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.

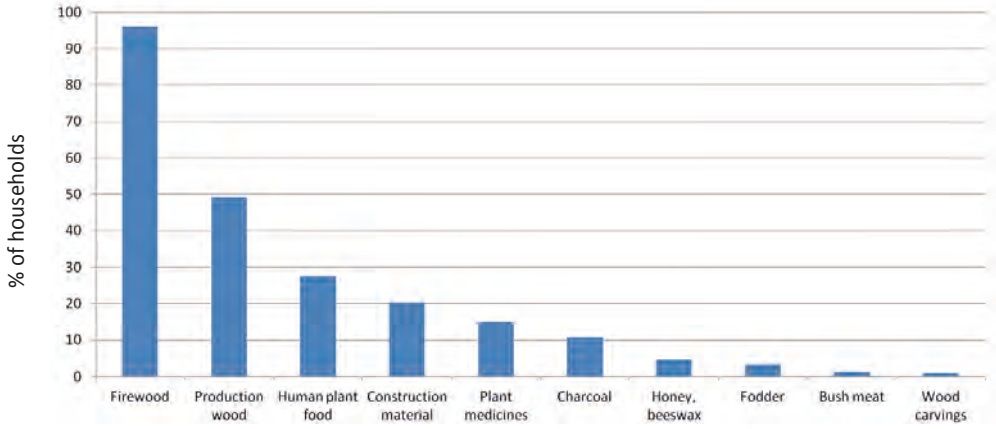
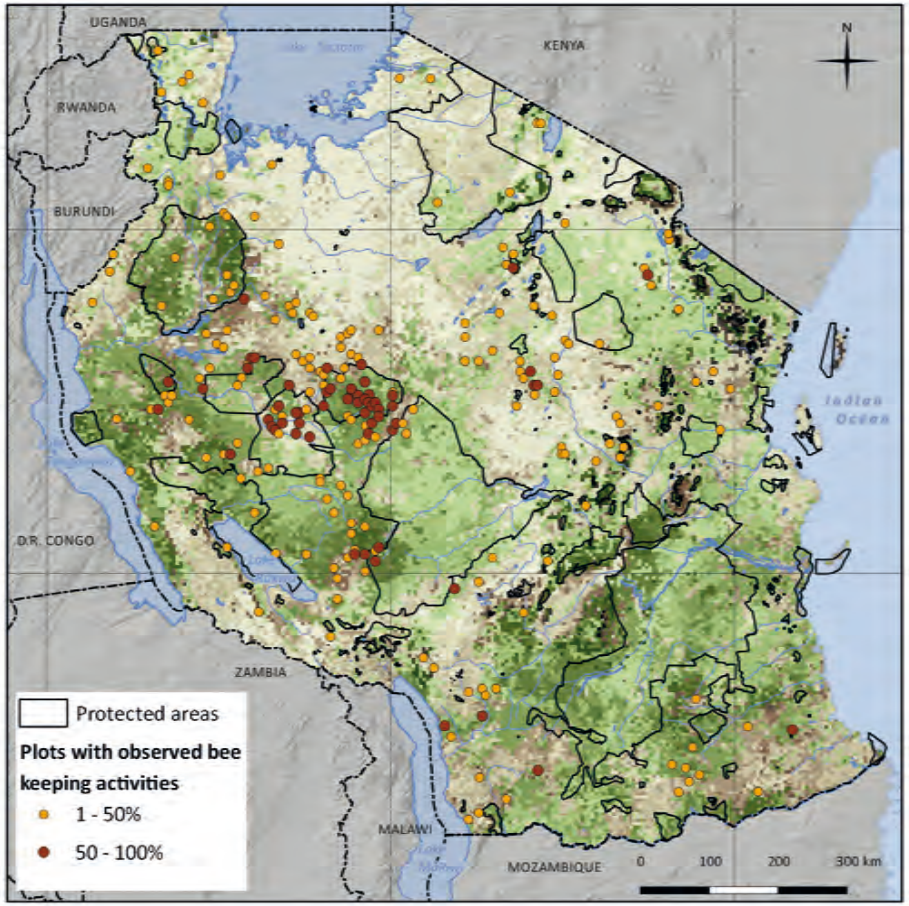
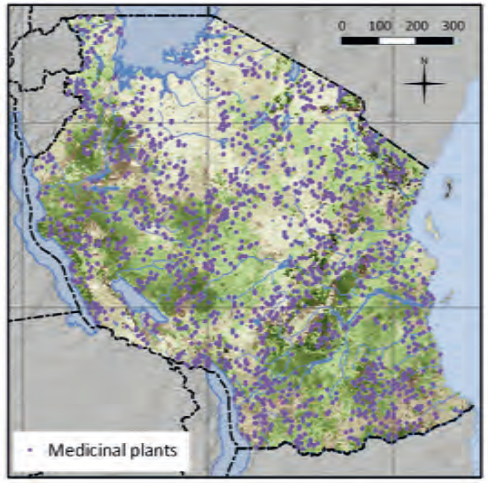


