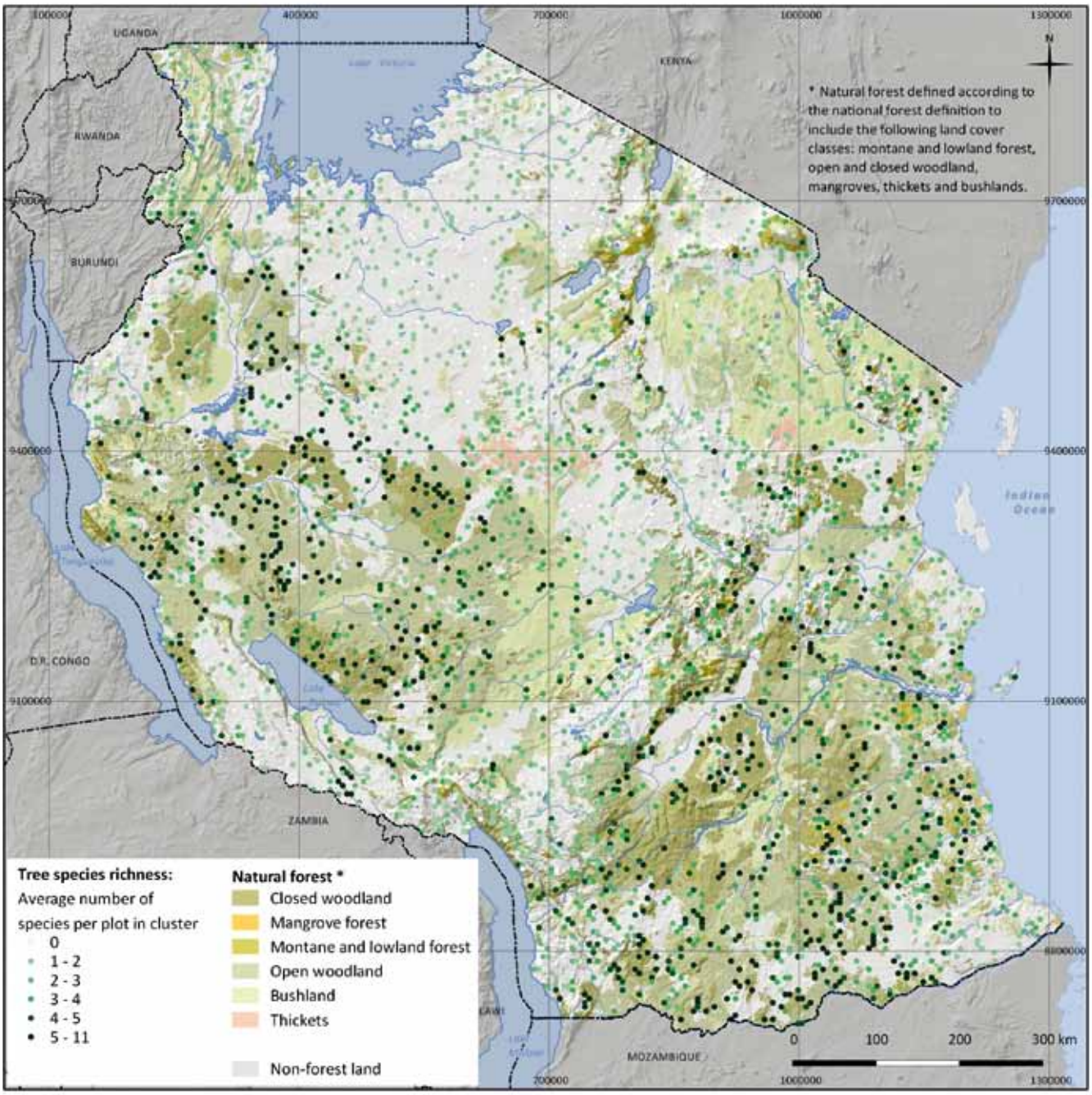

© Corinna Ravilious

[5] Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy (IUCN 2000).

[6] This map has been created based on the information at http://www.tzwildlifecorridors.org (accessed May 2013). The map includes five types of wildlife corridors, including three categories covering areas that have been either confirmed or suspected to be active movement routes, but which were data deficient. A fourth category covers proposed or potential corridor areas linking fragmented or threatened habitat patches (usually forest), and the final category is defined by "known animal movement between two protected areas" (Jones et al. 2012).

Map 6: Average tree species richness in NAFORMA plots

This map shows the average (mean) tree species richness per plot for each cluster in the NAFORMA inventory. Box 1 further explains what the NAFORMA inventory can say about tree species richness in Tanzania. The average values are generally higher in lowland forest, montane forest, and closed woodland, indicating the high biodiversity value of these forests.

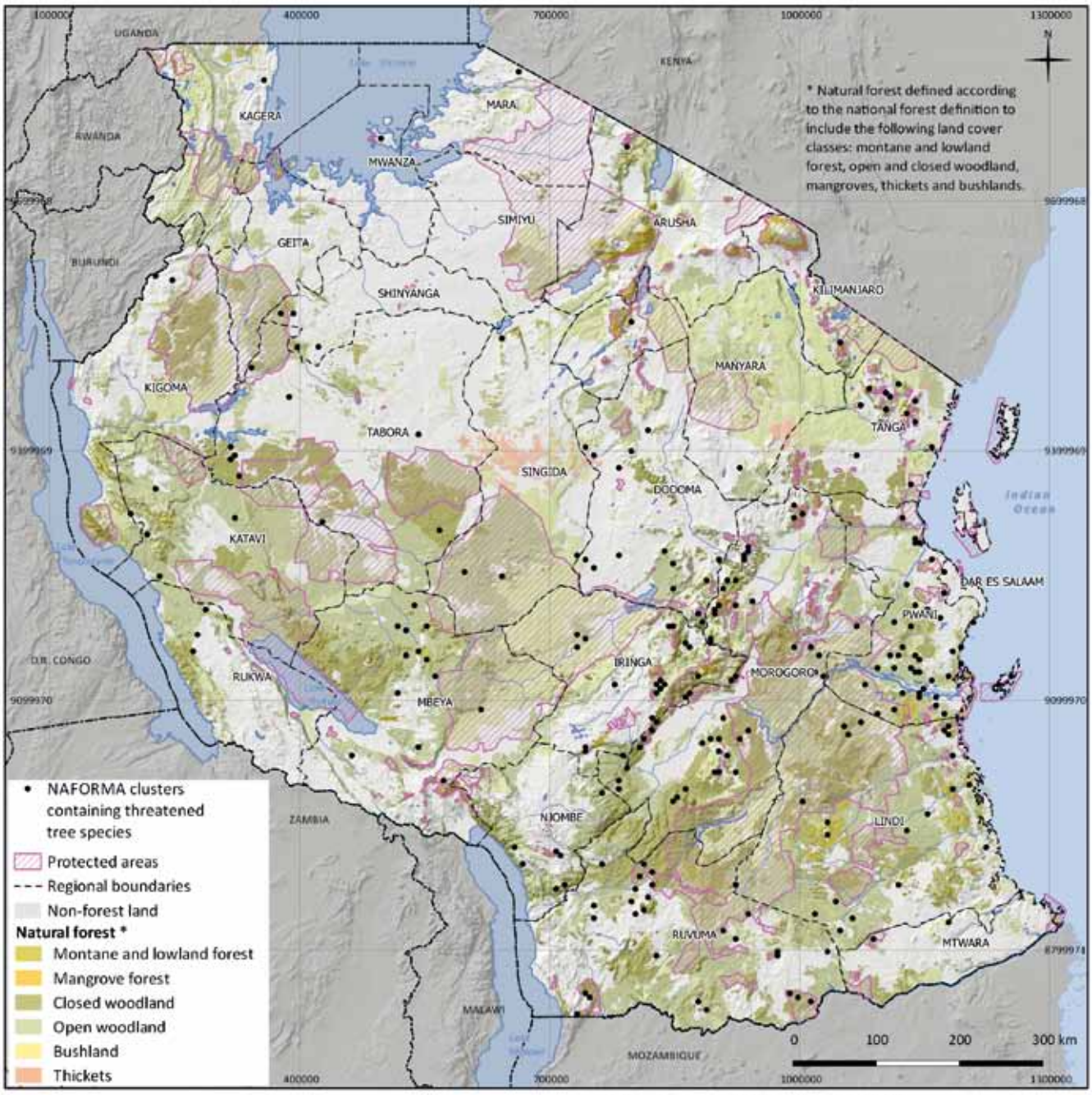


Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Tree species richness: NAFORMA. 2013. NAFORMA biophysical survey 2013.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013

Map 7: Observed threatened tree species in the NAFORMA inventory

The map shows the NAFORMA inventory clusters where threatened tree species were observed, in relation to natural forest* and protected areas. Concentrations of threatened species are found in particular in and around the Eastern Arc Mountains and in the coastal forest of Tanzania. This information may be helpful for defining areas where actions can be implemented to conserve forests and reduce deforestation and forest degradation.

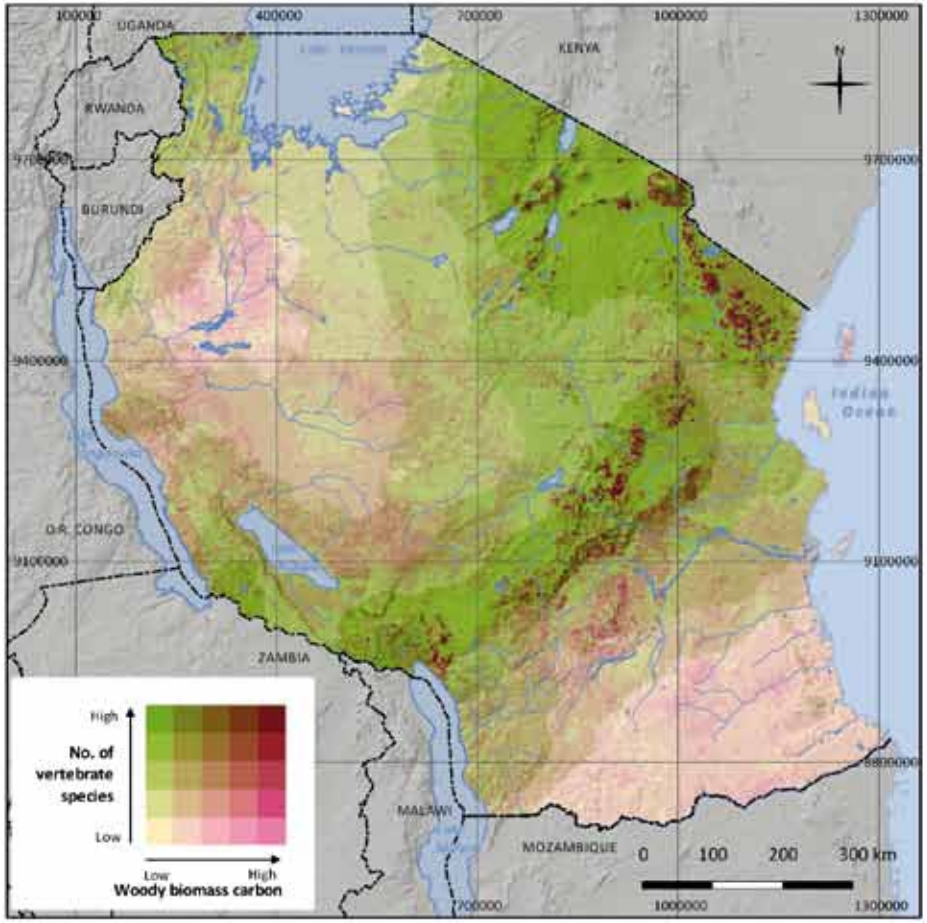


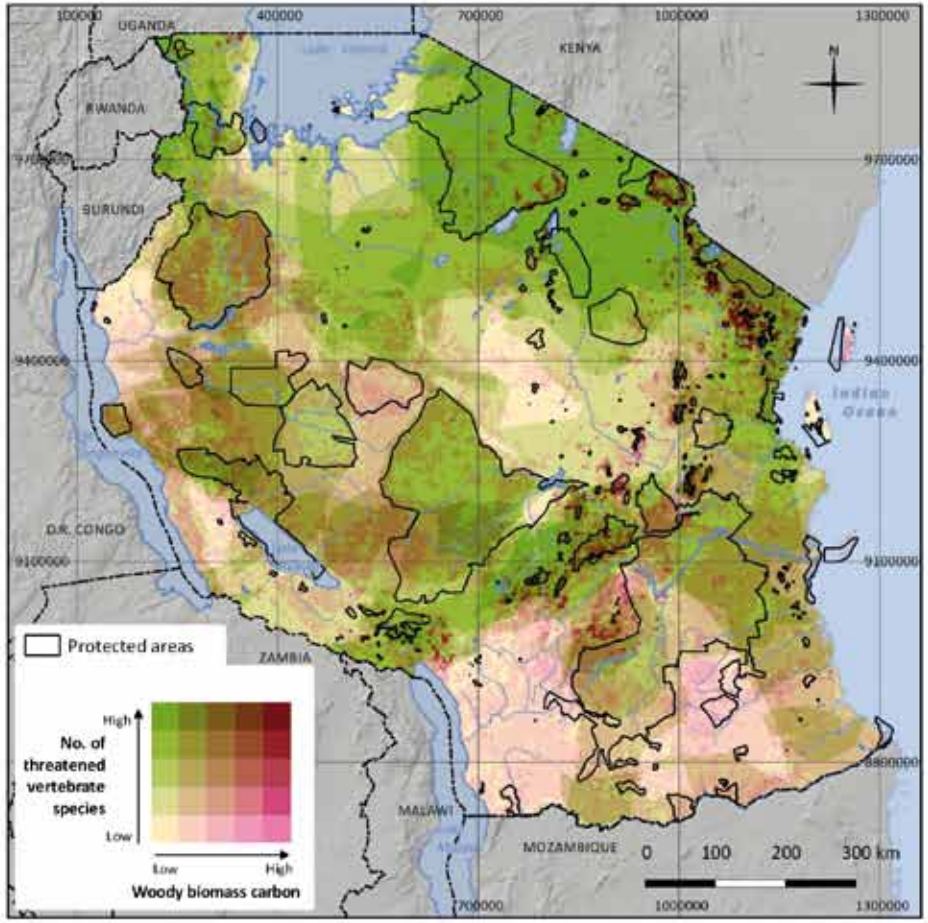
Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Threatened tree species: IUCN-SSC East African Plant Red List Authority. 2013.
Forest Reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected Areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013

Map 8: Animal species (mammals, birds, amphibians) richness in relation to above-ground woody biomass carbon

These maps shows areas that are important for both biodiversity and carbon (dark red) where it may be a priority to ensure that the forest is not degraded, areas with low carbon but high biodiversity (green), and areas with high carbon but low biodiversity (light pink). Different REDD+ actions may be appropriate for these different combinations of values. The map on the left includes all vertebrates assessed by IUCN, while the map on the right includes threatened animal species only, displayed with protected areas.