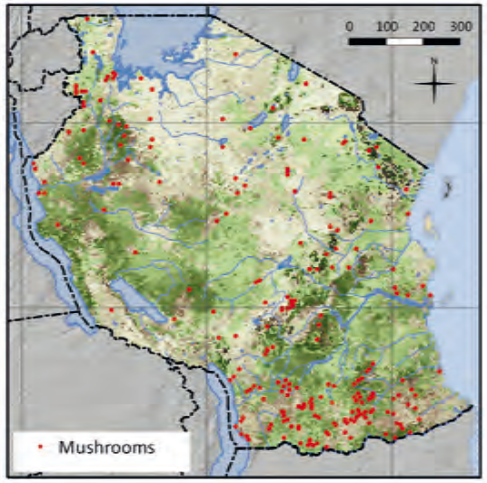
Figure 3: Top 10 tree and forest products reported to be used by households in the past 12 months by respondents to the NAFORMA socioeconomic survey.

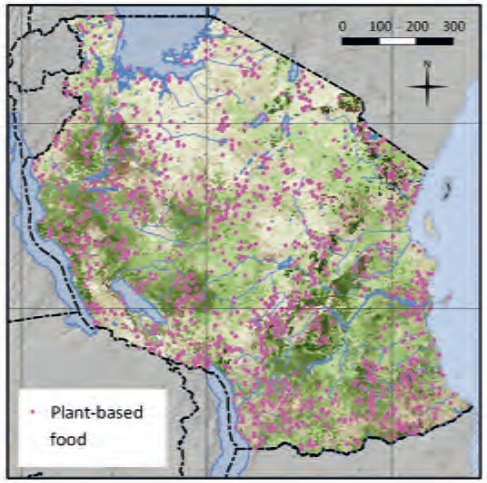
Map 11: Non-timber forest products observed in the plots of the NAFORMA biophysical survey

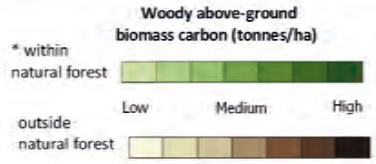
Non-timber forest products are important benefits that forest provides to the population of Tanzania. REDD+ activities could be designed to assist communities to sustainably extract subsistence or income sources from the forest, where possible. In Tanzania, beekeeping activities can be a sustainable 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