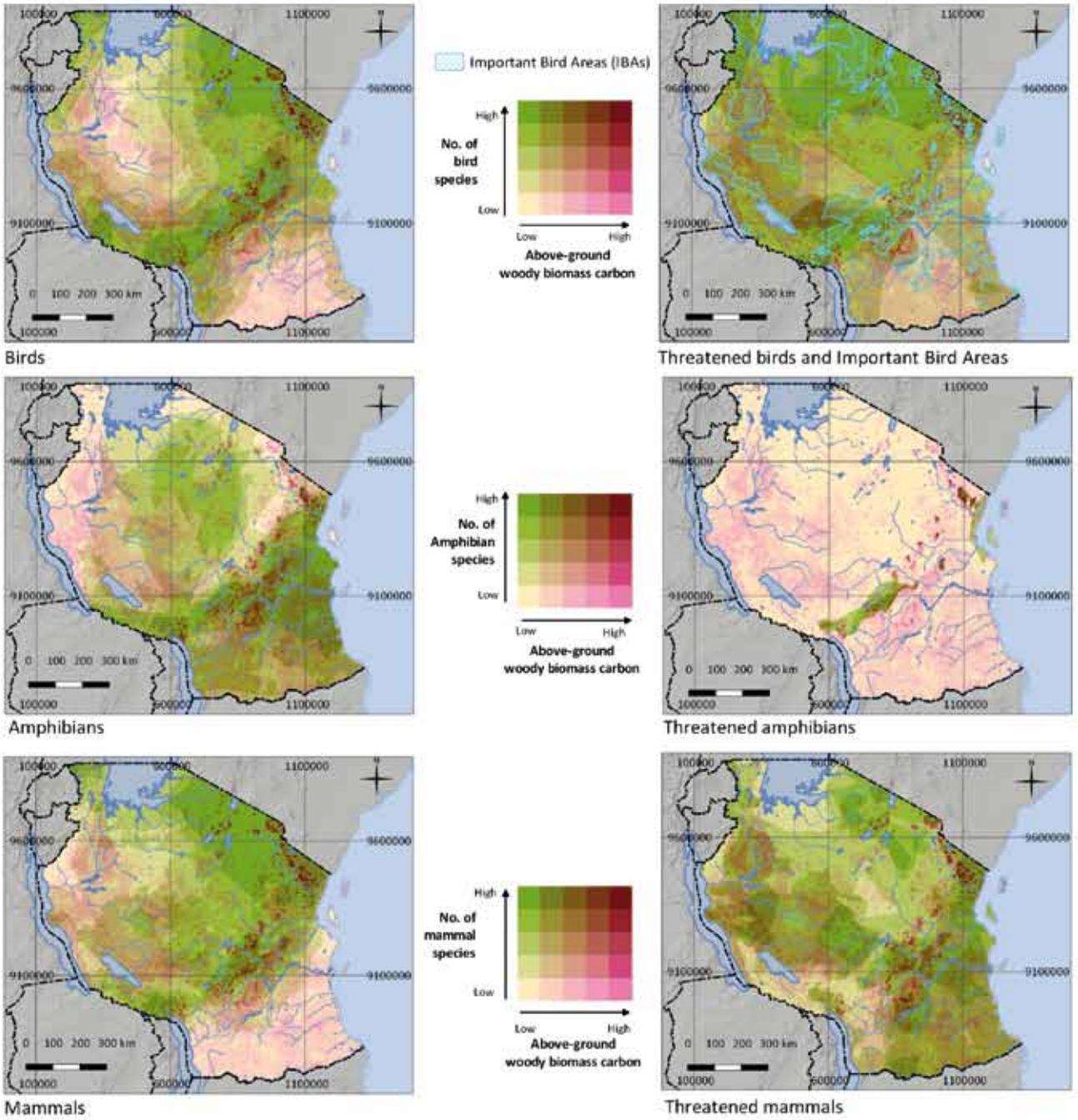


Data sources:
Woody biomass carbon: NAFORMA. 2013. NAFORMA woody biomass only. 5km preliminary dataset based on field data.
Vertebrates: IUCN. 2013. The IUCN Red List of Threatened Species. Version 2012.2. Downloaded March 2013 at http://www.iucnredlist.org
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

Map 9: Animal species (mammals, birds, amphibians) richness in relation to above-ground woody biomass carbon

Areas that are particularly important for both biodiversity and carbon are shown in dark red, which for all taxa, including threatened species, are largely found in the Eastern Arc Mountains. Threatened species are those species regarded as threatened with extinction by IUCN. IBAs, indicated on the map of threatened birds, are important bird areas, assessed by BirdLife International.



Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

Data sources:
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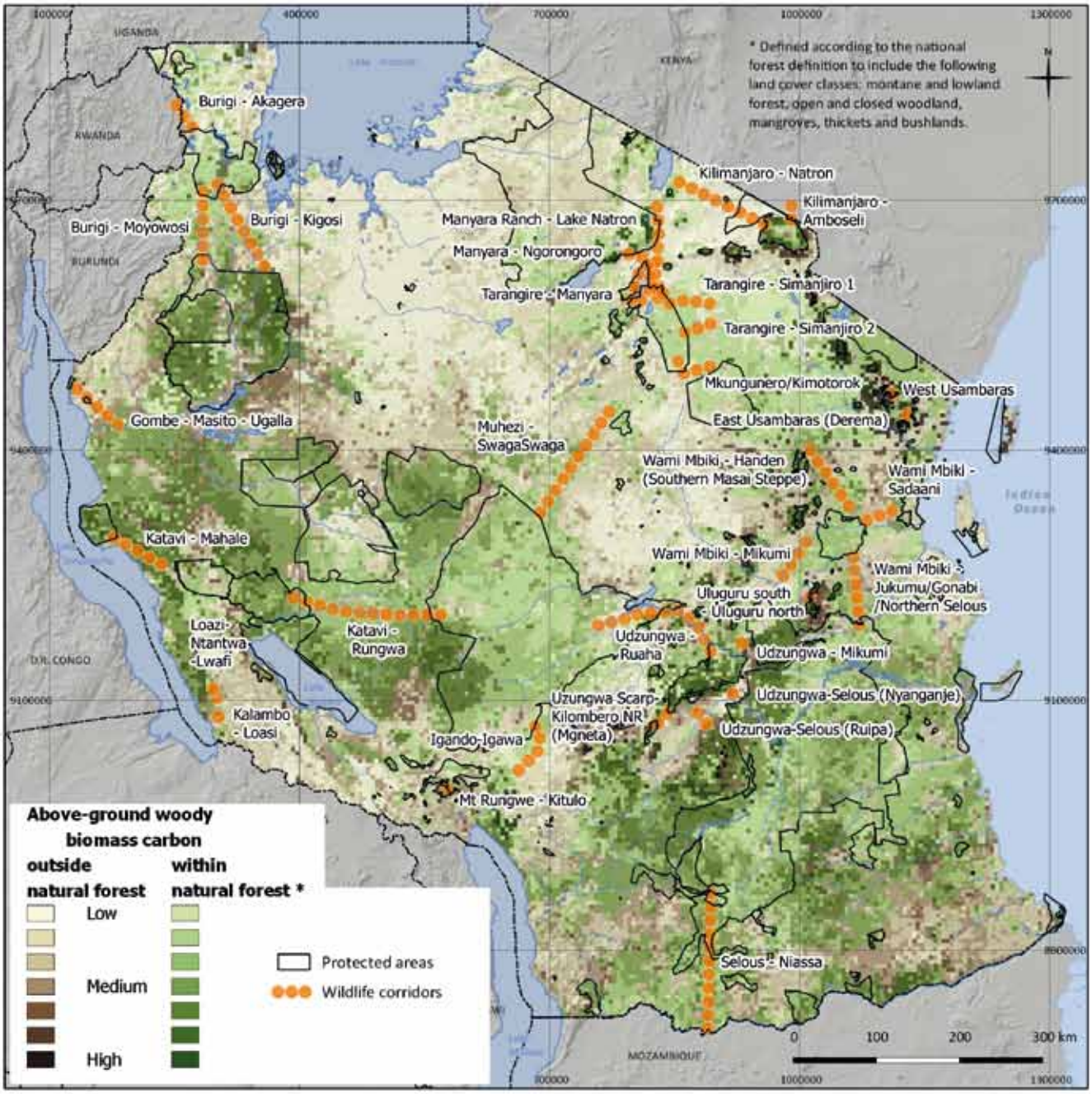
Vertebrates: IUCN. 2013. The IUCN Red List of Threatened Species. Version 2012.2. Downloaded March 2013 at http://www.iucnredlist.org
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Important Bird Areas: BirdLife International. 2013. Important Bird Areas in Tanzania (GIS data). Birdlife International, Cambridge, UK. Accessed May 2013. For further information please visit www.birdlife.org.

Map 10: Important wildlife corridors in relation to protected areas, natural forest and woody biomass carbon stocks.

This map shows the location of some important corridors in Tanzania where natural vegetation facilitates the movement of wildlife between protected areas. Wildlife migration corridors enable long-term health of protected ecosystems, extending the habitat of species and allowing the gene pools of different populations to mix. Many of the corridors on the map are threatened from agriculture, livestock keeping and other activities (Jones et al. 2012). REDD+ activities for forest rehabilitation or protection could help to preserve these crucial areas.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA woody biomass only. 5km preliminary dataset based on field data.
Wildlife corridors: based on information provided at tzwildlifecorridors.org. Accessed May 2013.
Forest reserves: Tanzanian Forest Service, 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC (2010), The World Database on Protected Areas (WDPA) Cambridge, UK: UNEP- WCMC. Available at: www.protectedplanet.net.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

2.4 Ecosystem services

2.4.1 Non-timber forest products (NTFP)

The NAFORMA biophysical survey, apart from recording tree parameters, also observed the presence of potential forest products in the ground plots of the inventory. Several types of NTFP were recorded, including the presence of non-timber forest products. Map 11 shows a selection of non-timber forest products identified in the plots of the NAFORMA biophysical survey (more potential products than these were recorded). The pattern for observed beekeeping activities, for example, shows a clear concentration of activities in the forests west and south of Tabora. The REDD+ Action Plan has ambitions to promote appropriate beekeeping practices in forests. This map of existing beekeeping activity can be helpful for guiding the establishment of beekeeping demonstration centres, and to target communities for training on proper beekeeping and entrepreneurship skills, for example.

The NAFORMA socioeconomic survey asked 4 600 respondents questions about what environmental services they believe the forest provides them with. There was a strong belief among communities that forests bring rain, and assist in keeping the air clean (NAFORMA 2013). Between 70 and 80 per cent of respondents also answered that forests regulate and conserve water, function as windbreaks and provide soil protection and shade.

NAFORMA also investigated what non-timber forest products were used by people. The results suggest that the respondents did not rely to a great extent on selling forest products for cash income, with only about 5 per cent of the average household income reported to come from forest products. Agriculture, livestock, income from their own businesses and wage income were much more important. For subsistence, however, forest products are widely used. Figure 4 shows that 96 per cent of respondents answered they had used firewood from the forest in the past 12 months, nearly 50 per cent had used wood for construction, nearly 30 per cent had included food from the forest in their diet and around 15 per cent used plant medicines collected from the forest. In comparison, Map 11 shows that edible and medicinal plants were found in most parts of the country.

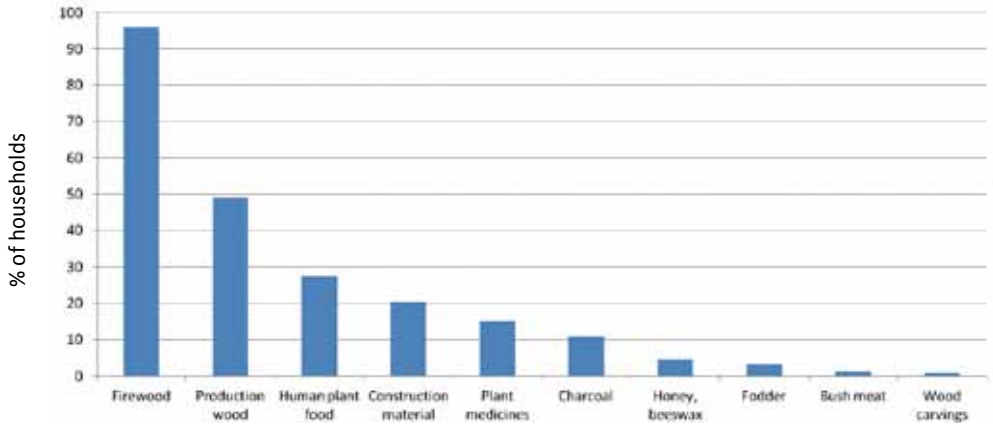
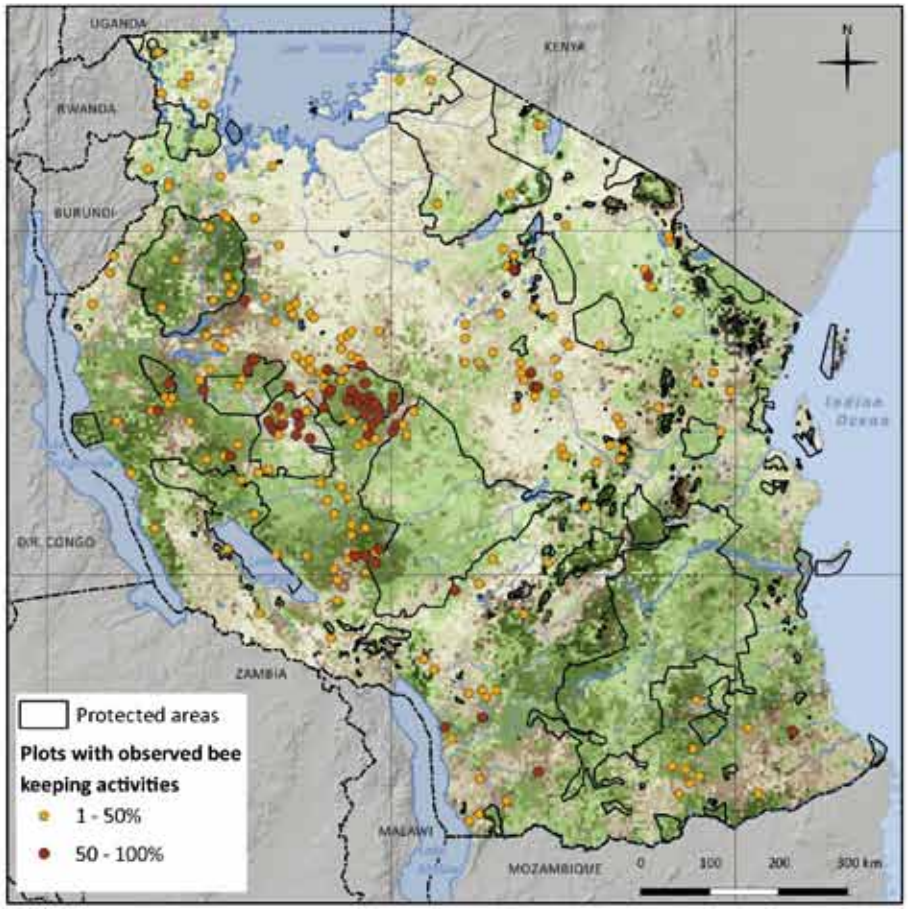
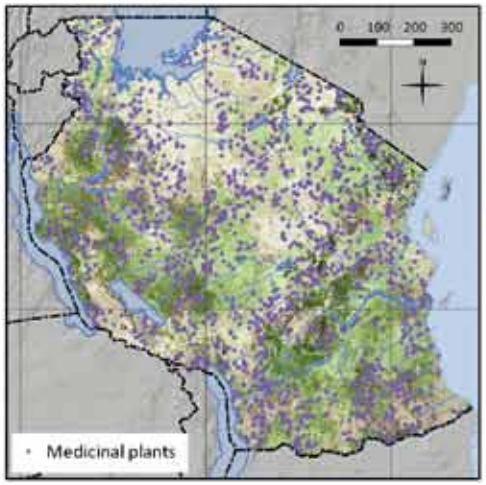


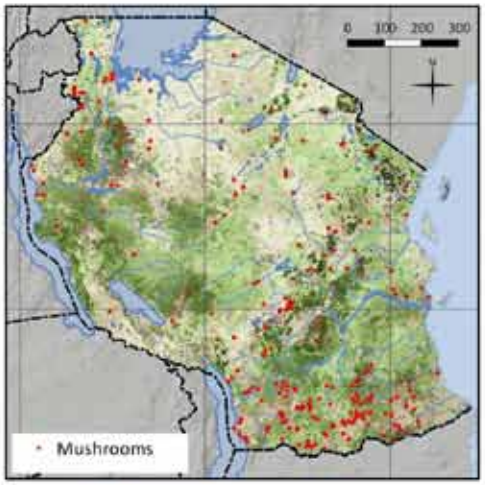
Figure 3: Top 10 tree and forest products reported to be used by households in the past 12 months by respondents to the NAFORMA socioeconomic survey.