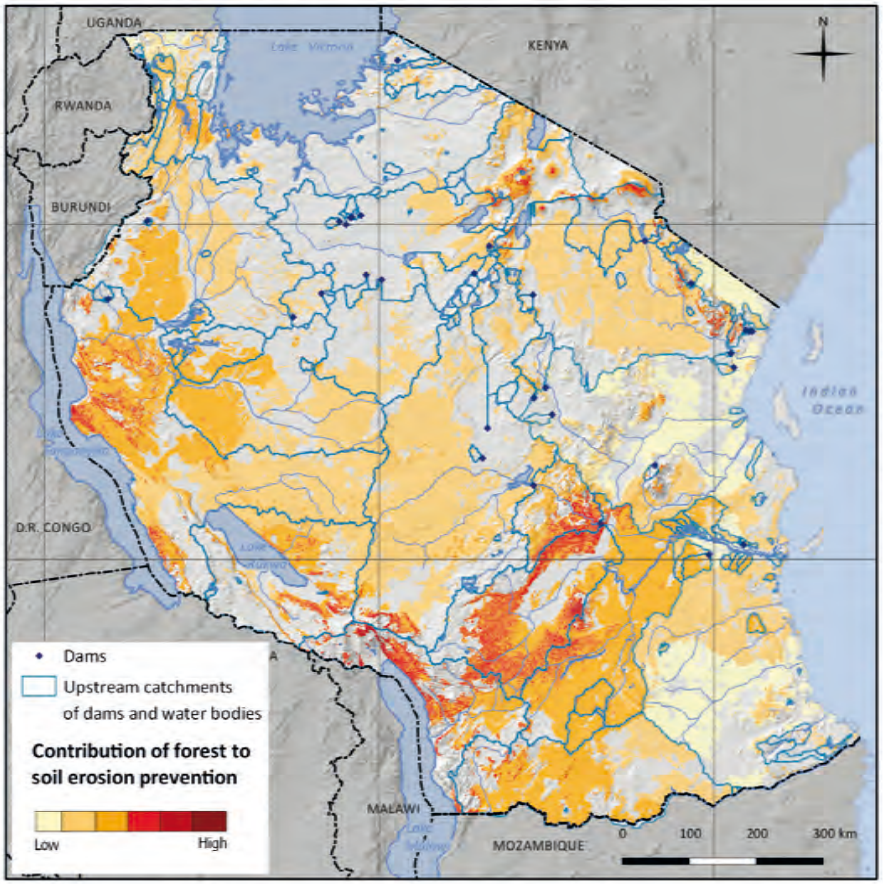
Forests, especially those on slopes, can stabilize soils and prevent soil erosion. The tree canopy, saplings, litter layer and woody debris protect the soil surface from the erosive power of raindrops and controls runoff, thereby preventing soil detachment. On high slopes, deforestation or forest degradation 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.

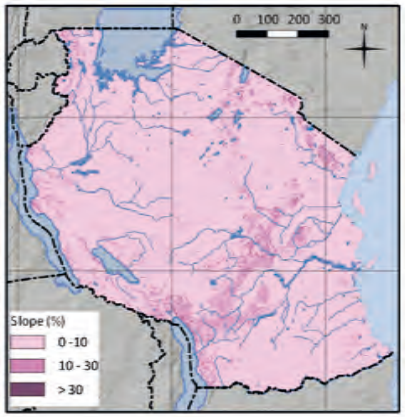
[7] More information about this methodology can be found in the Tanzania Methodological Brief, available at: http://www.un-redd.org/UNREDDProgramme/CountryActions/Tanzania/tabid/1028/Default.aspx

Map 12: Importance of forests for limiting soil erosion

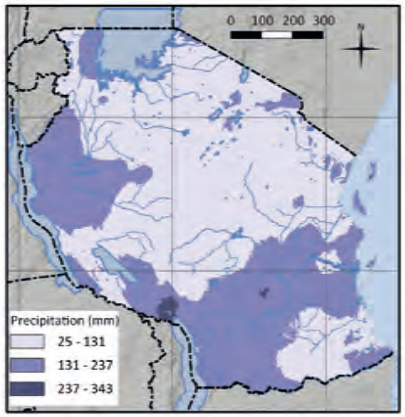
This map shows areas where forests are particularly important for limiting soil erosion that might cause sedimentation problems for dams in Tanzania. The methodology is based on four parameters: slope, precipitation, locations of dams and water bodies and their catchments, and forest. Soil erosion prevention 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).



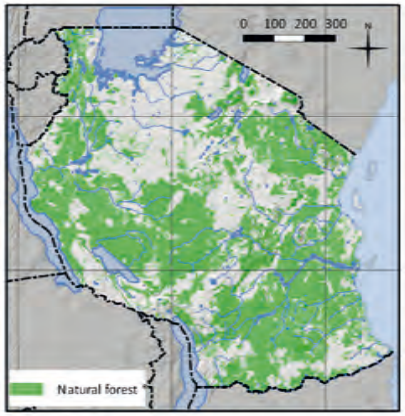
Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.



3 slope classes (%)

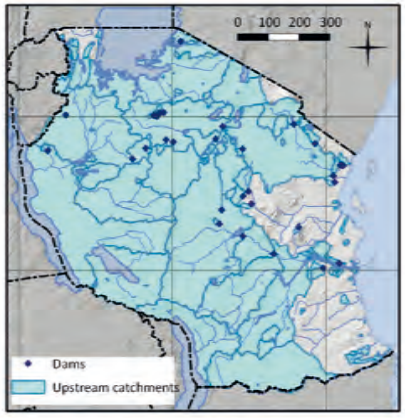


Average precipitation for rainy season (March, April, May, November, December and January)



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

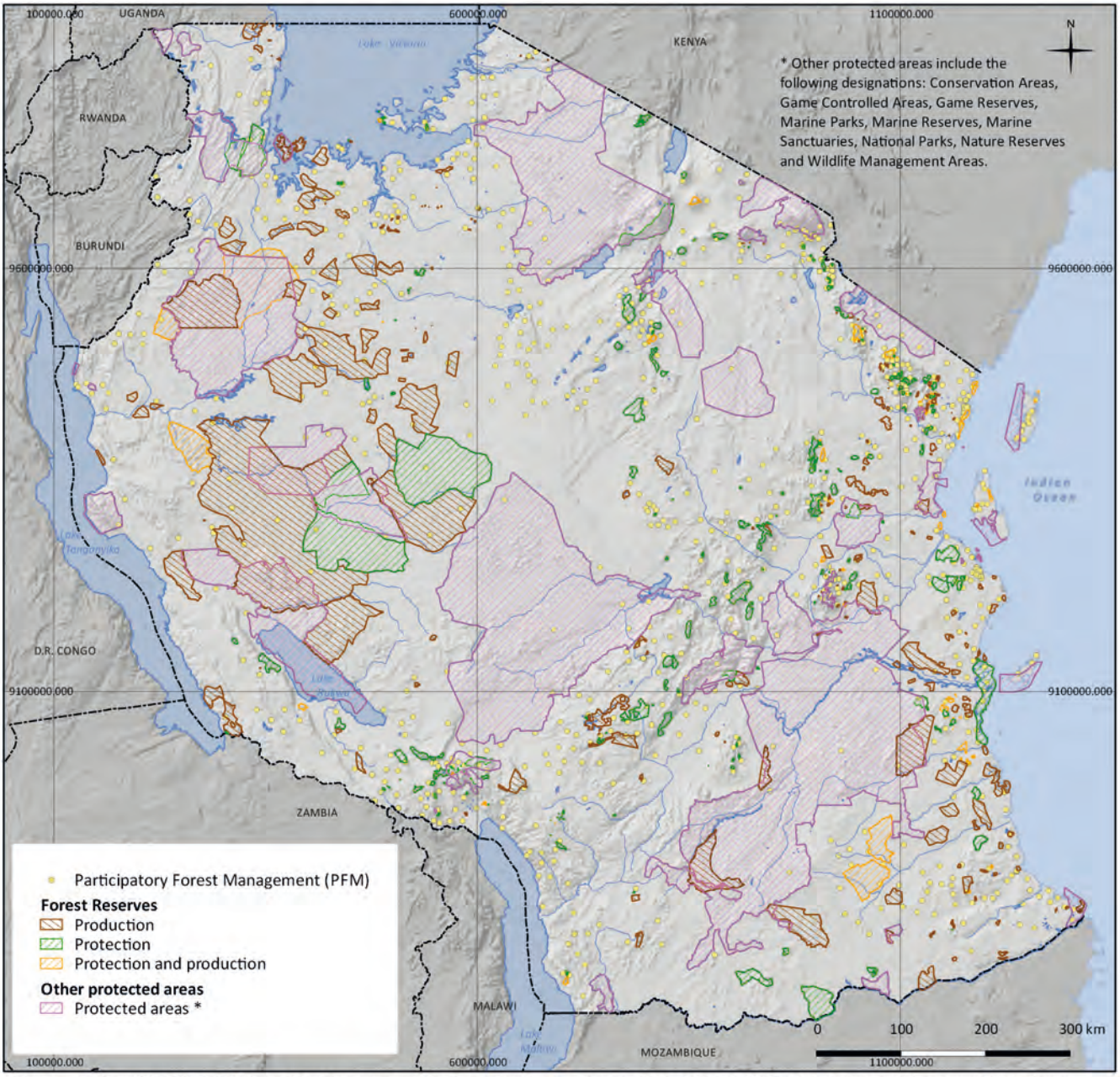
Naturally, REDD+ planning will need to account for competing land uses, depending on location. Oil and gas exploration has been ongoing in Tanzania for the past 60 years. Map 15 shows the location of current oil and gas exploration licences in Tanzania, applications and open acreages (areas open for search for oil and gas). The great extent of these blocks is a significant consideration for land-use planning.