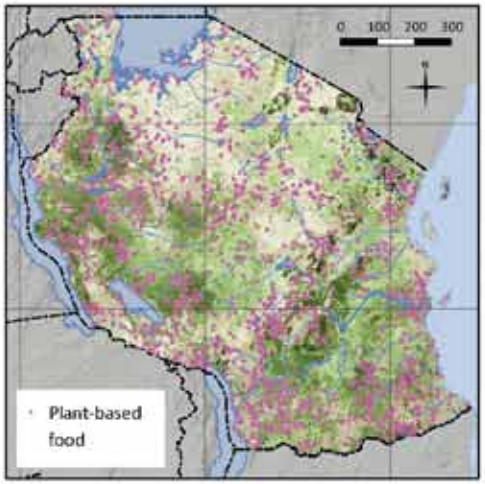
Map 11: Non-timber forest products observed in the plots of the NAFORMA biophysical survey

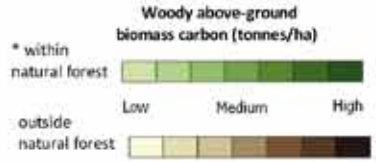
Non-timber forest products are important benefits that forest provides to the population of Tanzania. REDD+ activities could be designed to assist communities to sustainably extract subsistence or income sources from the forest, where possible. In Tanzania, beekeeping activities can be a sustainable forest supported livelihood source. Activities were found concentrated in forests south of Tabora. Edible and medicinal plants were observed in most parts of the country, while mushrooms were observed mostly in the south (more potential products than these were recorded). The NAFORMA inventory found that nearly 30% of interviewed households collected plant-based food from the forest, and around 15% collected plant-based medicines.











* Defined according to the national forest definition to include the following land cover classes: montane and lowland forest, open and closed woodland, mangroves, thickets and bushlands.

Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Observed non-timber forest products: NAFORMA. 2013. NAFORMA biophysical survey 2013.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.

2.4.2 Soil erosion

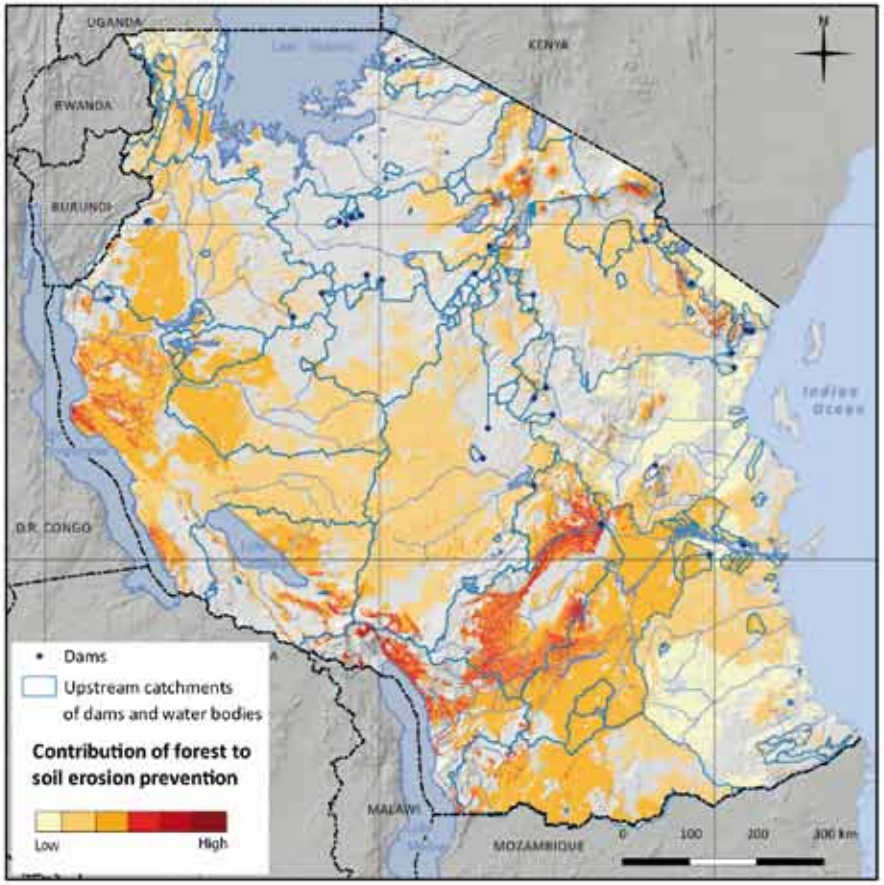
Forests, especially those on slopes, can stabilize soils and prevent soil erosion. The tree canopy, saplings, litter layer and woody debris protect the soil surface from the erosive power of raindrops and controls runoff, thereby preventing soil detachment. On high slopes, deforestation or forest degradation can lead to several detrimental effects. They can diminish the capacity of the land to store water, cause greater surface runoff after heavy rains, thus increasing the risk for flooding downstream and water shortages at other times of the year. Removal of forests can also result in erosion of topsoil. When the soil particles are carried by runoff into rivers and streams, they contribute to higher sediment loads. Increased sediment loads can have negative effects, for example for downstream infrastructure such as dams.

Map 12 indicates where forests are particularly important for limiting soil erosion that might negatively affect dams in Tanzania. This map has been developed using a simple method of summarizing four factors: forest land, slope, precipitation and upstream catchments of dams[7]. High slopes and high precipitation both contribute to soil erosion risk. Dams constitute valuable infrastructure, which is affected by the sediment load carried downstream by the watercourse, and may therefore be of particular concern for limiting soil erosion in catchment areas upstream. Forests that have particular value for preventing soil erosion could be targeted by REDD+ actions to maintain and restore forest cover, especially on steep slopes.

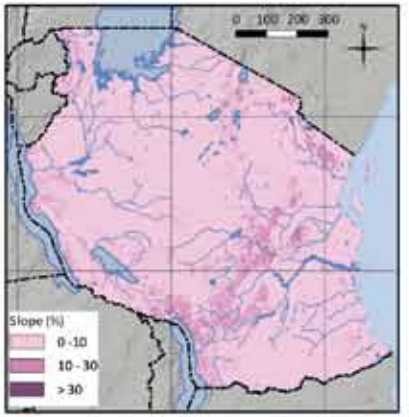
[7] More information about this methodology can be found in the Tanzania Methodological Brief, available at: http://www.un-redd.org/UNREDDProgramme/CountryActions/Tanzania/tabid/1028/Default.aspx

Map 12: Importance of forests for limiting soil erosion

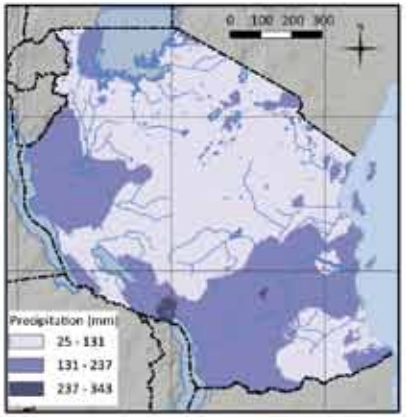
This map shows areas where forests are particularly important for limiting soil erosion that might cause sedimentation problems for dams in Tanzania. The methodology is based on four parameters: slope, precipitation, locations of dams and water bodies and their catchments, and forest. Soil erosion prevention and protection of dams against siltation can be ecosystem services of high monetary value. A large part of Tanzania's reserved protection forests are catchment areas, but population pressure and inefficient forest management and protection have contributed to their deterioration (Tanzania National Forest Policy 1998).



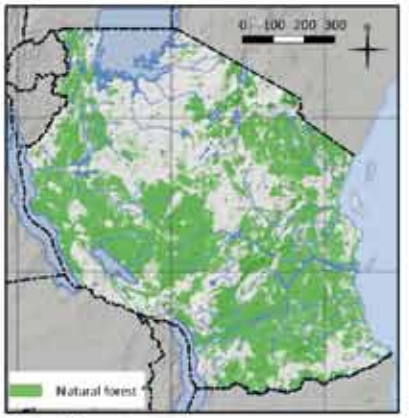
Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.



3 slope classes (%)

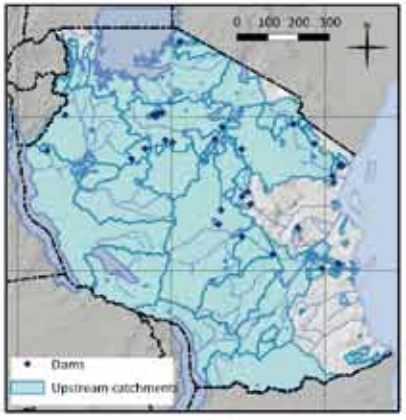


Average precipitation for rainy season (March, April, May, November, December and January)



Natural forest extent*

* Defined according to the national forest definition to include the following land cover classes: montane and lowland forest, open and closed woodland, mangroves, thickets and bushlands.



Upstream catchments of dams and water bodies

Data Sources:
Natural forest and water bodies: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Dams: Dr. Mark Mulligan, Department of Geography, Kings College, London.
Slope: generated from Lehner, B., Verdin, K., Jarvis, A. 2008: New global hydrography derived from spaceborne elevation data. Eos, Transactions American Geophysical Union, 89 (10) (2008) 93-94. Journal Article.
Precipitation: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. 2005. Jarvis. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25 (2005): 1965-1978. Journal Article.

2.5 Land designations

2.5.1 Land-use planning

REDD+ planning will need to be carried out in the context of national policies, laws and regulations. Relevant background information for REDD+ planning thus includes existing legal designations of lands and natural resources. Tanzania has three land designations, according to the National Land Act No.4 of 1999 and Village Land Act No.5 of 1999: reserved land, village land, and general land. *Reserved land* is all land set aside for special purposes, including forest reserves, different categories of protected areas for nature conservation purposes, land reserved for public utilities and highways, hazardous land and land designated under the Town and Country Planning Ordinance. *Village Land* includes registered village land, land demarcated and agreed to as village land by relevant village government, and non-reserved land that villagers have occupied and used as village land for 12 or more years under customary law. *General Land* includes all land which is not reserved land or village land, including any unoccupied or unused village land[8]. According to Tanzania's REDD+ Strategy Document: "unreserved forests on village and general land are 'open access', characterized by unsecured land tenure, shifting cultivation, annual wild fires, harvesting of wood fuel, poles and timber, and heavy pressure for conversion to other competing land uses, such as agriculture, livestock grazing, settlements and industrial development." Spatial data for these land designations could provide a useful starting point for REDD+ planning. The maps in this section provide information on some of these categories.

Map 13 shows some of the categories under reserved land: different types of protected areas for wildlife and nature conservation, and Forest Reserves, which can have protection or production status (or both, in different parts of the same reserve). Map 13 also shows the location of wards that have Participatory Forest Management activities, either Community based Forest Management (CBFM) or Joint Forest Management (JFM). Map 14 shows reserved land designations in relation to woody biomass inside and outside natural forest according to the two definitions in Map 5, and indicates which of the reserved areas are designated for protection vs. production. The data on forest reserves used for these maps is not entirely up to date, though a significant effort was made in the context of this work to improve the data. The Tanzania Forest Service is currently working to further improve this spatial dataset.

Natural forest that is within protected areas could potentially be included in REDD+ planning in several ways. If forests are already protected and managed well, the carbon stocks within them are likely to be under a low level of threat and REDD+ activities would thus only have a small effect. However, if the protected forest is being degraded for any reason, then improving management to maintain the forest and allow it to regenerate could be considered a REDD+ action that brings benefits in terms of carbon, and most likely for biodiversity and ecosystem services as well. There may also be a case for active forest restoration through management interventions, which could also be considered a REDD+ action.

In forest reserves designated for production, if carbon stocks are decreasing and other values of the forest are degrading, changing management techniques to ensure sustainable timber extraction, rehabilitating degraded areas, or, if appropriate, changing the forest status to a protective function could be possible REDD+ approaches that would yield carbon and multiple benefits.

These approaches will only be effective if combined with action on the drivers of deforestation and forest degradation. Otherwise there is a risk of leakage of land-use change to other forests. Section 2.6 outlines some of these drivers of land-use change in Tanzania.

2.5.2 Oil and gas exploration

Naturally, REDD+ planning will need to account for competing land uses, depending on location. Oil and gas exploration has been ongoing in Tanzania for the past 60 years. Map 15 shows the location of current oil and gas exploration licences in Tanzania, applications and open acreages (areas open for search for oil and gas). The great extent of these blocks is a significant consideration for land-use planning.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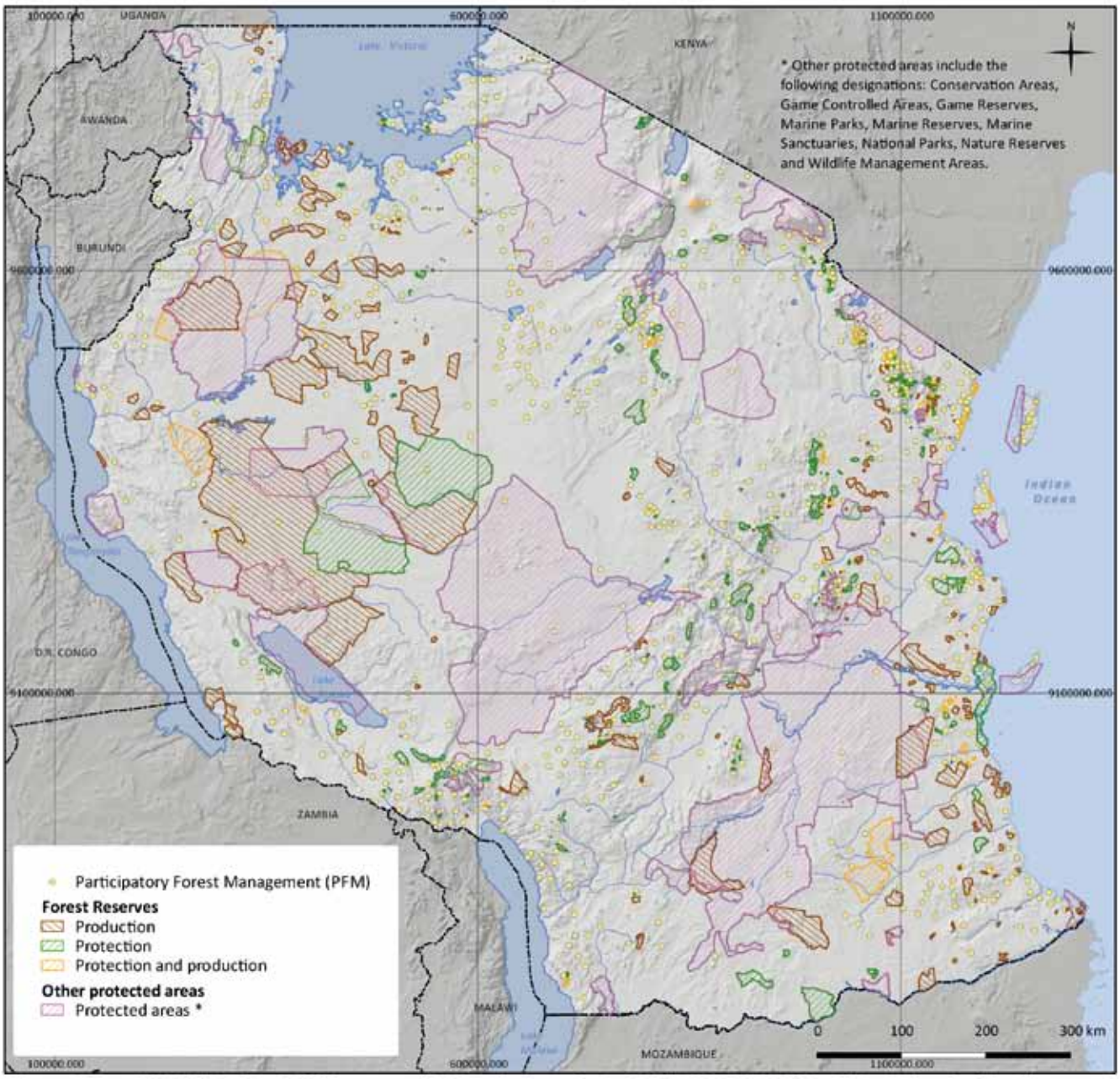
[8] Tanzania Land Act (1999) and Village Land Act (1999). For more information, see Tanzania Vice President's Office (2013c)

Map 13: Land-use designations: reserved land by the Tanzanian government (forest reserves and other protected areas) and location of PFM (CBFM and JFM) activities

This map shows forest reserves for protection and/or production purposes (some forest reserves have different areas designated for protection and production), and other types of protected areas, such as nature reserves and game reserves. Shown as point locations are places where Participatory Forest Management (PFM) has been implemented: Joint Forest Management JFM) is the format for reserved land, and Community Based Forest Management (CBFM) is the format for village land. Up-to-date spatial information about different land-use designations form an important basis for land-use planning, including for REDD+



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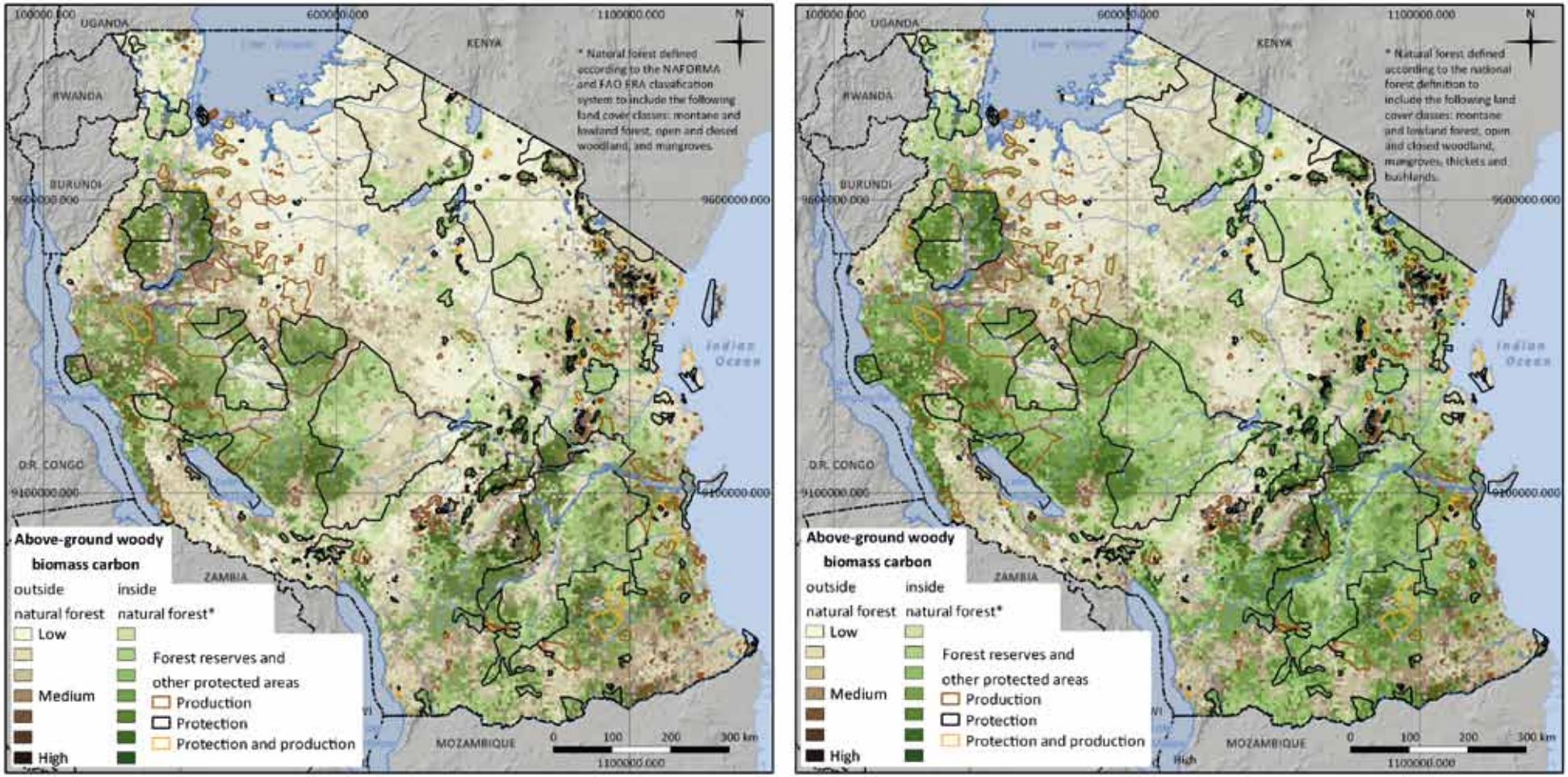
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Participatory Forest Management: Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division. 2008.

Map 14: Woody biomass carbon stocks, natural forest and protected areas

These maps shows where there are high and low woody biomass carbon stocks inside and outside the natural forest, what forest land is protected, and what forest land is reserved for production by the state. This information can help to understand what areas are available for different REDD+ actions. The two maps illustrate the difference between two definitions of natural forest.

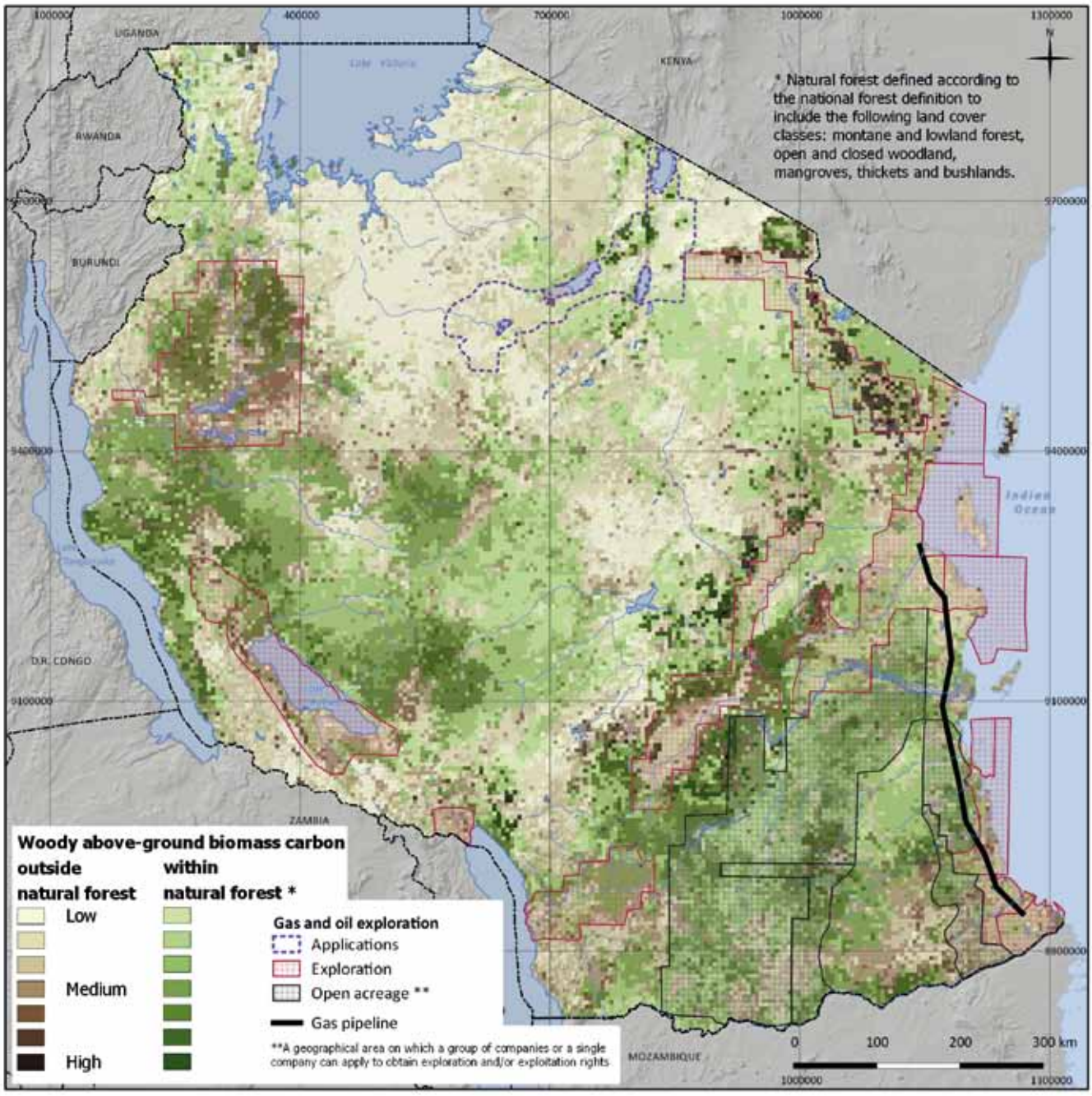


Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.

Map 15: Current oil and gas exploration licences, applications and open acreage

This map shows the blocks of oil and gas exploration licences, applications and open acreage in Tanzania. REDD+ planning needs to take these and other competing land uses into account. Some of these blocks lie in high carbon and high biodiversity areas of Tanzania.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Gas and oil exploration: Tanzania Petroleum Development Corporation. 2013. Exploration Activity map, Licensing situation - June 2013.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

2.6 Pressures on biodiversity, carbon and other ecosystem services

Understanding the spatial distribution of drivers of deforestation and forest degradation can contribute to understanding their mechanisms, where they have the strongest impact, how they interact with carbon stocks and potential multiple benefits from REDD+, and finally how they may be addressed. This report maps four drivers of deforestation in Tanzania: population density and increase, accessibility, charcoal production and fire incidence.

2.6.1 Population density in relation to forests and carbon stocks

Maps 16 and 17[9] show aspects of Tanzania's population density based on the 2012 Population and Housing Census (Tanzania National Bureau of Statistics 2013). Map 16 shows a combination of population density and woody biomass carbon. The map indicates that there are very few areas in Tanzania where population density is high or moderately high and carbon stocks are simultaneously high. Kilimanjaro is one exception to this, where complex agroforestry systems have maintained large populations for hundreds of years. In regions like Tabora and Kigoma, there are high population densities close to the border of the forest, which is largely, but not fully, covered by either forest reserves or other protected areas like game reserves (see Map 14).

Map 17 shows change in population density in Tanzania between 2002 and 2012. Population growth is fairly homogenous across the country, however sharp increases in population are observed in urban centres such as Dar es Salaam, Mwanza, Arusha and Moshi. At the current growth rate of 2.7 per cent, the population of Tanzania would double in the next 26 years (Tanzania National Bureau of Statistics & Office of Chief Government Statistician 2013).

2.6.2 Road network and link to charcoal production

Biomass fuels are by far the most important energy source in Tanzania, with firewood being utilized in the countryside by 96 per cent of households (NAFORMA 2013), and charcoal being very common in population centres (Milledge et al. 2007). The majority of urban households use charcoal for cooking (Schaafsma et al. 2012), and small and medium sized enterprises use it for energy. Charcoal production is a direct cause of forest degradation, involving selective felling of trees above a certain size. In addition, it is an indirect cause of forest degradation, in that uncontrolled charcoal production can also cause forest fires.

Map 18 shows places where the NAFORMA field inventory recorded impacts from charcoal making activities. The map also shows the road network including smaller tracks, and it appears that charcoal production is very closely linked to the road network, and manufacturing is aggregated around urban population centres[10]. If the results from the NAFORMA field inventory represent the true pattern of charcoal production in the country, Map 18 indicates that charcoal-making offers a livelihood where there are good transport networks and demand from a large human population, and that road network expansion could also drive the distribution of charcoal making activities.

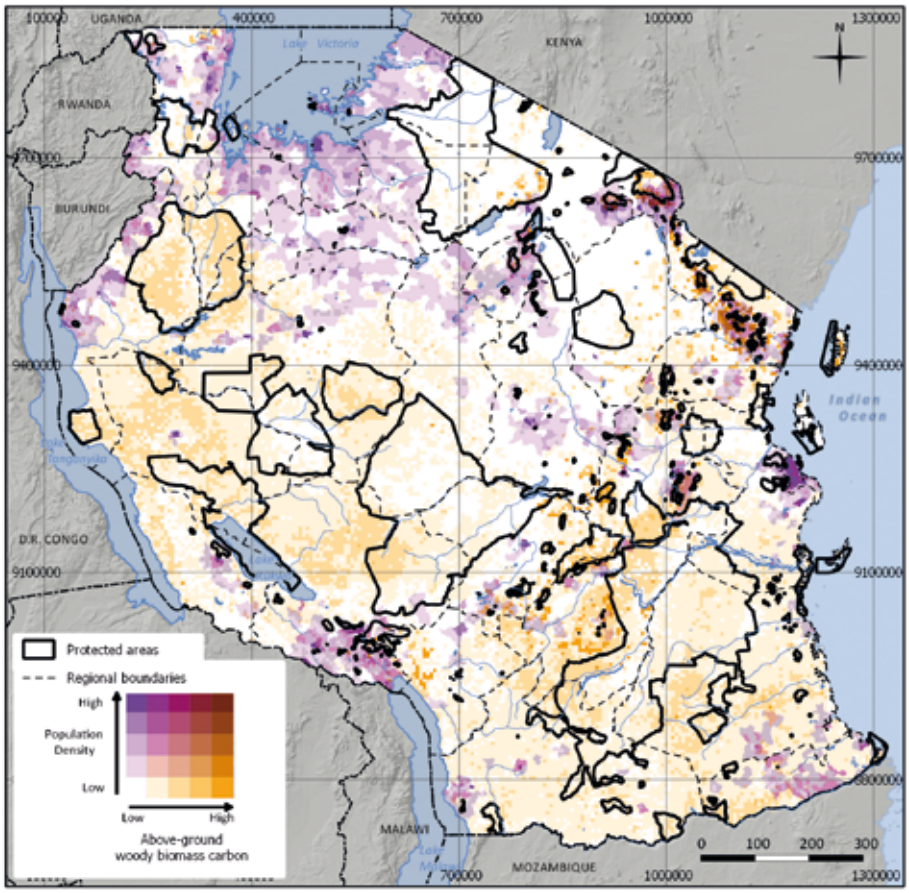
Understanding the spatial pattern of charcoal-making activities can help target REDD+ activities to increase employment opportunities, promote forest conservation and efficient resource use to address this driver of forest degradation. The Tanzania REDD+ Action Plan outlines strategic actions to address charcoal making, including: conducting training and investing in improved charcoal making technologies; investing in sustainable forest-based enterprises to create more employment opportunities, especially for marginalized groups; diversifying energy sources other than traditional biomass; and promoting forest conservation.

[9] The National Bureau of Statistics has released the population count per ward, but not yet the spatial dataset of the census tracts. Maps 16 and 17 have therefore been constructed by applying the 2012 census results to the spatial polygons of the census tracts of the year 2002 population census. It is possible that these polygons have changed somewhat between the 2002 and 2012 population census, in which case some of the values will be inaccurate. This map should be updated when the census tract polygons for the 2012 census are released.

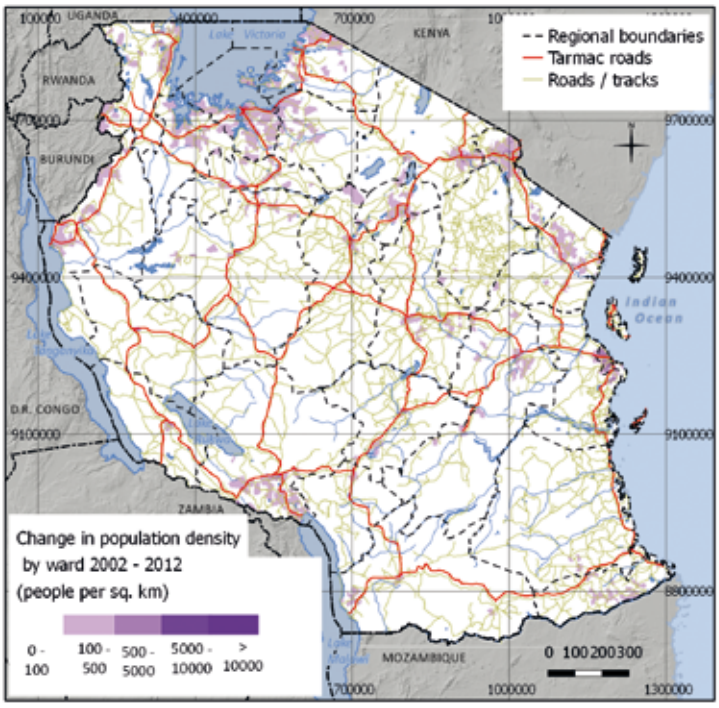
[10] This map has been prepared from the section of the NAFORMA inventory that recorded human impact on field plots in terms of disturbance or change in ecosystem composition, structure, or function. The NAFORMA biophysical survey measured 18 variables of human impact.

Map 16: Population and woody biomass carbon density

This map shows the relationship between population density and biomass carbon. Population density influences the quantity of need for forest products (especially biomass fuels) and related pressure on nearby forests. In areas where population is high and forest carbon is low (purple areas), woodlot establishment might be a useful strategy. Where carbon values are high and population pressure low (orange) measures to protect and sustainably manage the forest may be appropriate. There are very few areas where both carbon and population density is high (brown), but these areas may be important to investigate further to understand current trends and management.



Data sources:
Population density: National Bureau of Statistics (NBS) Tanzania. 2013. Census 2012. (Census data linked to 2002 ward boundaries).
Woody biomass carbon: NAFORMA. 2013. NAFORMA woody biomass only. 5km preliminary dataset based on field data.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Ward boundaries: Ministry of Lands, Housing and Human Settlements Development. 2002. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.



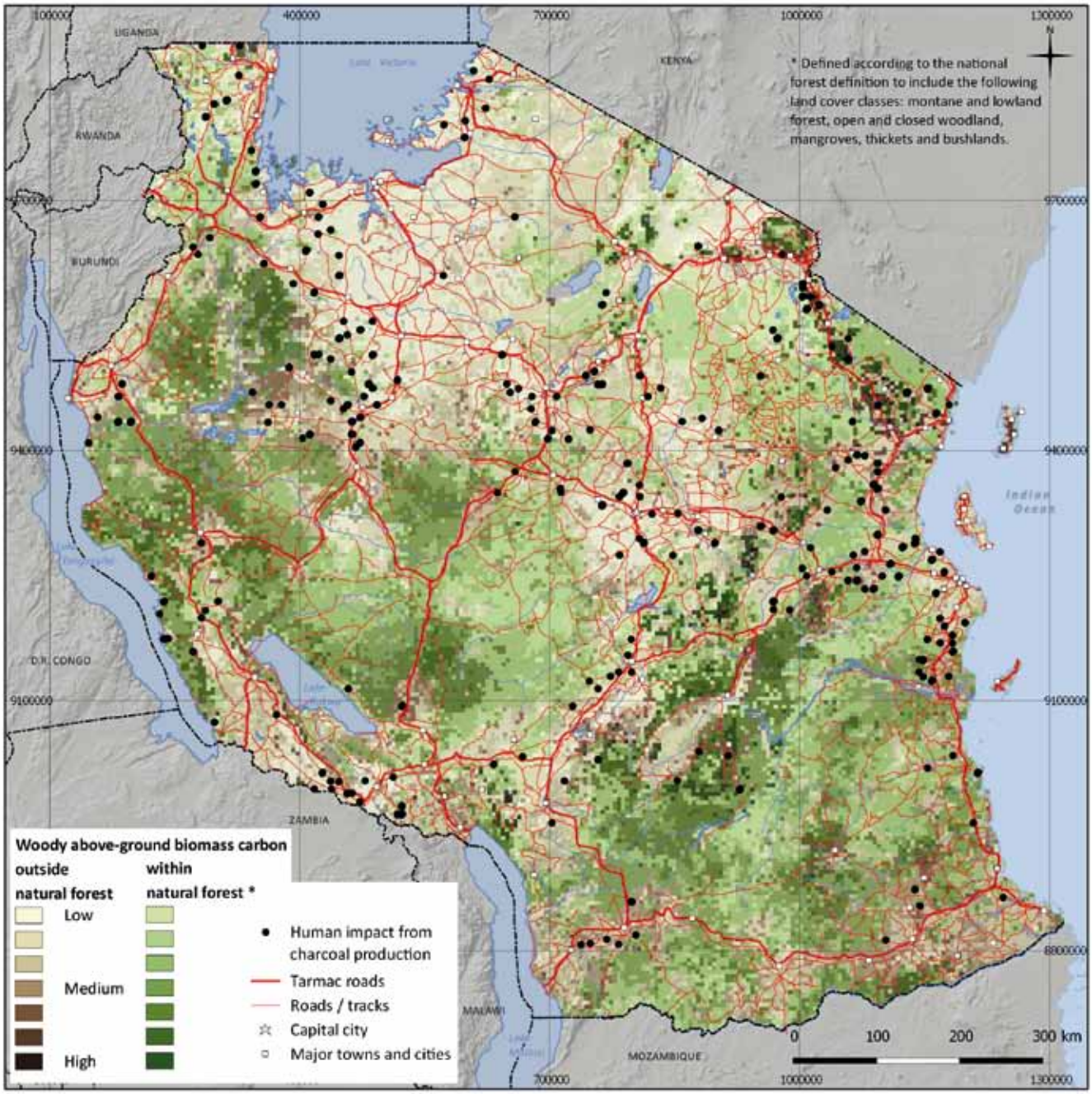
Map 17 (left): Change in population density in Tanzania between 2002 and 2012 (increase in persons per square kilometer)

Data sources:
Population density: National Bureau of Statistics (NBS) Tanzania. 2013. Census 2012. (Census data linked to 2002 ward boundaries).
Population density: National Bureau of Statistics (NBS) Tanzania. 2002. Census 2002. (Census data linked to 2002 ward boundaries).
Ward boundaries: Ministry of Lands, Housing and Human Settlements Development. 2002. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.
Roads: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC,FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013

Map 18: Plots where the NAFORMA field inventory has observed impact on the land from charcoal production

Charcoal production is a major driver of forest degradation in Tanzania, and the REDD+ Action Plan has identified a number of activities for addressing this problem, including diversifying energy sources and conducting trainings and investing in improved charcoal making technologies. Understanding the spatial distribution of charcoal production will help in targeting such interventions. The observed impact on land from charcoal production (black dots) appears to be closely correlated to the road network and proximity to population centres.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Human impact from Charcoal production: NAFORMA. 2013. NAFORMA biophysical survey 2013.Roads: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

2.6.3 Fire

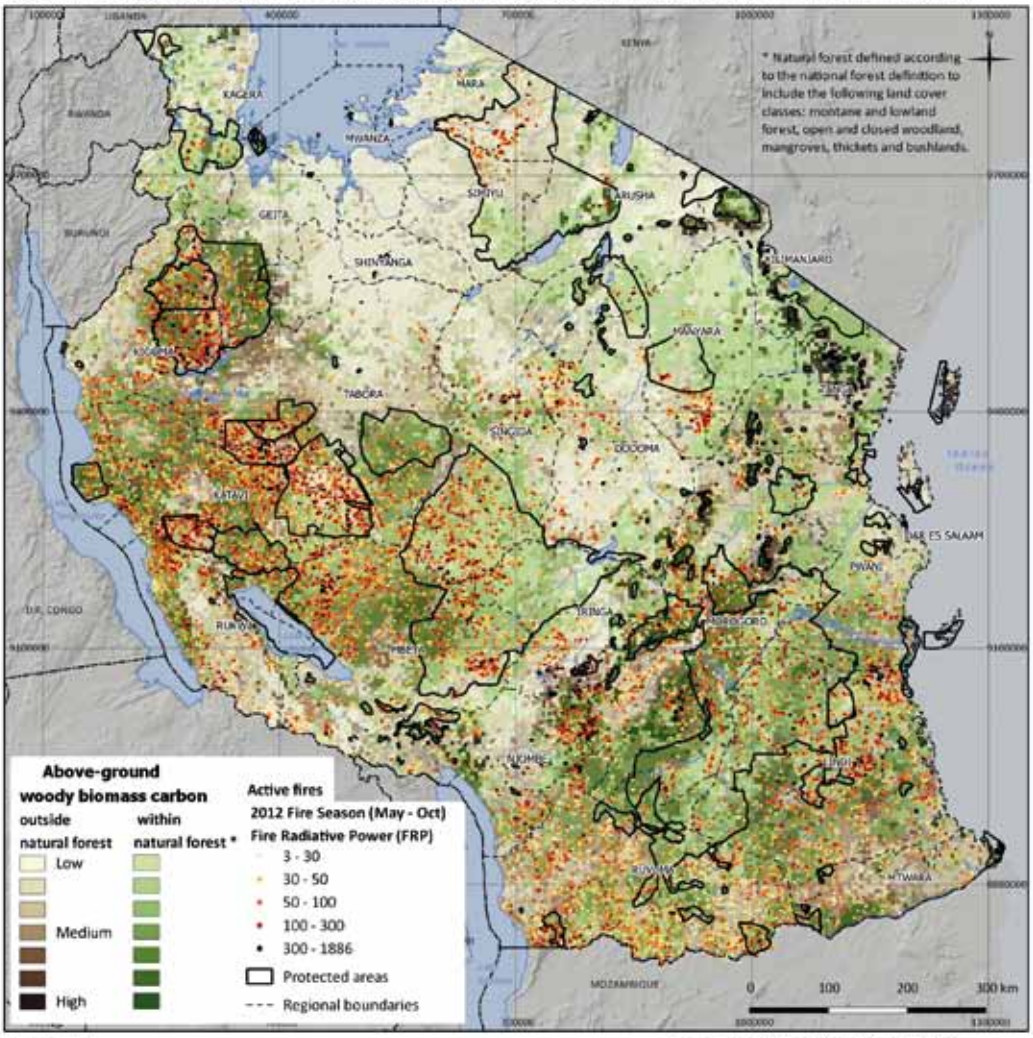
The uncontrolled spread of fires set by people has become a common phenomenon in the dry season, particularly in the miombo woodlands. Fires occur also in plantations and even in catchment forests, and have become a significant driver of forest degradation in Tanzania (Pfeifer et al. 2012). The main origins of uncontrolled fires include land preparation for shifting cultivation, collection of honey, charcoal making, burning of land to improve pasture growth for livestock, and pest control (Ministry of Natural Resources & Tourism 2001).

Map 19 shows the incidence of fire during 2012 in Tanzania, based on satellite estimates of radiant heat output from fire using the AMESD Modis Active Fire Product. Particularly high incidences of fire can be observed in the miombo woodlands in the western parts of the country. There are also significant amounts of fire in the south and central forest areas of Tanzania. The map shows that protected areas are also intensely exposed to fire in some places, as was seen in other studies looking at fire incidence over time (Pfeifer et al. 2012).

Map 19 can be useful for targeting policy measures to address forest fires. The REDD+ Action Plan aims to address forest fires by undertaking awareness campaigns for forest-dependent communities and law enforcers regarding the effects of fire on forest ecosystems, promoting appropriate beekeeping and charcoal-making practices, and conducting training on alternative methods of clearing farmland.

Map 19: Areas exposed to fire in 2012

Fire causes forest degradation in Tanzania as a result of human activities, and many natural forests and protected areas are affected by this problem. This map can facilitate spatial planning for actions to reduce fire incidence.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Active Fires: AMESD. 2012. Modis Active Fire product.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

3. Potential zones for implementing different REDD+ activities – some examples

Results-based REDD+ actions comprising the final phase of REDD+ will be linked to payments, and must contribute to climate change mitigation through forest-related activities. These could include *reduced deforestation* and *forest degradation, sustainable management of forests* and *conservation of forest carbon stocks,* which can help to lessen carbon dioxide emissions; and *enhancement of forest carbon stocks,* which can remove carbon dioxide from the atmosphere. While emissions reductions and carbon sequestration are the main goal, actions also need to contribute to a desirable development pathway for the country. As elaborated upon in Section I of this report, the purpose of REDD+ safeguards is to avoid REDD+ actions causing harm, and promote social and environmental benefits.

The National REDD+ Strategy for Tanzania identifies a number of strategic actions for addressing drivers of deforestation and forest degradation and thereby maintaining or enhancing forest carbon, while also respecting safeguards. Some examples are shown in Box 1.

- **Promote forest conservation**
- **Scale-up the Participatory Forest Management regime**
- **Support participatory land-use planning**
- **Invest in sustainable forest based enterprises for both timber and NTFP's**
- **Support the land-use planning commission to develop and implement national land use plans**
- **Establish and manage forest plantations/wood lots, agro-forestry for commercial use**
- **Promote establishment and management of woodlots at household level**
- **Promote planting and awareness raising of timber species**
- **Promote environmentally friendly wood utilization technologies**
- **Promote the use of lesser known and lesser utilized timber species**

Box 1: Examples of strategic actions identified by the Government of Tanzania to address drivers of deforestation and forest degradation through REDD+.

This section aims to demonstrate how mapping processes can be used to identify potential zones for implementation of Tanzania's strategic actions, through four example maps. These maps cover four categories for action:

1. Possible zones for maintaining existing forest and avoiding timber extraction
2. Possible zones for employing sustainable forest management techniques in production forest reserves
3. Possible zones for extending areas of community based forest management (CBFM)
4. Possible zones for REDD+ actions to rehabilitate forests

The maps can serve as an initial assessment of potential zones where certain REDD+ actions could be implemented. However site-scale spatial information is likely to be needed later in the planning process for detailed decisions on locations for REDD+ interventions. The maps could be improved with the addition of more refining parameters, and other maps could be developed for more strategic actions than the ones covered here, for example zones where plantations, woodlots or agro-forestry could be established.

Map 20

Identifying potential zones for REDD+ actions to maintain existing forest and avoid timber extraction (for example by enhancing forest conservation)

Relevant REDD+ activity/ies: *reduced deforestation* and *forest degradation; conservation of forest carbon stocks*

Examples of relevant strategic actions from the REDD+ Action Plan: Promote forest conservation

ABOUT THE MAP

This map can be used to identify where actions to maintain forest could provide the highest carbon benefits (forest areas with high current carbon stock will give higher benefits). In addition to carbon stocks, the following parameters could be taken into account in order to identify potential zones for maintaining existing forest and avoiding timber extraction: **importance for biodiversity and ecosystem services** (high existing values of biodiversity and ecosystem services would yield greater benefits if the forest was maintained, **see maps 6-10**); **current and expected future pressures on carbon stocks, biodiversity and ecosystem services** (higher pressure on the above values means that the risk of deforestation or forest degradation is higher, and therefore that the benefit of actions to maintain the forest will be higher. On the other hand, higher pressure will often mean that REDD+ implementation costs are greater. **See maps 16-19**). These maps will allow for an initial assessment of the potential for multiple benefits, and where specific actions are needed if the forest is to be maintained. It is important that the REDD+ activity that is selected to mitigate pressures is carried out in accordance with the REDD+ safeguards, e.g. without harm to local livelihoods, or displacing the pressure to other areas. Furthermore, areas of high cultural heritage value could be prioritized, including sacred forests. Sacred forests are generally respected locally, but may need to be protected from external pressures. The NAFORMA inventory recorded 19 plots as having cultural heritage potential, but for planning purposes a more targeted survey of important cultural sites is likely to be necessary.

PROCESS

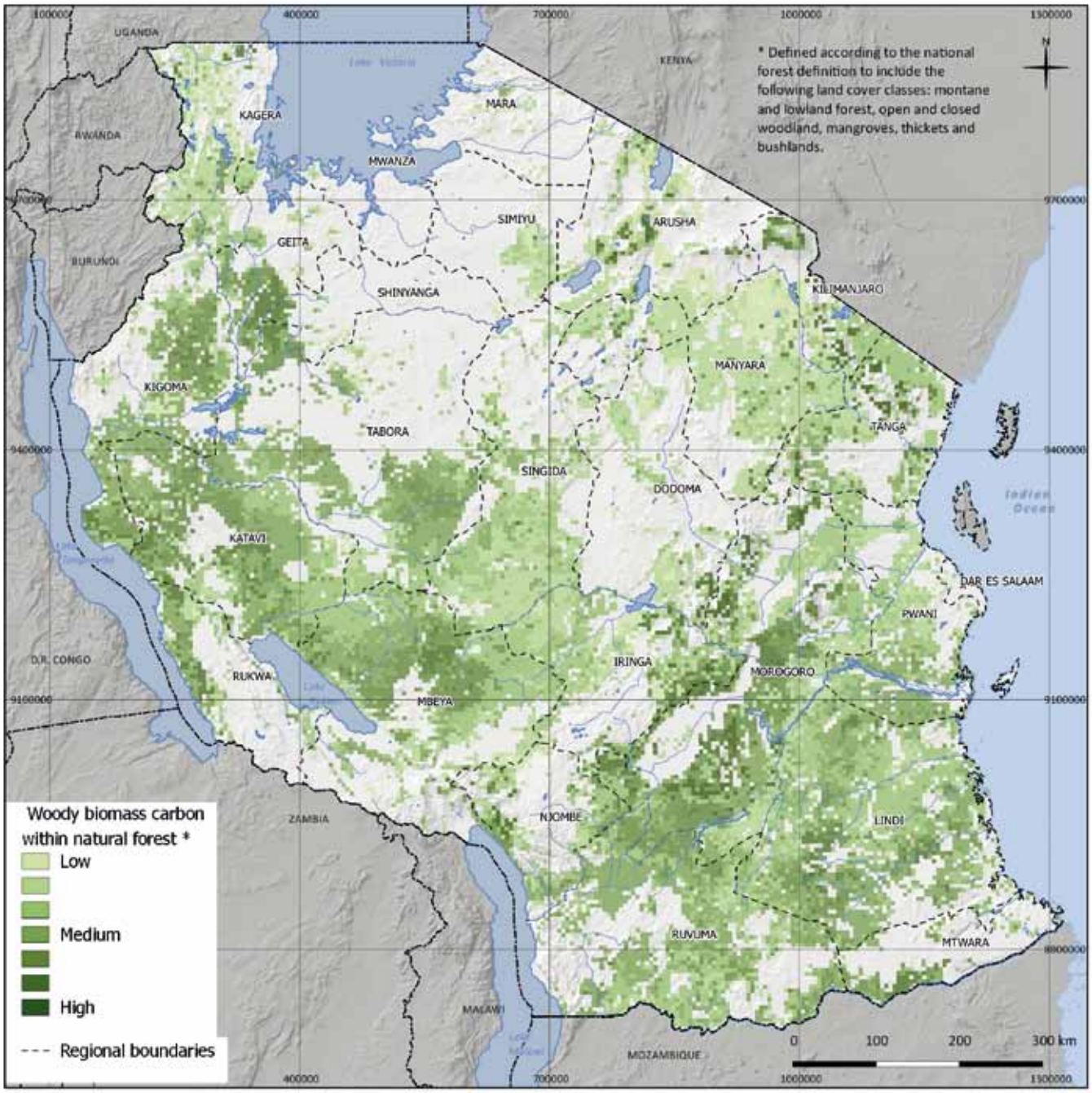
Map 20 was constructed as follows:

1. Natural forest (including thickets and bushlands) was selected from the NAFORMA land-use land-cover map. All other areas were blanked out.

2. Carbon values were assigned to the natural forest from the NAFORMA woody biomass carbon map.

Map 20: Potential zones for REDD+ actions to maintain existing forest and avoid forest degradation

This map shows natural forest with trees of a greater height than 2 m. A diverse set of REDD+ actions can be applied to maintain existing forest, and appropriate approaches will depend on local circumstances. High levels of carbon stocks will yield the greatest carbon benefits, which is the basic consideration of REDD+. However, actions to maintain existing forest can also yield numerous multiple benefits, such as protection of biodiversity and ecosystem services. This map can be complemented with spatial data relevant to the additional benefits desired from REDD+, to identify areas where the greatest multiple benefits can be achieved.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013

Map 21

Identifying potential zones for REDD+ actions to extend areas of Community Based Forest Management (CBFM) for enhancing sustainable management of forests

Relevant REDD+ activity/ies: *sustainable management of forests*

Examples of relevant strategic actions from the REDD+ Action Plan: Scale-up Participatory Forest Management regime; promote establishment and management of woodlots at household level;

ABOUT THE MAP

Tanzania has implemented Participatory Forest Management (PFM) Programmes over many years (Ministry of Natural Resources & Tourism 2006), with the intention of integrating communities into forest management and addressing some of the critical forest governance issues concerning deforestation and forest degradation (Tanzania Vice President's Office 2013b). PFM is therefore considered a central approach for ensuring sustainable management and conservation of Tanzania's forests, and the scaling up of PFM, including through Community Based Forest management (CBFM), is a strategic action in Tanzania's REDD+ Strategy.

Where CBFM is currently implemented, forests are owned and managed (using a management plan) by a village government through a Village Natural Resources Committee. By 2008, the area reported under CBFM was 2 345 000 ha, which represents 11.6 per cent of unreserved forests (wards where CBFM has been implemented are indicated on map 21). The REDD+ Strategy notes that the current pace under which CBFM projects are established is very low, and that access to REDD+ finance through fund-based financing arrangements could facilitate and speed up this process and possibly reduce the high levels of deforestation and forest degradation (Tanzania Vice President's Office 2013a). Improvement of governance at the local level that can facilitate sustainable CBFM is needed, as the village institutions need capacity development in planning, mobilization, finance management, good governance, and lobbying (Tanzania Vice President's Office 2013a).

Map 21 shows forests on village land, where CBFM could be possible. Wards where CBFM is already being implemented are indicated through point locations, but more detailed spatial information of what forest land is currently under CBFM would be helpful for planning purposes. Information about **carbon stocks** can inform what kinds of actions could be included in land management plans from a climate change mitigation perspective (whether forest restoration or regeneration is needed, or carbon stocks are still high). E**cosystem services, including potential for forest based livelihoods** will need to be taken into account in land management plans (high existing values of non-timber forest products would yield greater benefits if the forest was maintained). The Tanzania REDD+ Action Plan defines a strategic action for investment in sustainable forest-based enterprises for both timber and NTFPs. For example, sustainable forest based enterprises could potentially include ecotourism in some areas. It could also be important to consider where there are other land uses planned, including concessions for large-scale commercial purposes. Naturally, development of CBFM plans need to be based on local data. The purpose of Map 21 is to illustrate the potential for CBFM in Tanzania, by mapping the amount of forest on village land and the relative woody biomass carbon values of this forest.

Implementation of CBFM should ensure transparent and democratic systems of information, knowledge sharing and governance, with conscious efforts to reach community members beyond the forest management committees (particularly the poor and marginalised). This may require more human and financial resources than those allocated if only work with forest committees is envisioned (Vyamana 2009; Blomley et al. 2011). In the context of a seriously degraded forest resource, where it may take years for the resource to be rehabilitated, direct employment of village guards, providing income and employment to poorer members of the community, could be considered until such time as the forest is able to generate revenues (for village development funds).

Additionally, it is important to consider how benefits are shared within communities to avoid the risk of poorer or more marginalized members of a given community losing out from the direct benefits, forest product harvesting rights and revenues of CBFM.

PROCESS

Map 21 was constructed as follows:

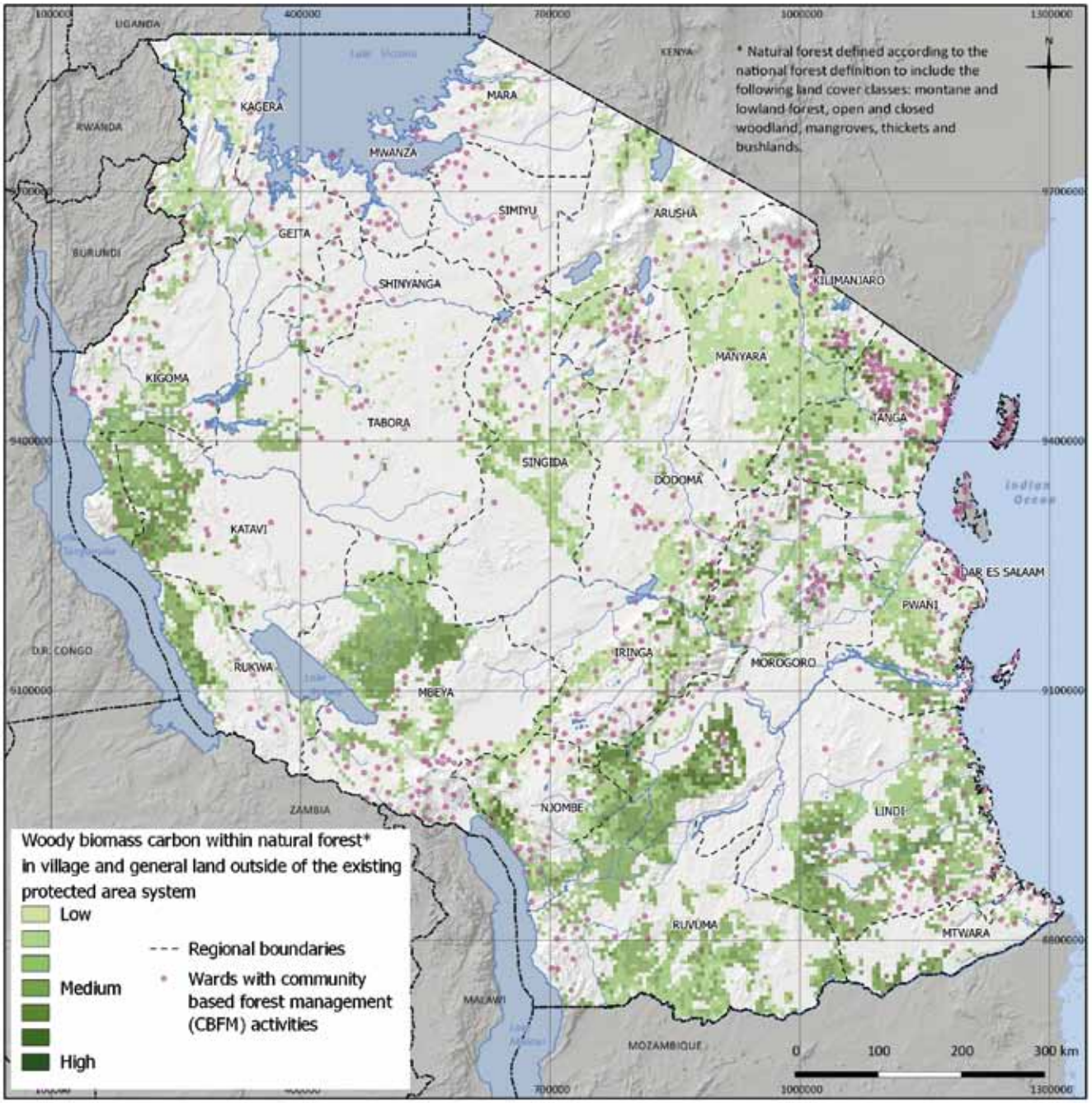
1. Natural forest (including thickets and bushlands) was selected from the NAFORMA land-use land-cover map. All other areas were blanked out.

2. Village and general land were displayed by blanking out reserved forest land (forest reserves and other protected areas), as this is land that is owned and managed by either central or local government. Remaining land should be largely village and general land (a definitive map of land designations was not available for constructing this map).

3. Carbon stocks were assigned to the village and general land, from the NAFORMA woody biomass carbon map.

Map 21: Potential zones for REDD+ actions to extend areas of Community Based Forest Management (CBFM) to enhance sustainable management of forests

This map shows areas of natural forest on village or general land. Points indicate wards that have existing (as of 2008) Community Based Forest Management (CBFM) activities. Scaling up the Participatory Forest Management Regime is part of Tanzania's REDD+ Action Plan. Participatory Forest Management is considered by the government to be a central approach for ensuring sustainable management and conservation of Tanzania's forests.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

Map 22

Identifying potential zones for REDD+ action to enhance sustainable management of forest in production forest reserves

Relevant REDD+ activity/ies: *sustainable management of forests*

Examples of relevant strategic actions from the REDD+ Action Plan: Establish and manage of forest plantations/ wood lots, agro-forestry for commercial use; promote planting and awareness raising of timber species; promote the use of lesser known and lesser utilized timber species

Actions to promote sustainable management of forests under REDD+ can only bring carbon benefits if they are implemented in forests that would otherwise be used in an unsustainable way. Some production forest reserves in Tanzania are suffering from deforestation or forest degradation from different drivers, and improved management could ensure that loss of natural forest is avoided. Selection of production forest reserves where efforts could be made to improve management could start from Map 22 and take into consideration **carbon stocks** as shown on the map, **level of current degradation, and biodiversity and ecosystem services values** (maps 6-10). Adding information about **pressures on forest resources** (**see maps 16-19** for some examples) could provide some indication as to which production forest reserves are more likely to suffer from deforestation and forest degradation in the future if management efforts do not prevent these drivers.

Map 22 can thus provide a starting point for understanding where efforts could be targeted to introduce or enhance techniques for sustainable forest management in production forest reserves. The Tanzania REDD+ Action Plan defines several actions that can be considered in a framework for managing forests sustainably, including: investment in sustainable forest-based enterprises for both timber and NTFPs, promotion of environmentally friendly wood utilization technologies, and promotion of the use of lesser known and lesser utilized timber species. If this map is brought together with data layers that indicate **biodiversity and ecosystem services values** (**maps 6-10** provide some examples of relevant data), the potential for multiple benefits can be assessed.

PROCESS

Map 22 was constructed as follows:

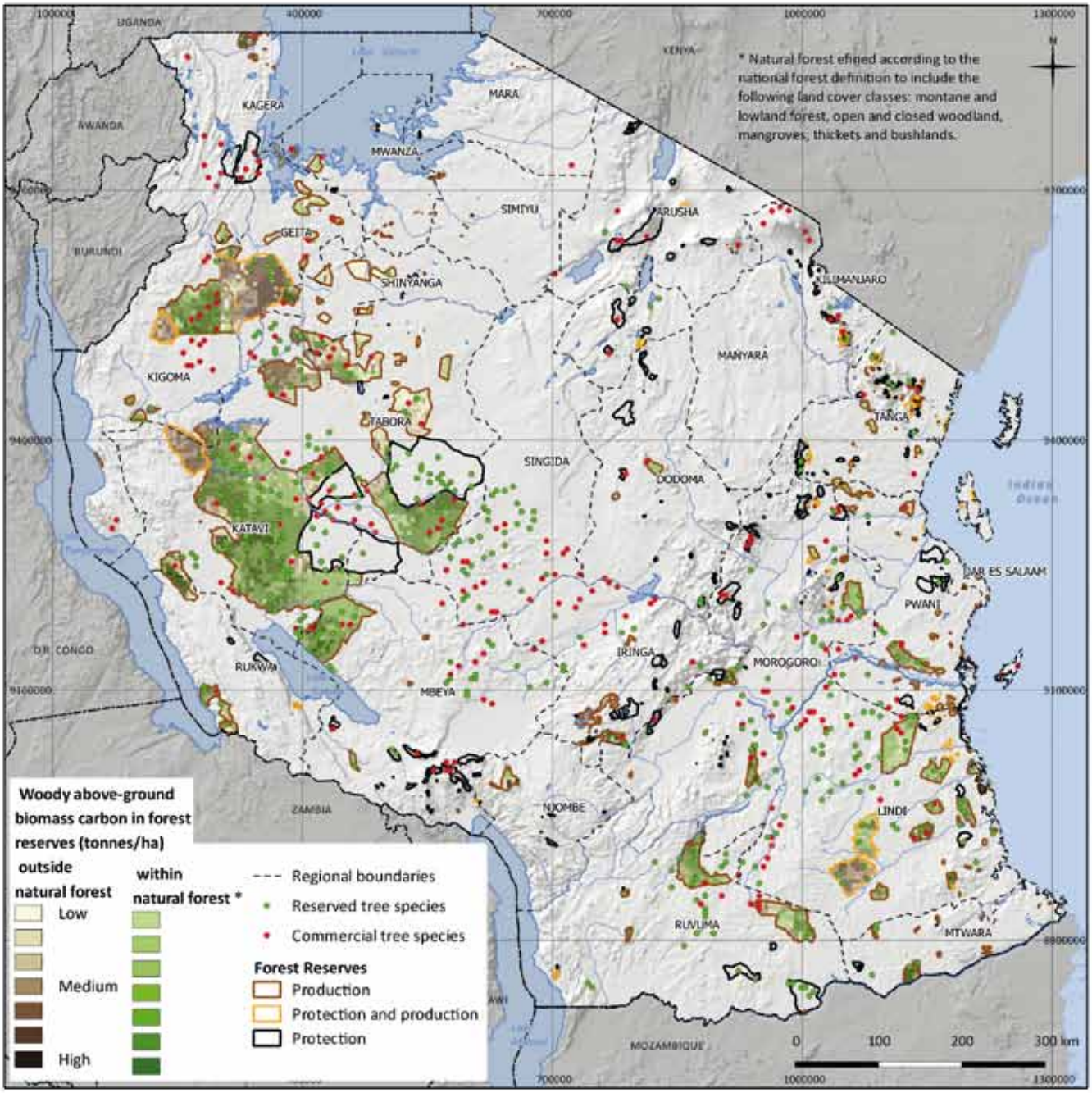
1. Forest areas (including thickets and bushlands) were selected from the NAFORMA land-use land-cover map. All other areas were blanked out.

2. Protected areas (forest reserves with protection status and other protected areas) were blanked out, as logging and other extractive activities are not permitted in such areas. Remaining areas are (a) within production forest reserves, defined by the Forest Act of 2002 as “an area of land covered by forest reserved or used principally for purposes of sustainable production of timber and other forest produce”, and (b) forests on village or general land. Forests on village or general land were subsequently blanked out.

3. From the NAFORMA woody biomass carbon map, carbon stocks were assigned to the forest land on this map.

Map 22: Potential zones for REDD+ action to enhance sustainable management of forest in production forest reserves

This map shows woody biomass carbon stocks inside production forest reserves. Numerous production forest reserves are suffering from forest degradation, and would benefit from improved forest management. The Tanzania REDD+ Action Plan defines allocation of sufficient funds for management of forest reserves at all levels as a strategic action. Sustainable management of forests as a REDD+ activity is often assumed to refer to refers to management strategies that allow timber extraction on a sustainable level that does not lead to forest degradation. Carbon benefits are likely to be greatest where carbon stocks are high, but the importance of the forest for livelihoods and biodiversity or ecosystem services can also be factors that influence the decision. The red and green dots on the map indicate where the NAFORMA inventory observed trees of particularly valuable timber species. Logging or trading reserved species requires a special permit from the government.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Forest reserves: Tanzanian Forest Service. 2013. Forest Reserves of Tanzania.
Protected areas: IUCN and UNEP-WCMC. 2013. The World Database on Protected Areas (WDPA) Cambridge, UK. Available at: www.protectedplanet.net.
Reserved and commercial tree species: NAFORMA. 2013. NAFORMA biophysical survey 2013.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

Map 23

Identifying potential zones for REDD+ action to rehabilitate forests

Relevant REDD+ activity/ies: *Enhancement of carbon stocks*

Examples of relevant strategic actions from the REDD+ Action Plan: To mobilize funding for forest resources management

Forest rehabilitation can be defined in different ways. Here, the concept is used in the sense of re-establishment of forest cover on degraded forest land, with the aim to restore biomass and to some degree the biodiversity and ecological functions that were originally present. From a carbon stock perspective, forest rehabilitation has the highest potential benefit where carbon stocks are low. However, efforts to rehabilitate forests may be in vain if the forests that are restored are soon degraded or deforested again. Therefore, such actions may be most feasible in areas that are also under some level of protection or effective forest management. On Map 23, protected areas are highlighted, and carbon stocks indicated inside and outside forest land. Data on past deforestation and forest degradation would be relevant to add to this map, when it becomes available. Approaches to forest rehabilitation should be selected based on (i) feasibility, e.g. the local conditions of soil and vegetation, including the status of the soil, and (ii) the effects of the selected approach on biodiversity and ecosystem services (see Miles et al. 2010) Competing land uses may also need to be taken into account.

Forest rehabilitation could yield multiple benefits in the form of enhanced habitat for biodiversity, increased provisioning of ecosystem services such as water regulation, and livelihood opportunities. For example, catchment forests are particularly **important for water regulation**, and have strong protection status in Tanzania, but still suffer from forest degradation, including from **fires** (see **Maps 12** (contribution of forests to soil erosion prevention) **and 19** (land exposed to fires)). Such forest areas may be particularly suitable for forest rehabilitation. Areas with high **biodiversity**, or areas of importance for **movements of different species**, may yield high benefits for biodiversity if restored (see **Maps 6-10**, where Map 10 shows the location of wildlife corridors).

In Map 23, carbon stocks on land outside of current forest land are highlighted in brown. Some areas within these zones may be suitable for forest rehabilitation, while other areas have other preferred land uses, such as agriculture.

The REDD+ Strategy discusses the potential for landscape restoration in Tanzania, and concludes, based on studies, that *"natural regeneration through active involvement of local communities, promoted under PFM and supported by the new forestry legislation and programme, is by far the most promising option for restoration of the large areas of degraded land in Tanzania".* The Strategy further notes that successful forest landscape restoration needs to have active involvement of communities; with their interests, local knowledge and practices taken into account (Tanzania Vice President's Office 2013a). Existing policies and legislation for most sectors take this into consideration, putting in place the necessary enabling environment for restoration of degraded lands.

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Map 23 was constructed as follows:

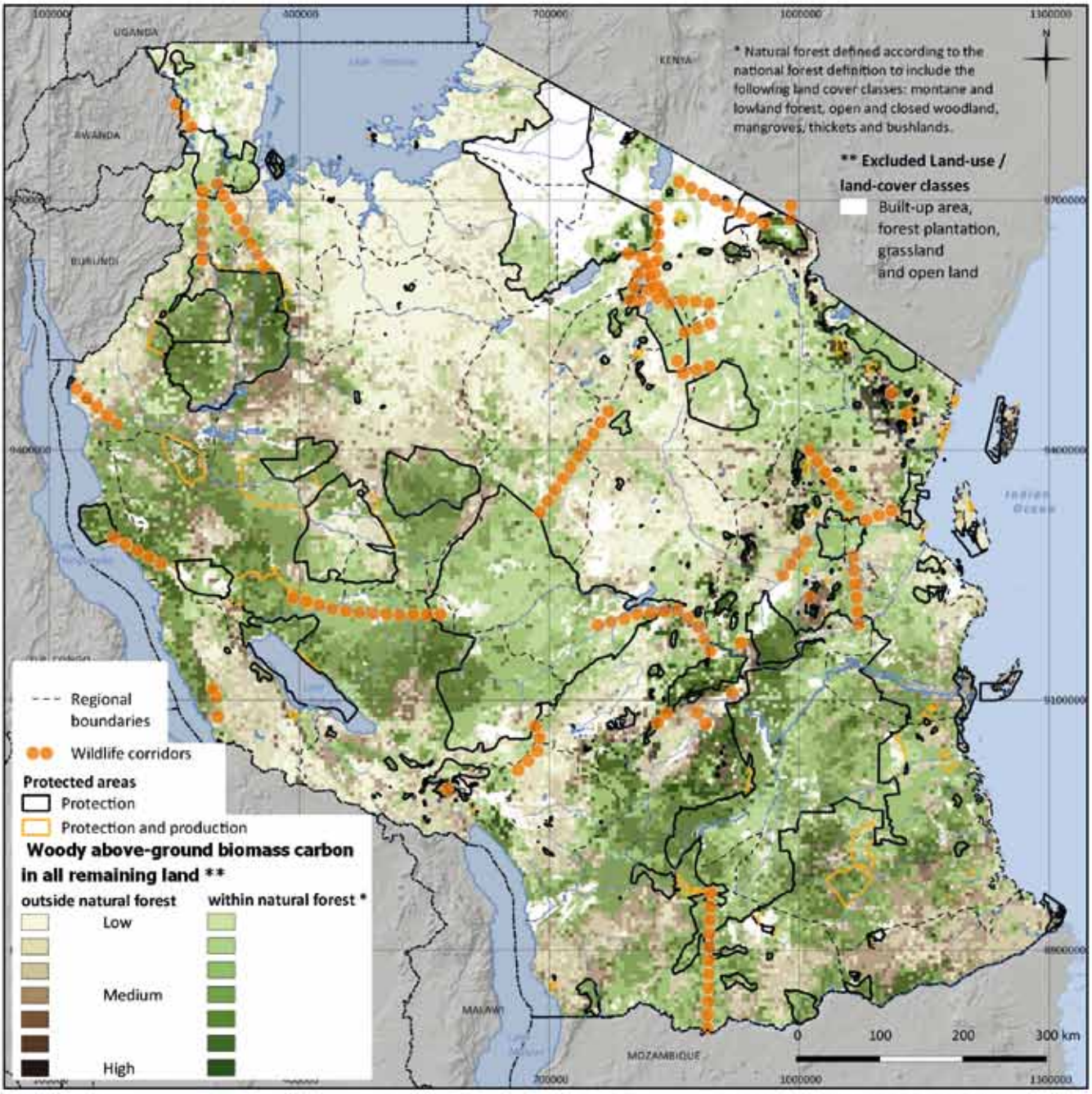
1. Built up areas, forest plantations, open land and grasslands were blanked out from the NAFORMA land-use land-cover map, as these were assumed to be unavailable for forest rehabilitation activities.

2. From the NAFORMA woody biomass carbon map, carbon stocks were assigned to all remaining land, with carbon stocks on natural forest land (including thickets and bushlands) indicated in green, and carbon stocks on other land indicated in brown.

3. Protected areas (including forest reserves with protection status, defined in the Forest Act of 2002 as "land covered by forest reserved or used principally for the purposes of protection of water sheds, soil conservation and the protection of wild plants") were highlighted.

Map 23: Potential zones for REDD+ action to rehabilitate forests

This map excludes built up areas, forest plantations, grasslands and open land, assuming that these are generally not available for forest restoration activities. Forest restoration activities can be worthwhile where the forest has been degraded or removed, but where previous values and functions of the forest can be restored, including enhancement of carbon stocks. For example, wildlife corridors that have degraded through expansion of human activities may be of priority for restoration. Areas that have been degraded through unsustainable wood extraction but where the forest remains important for livelihoods and/or ecosystem services such as water regulation may also be of priority. It may make more sense to rehabilitate forests in areas where there is a strong management regime, to avoid that they will be quickly degraded again.



Data sources:
Natural forest: NAFORMA. 2013. NAFORMA land-use / land-cover Map 2010.
Woody biomass carbon: NAFORMA. 2013. NAFORMA Woody biomass only. 5km preliminary dataset based on field data.
Regional boundaries: Ministry of Lands, Housing and Human Settlements Development. 2011. Administration Map of Tanzania. Surveys and Mapping Division, Dar es Salaam Tanzania.
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Wildlife corridors: based on information provided at tzwildlifecorridors.org. Accessed May 2013.

Map projection: WGS84 / UTM Zone 36S
Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI).
Date: May 2013

4. Conclusions and outlook

Safeguards and associated multiple benefits need to be considered explicitly in all stages of national planning for REDD+. Tanzania has completed the initial steps of drafting a REDD+ Strategy, Action Plan and national REDD+ safeguards. The REDD+ Strategy sets an ambition for REDD+ to achieve multiple benefits, and makes provisions for a safeguards information system that includes spatial data to be included in the country's MRV system. The REDD+ Action Plan includes an activity to develop methods for REDD+ co-benefits mapping, to which this report makes a major contribution. The draft national REDD+ safeguards document affirms that REDD+ activities are [to be] designed to maintain and enhance biodiversity, ecosystem services and to meet forest dependent community needs, and that possible impacts on biodiversity and other ecosystem services are [to be] analyzed when considering options for REDD+ actions.

The maps and analyses in this report aim to support decisions on where REDD+ can be undertaken, and identification of potential actions for achieving multiple benefits from REDD+. They provide spatial information that can be used to facilitate consideration of the environmental components of Tanzania's draft REDD+ safeguards. Box 2 provides examples of how the different maps developed link to specific safeguards criteria.

The maps in this report can help to identify how biodiversity and ecosystem services relate spatially to drivers of deforestation, as well as to current land-use designations. The maps could also be used in other land-use planning processes at the national scale. Together with additional relevant information, they can support discussions and decision making in an integrated sectoral planning process, including for monitoring and evaluation of land-use planning, as called for in the REDD+ Action Plan.

Some of the spatial information presented here could also be used as input to defining indicators in a safeguards monitoring plan for Tanzania. Guidelines for the development of such a monitoring plan are outlined in Annex 4 of the draft REDD+ safeguards document (June 2013). The guidelines state that a monitoring plan will be prepared, which will define: the specific information to be collected; where such information can be found; how it will be gathered and analyzed; and who will be responsible. Furthermore, the guidelines state that a facilitation team and a standards committee should agree on which indicators should be assessed at a particular assessment period. The facilitation team and a consultant should try as much as possible to collect primary data provided this can be done properly and effectively. Where reliable sources already exist, these should be used in the interests of cost effectiveness. The facilitation team should prepare a draft report of the performance of the REDD+ programme for each of the indicators in the REDD+ safeguards.

Safeguards Criterion 7.1: The REDD+ initiative analyses the possible impacts on biodiversity and other ecosystem services when considering options for REDD+ actions, and:
Safeguards Criterion 7.2: The REDD+ initiative maintains and enhances the conservation of biodiversity and other ecosystem services and considering the needs of forest dependent communities and appropriate management and utilization methods.
Maps 6-10 illustrate areas of high species diversity, including threatened species, and wildlife corridors that constitute key habitat for biodiversity. Maps 19-23 and associated text illustrate example decision processes for allocating areas for REDD+ interventions, and discusses how biodiversity and ecosystem services can be considered in the process.

Safeguards Criterion 7.3: The REDD+ program protects natural forests from degradation and conversion to other land uses including forest plantations.
Map 5 shows the distribution of natural forest in Tanzania according to two relevant definitions of natural forest.

Safeguards Criterion 7.4: The REDD+ Program ensures restoration of degraded areas using indigenous species.
Map 22 and associated text discusses the process of forest rehabilitation.

Box 2: Examples of maps which link to specific safeguards criteria in Tanzania's draft REDD+ safeguards document

The maps in this report can contribute to this process by helping in the identification of priority aspects of environmental multiple benefits and safeguards, which can be discussed in the context of possible REDD+ actions. For example, wildlife corridors and threatened species are mapped in this report. Tanzania may find it important to monitor the impact of REDD+ activities on these wildlife corridors and threatened species, in addition to using their current spatial distribution to inform the location of REDD+ actions. The way in which REDD+ actions are implemented will have a great impact on the results, but identifying what benefits REDD+ could generate, and what risks need to be mitigated, is also an important initial step.

The maps in this report largely build on NAFORMA products, bringing in other datasets as necessary to provide a more comprehensive picture. The land-use land-cover map makes it possible to understand the likely distribution of natural forest, which is essential

for effective application of the REDD+ safeguards. NAFORMA's woody biomass map improves previous knowledge of carbon stocks in Tanzania. The NAFORMA biophysical field inventory provides information on the distribution of tree species in Tanzania, the types and distribution of human impacts on forest, and the potential for non-timber forest products. The socioeconomic survey provides information on people's use of forest products. These parameters can all be used in REDD+ planning to help ensure that REDD+ actions contribute to multiple benefits, and consider social and environmental risks, as outlined in Tanzania's draft REDD+ Safeguards document.

A number of additional maps and analyses could further improve the data available for REDD+ planning and monitoring in Tanzania. For example, themes not addressed in this document include key areas of **agricultural expansion** (including for **biofuels**), and other competing land uses. Mapping such areas would help expand the picture of current land uses and land-use plans in Tanzania, and inform the potential for REDD+ actions to complement developments in sectors other than forestry. The REDD+ Action Plan specifies strategic activities such as supporting **agricultural practices** that promote soil fertility, productivity and crop protection (**conservation agriculture**), and documenting and promoting existing best **agro-forestry** practices. It would be useful to explore further where such activities could appropriately be implemented. Similarly, it would be helpful to identify appropriate locations for the establishment of **woodlots and plantations**, potentially important for addressing some of drivers of deforestation and forest degradation in Tanzania, such as the high and growing demand for biomass based fuels.

Access to comprehensive maps showing the **locations of current sites for Community Based Forest Management (CBFM), Joint Forest Management (JFM) and village forest reserves** would be particularly useful for REDD+ planning, since such maps would allow for an understanding of which forest areas on village land have a management plan already, and which areas are still unregulated and suffering from insecure land tenure. One output in the REDD+ Action Plan concerns a database on ownership of forest related rights. Maps 13 and 21 show the location of wards that have PFM and CBFM activities, but more detailed spatial data on what forests are covered under management plans are not yet available.

Maps of alien and invasive species would also be useful in REDD+ planning, as these are among the drivers identified in the REDD+ Action Plan. In the case of invasive tree species, the NAFORMA data could be used to assess their current distribution, as a basis for developing a monitoring plan and for designing policies and actions to control them. Complementing data sources would be needed for other invasive species.

Furthermore, the REDD+ Strategy and Action Plan mention the need to support the development of a **livestock** strategy in the context of REDD+. Strategic interventions include implementation of effective plans for sustainable management of forest that enhance forage productivity under different forest management regimes. Specific actions include promotion of silvi-pastoral technology, implementation of rotational grazing, and dry season fodder production on private, communal and general lands. Further mapping exercises could look into potential zones for implementing such actions.

The maps in this report are intended for national level planning. Maps with the same or similar themes can be developed for sub-national planning, using appropriate data. Furthermore, subject to availability of appropriate input data, more sophisticated analyses could be undertaken using modelling or spatial planning software to estimate the carbon and co-benefits objectives that can be achieved by a proposed set of REDD+ actions.


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Annex I

What can NAFORMA survey results say about tree biodiversity in Tanzania?

The NAFORMA inventory is one of the biggest efforts made by any developing country to map its forest resources. It comprised over 32 000, 15m-radius plots grouped into L-shaped clusters of between 6 and 10 plots. The survey was designed to provide an assessment of the country's forest resources (extent, composition, condition, uses and other socioeconomic parameters). The carbon stocks can be easily derived from the NAFORMA results.

The NAFORMA survey recorded 1 229 species, which includes 67% of the species listed in the NAFORMA species checklist (983 species) and an additional 246 species not contained within this original expected species list. A total of 33% of the species on the checklist were not found in the plots. In addition, 89 taxa were recorded but only identified to genus level. Of these 89, 31 were not on the original check list.

The NAFORMA species checklist will be revised to reflect the latest knowledge, including the findings of the inventory, which will involve adding the 246 species and 31 genera. Tanzania is a biodiverse country so the plot sampling area of just over 700 m^2 for each plot may not have picked up all species present within the area around the sample site, especially in the more species-rich forest types.

Within each NAFORMA plot, the vegetation type was recorded. It is therefore possible to investigate how the species richness of NAFORMA plots varies between different types of vegetation. Results show that the total number of species recorded in a vegetation type increased with the number of plots surveyed for that vegetation type (Fig. 2). For all vegetation types, additional species continued to be found in new plots; showing that NAFORMA sampling was insufficient to record total species richness. This is particularly true for humid and lowland forests, and helps explain why fewer species were recorded in the NAFORMA inventory from lowland and humid montane forest than from open and closed woodland, where there was a lot more sampling and better sampling of overall diversity.

An alternative way of assessing the relative species richness of the different vegetation types uses the average number of species found per plot in each of the vegetation types (Fig. 2). The average number of species per plot varied between vegetation types, with more species being found in forested and wooded plots than cultivated ones. However, since the NAFORMA inventory does not fully register the tree species richness pattern in most vegetation types (Fig. 2), it is not possible to simply extrapolate from the average plot richness to the total richness of the vegetation types. It should also be noted that the number of species identified in a plot may have been influenced by differences in the difficulty of species identification between vegetation types, and differences in the familiarity of the field workers with the species (some rare species may be mistaken for more common ones, for example[11]). The relative distribution of local-level, plot-scale, tree species richness is presented in Map 6, which shows that the highest localised tree species richness were in areas of forested and wooded land.

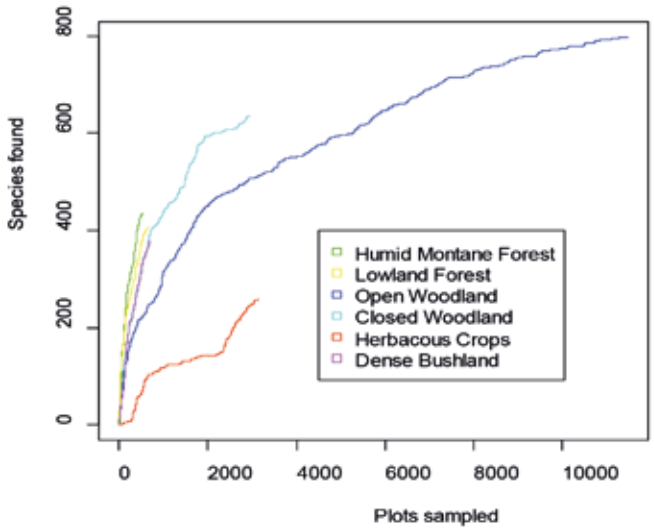

Figure 1: Cumulative number of species found in selected vegetation types as more plots were sampled. If this curve flattened out it would indicate that the survey has recorded most of the richness in that vegetation type. As the figure shows, the curve of the humid montane forest is the steepest, showing that if more plots were sampled, many more species would have been found.

The NAFORMA data also contains information on species of particular conservation importance including: species that are a) only found in (endemic to) the Eastern Arc Mountains of Tanzania or b) threatened with extinction according to the Eastern Africa Plant Red List Authority. Of the 52 tree species listed as endemic to the Eastern Arc Mountains (Burgess et al 2007), 8 were identified within the Eastern Arc area (in 1 639 NAFORMA inventory plots covering 116 ha across 264 clusters). Interestingly, 11 of the 52 Eastern Arc endemic species were picked up within the NAFORMA survey outside of the Eastern Arc area; suggesting that either some of these

[11] Ahrends, A., Rahbek, C., Bulling, M. T., Burgess, N. D., Platts, P. J., Lovett, J. C.,Marshall, A. R. (2011). Conservation and the botanist effect. *Biological Conservation*, 144(1), 131–140.

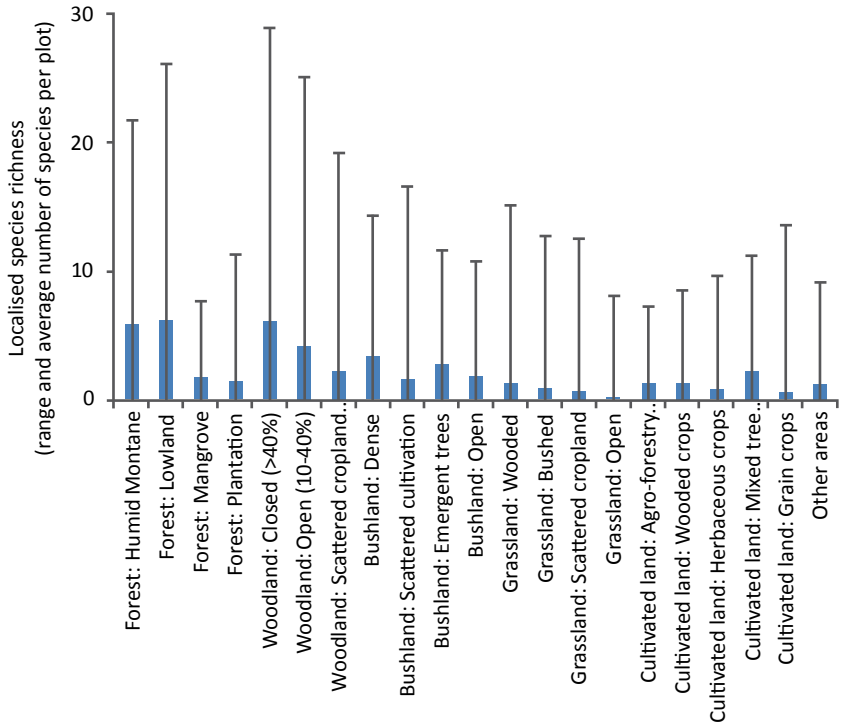

Figure 2: The average (mean) number of species found per plot for each of the vegetation types (blue bars), with the range in number of species shown as black lines.

species of conservation importance may have a wider distribution that was previously thought, or that the NAFORMA identifications need to be reassessed. Recent updated assessments of confirmed specimens suggest that three of the species are not strict endemics to the Eastern Arc; two occur in coastal areas and one in remote forest near northern part of Lake Tanganyika (Roy Gereau, pers. comm.).

In terms of threatened species, the NAFORMA inventory recorded 38 of 394 Tanzanian species listed as threatened by the Eastern Africa Plant Red List Authority (EAPRLA via Roy Gereau, pers. comm.). The humid montane forests had a particularly high number of threatened tree species (20) given the number of plots sampled (Table 2). Map 7 shows the location of clusters containing threatened tree species highlighting that they were mostly recorded within forest habitats, including humid montane forest.

Table 2: The number of threatened species found and plots surveyed within the NAFORMA vegetation types.

Vegetation cover	Number of threatened species recorded	Number of plots surveyed
Forest: Humid Montane	20	585
Forest: Lowland	13	868
Forest: Mangrove	0	119
Forest: Plantation	1	299
Woodland: Closed (>40%)	13	3 544
Woodland: Open (10-40%)	21	11 489
Woodland: Scattered cropland (unspecified density)	2	814
Bushland: Dense	8	831
Bushland: Scattered cultivation	1	480
Bushland: Open	6	1 159
Grassland: Wooded	4	1 662
Grassland: Scattered cropland	0	234
Grassland: Open	0	1 068
Cultivated land: Wooded crops	1	669
Cultivated land: Herbaceous crops	5	1 932
Cultivated land: Mixed tree cropping	3	81
Cultivated land: Grain crops	2	3 389
Other areas	4	720

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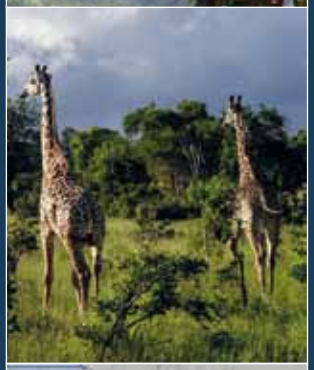

REDD+ has the potential to contribute to achieving more policy goals than climate mitigation alone. In Tanzania, REDD+ is expected to deliver multiple benefits, whose nature and extent will depend on the location and type of REDD+ activity implemented. These benefits include sustainable use of forest resources, biodiversity conservation, poverty alleviation, maintenance of forest dependent communities' rights, and improved community livelihoods. The REDD+ safeguards agreed under the United Nations Framework Convention on Climate Change are intended to guide REDD+ implementation to avoid adverse effects to people and the environment, and to ensure multiple benefits.

During the last years, the Tanzanian Forest Service has produced a unique set of forest, socioeconomic and governance related data and maps from 32 000 field inventory plots and interviews with 3500 households and 1100 key informants, which among other sources of data have been used for the production of analysis and maps in this publication.

Maps can help to increase understanding of the spatial distribution of such potential benefits, and support decision-making on where and how REDD+ might be implemented. The maps presented in this brochure were developed to support Tanzania's implementation of the REDD+ safeguards, and planning for multiple benefits from REDD+. Themes include natural forest, biodiversity, ecosystem services, drivers of deforestation and forest degradation, and potential zones for implementation of REDD+ activities.

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UN-REDD PROGRAMME

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