©FAO/Simon Maina / FAO

[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+

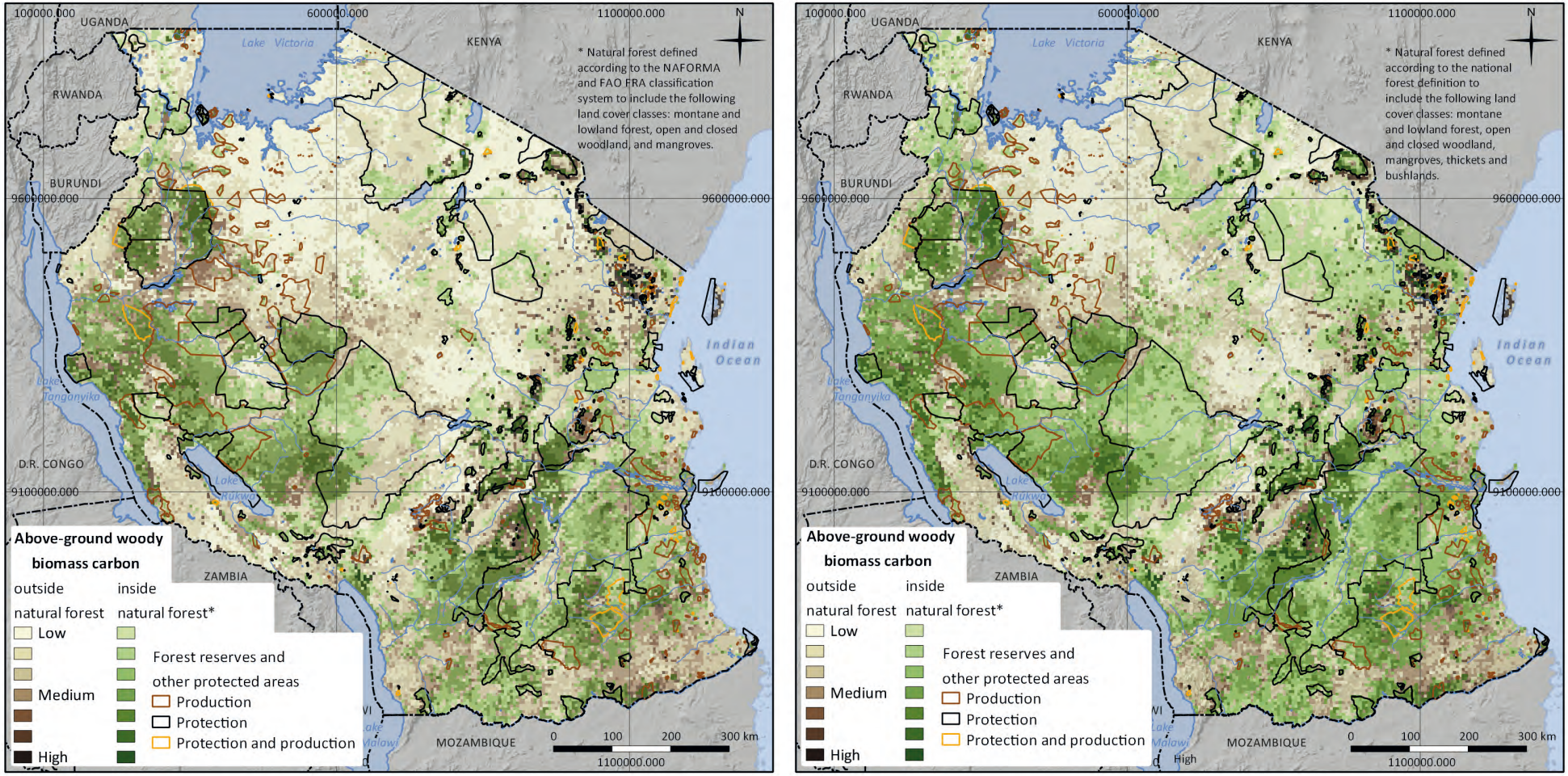


Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

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.
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.

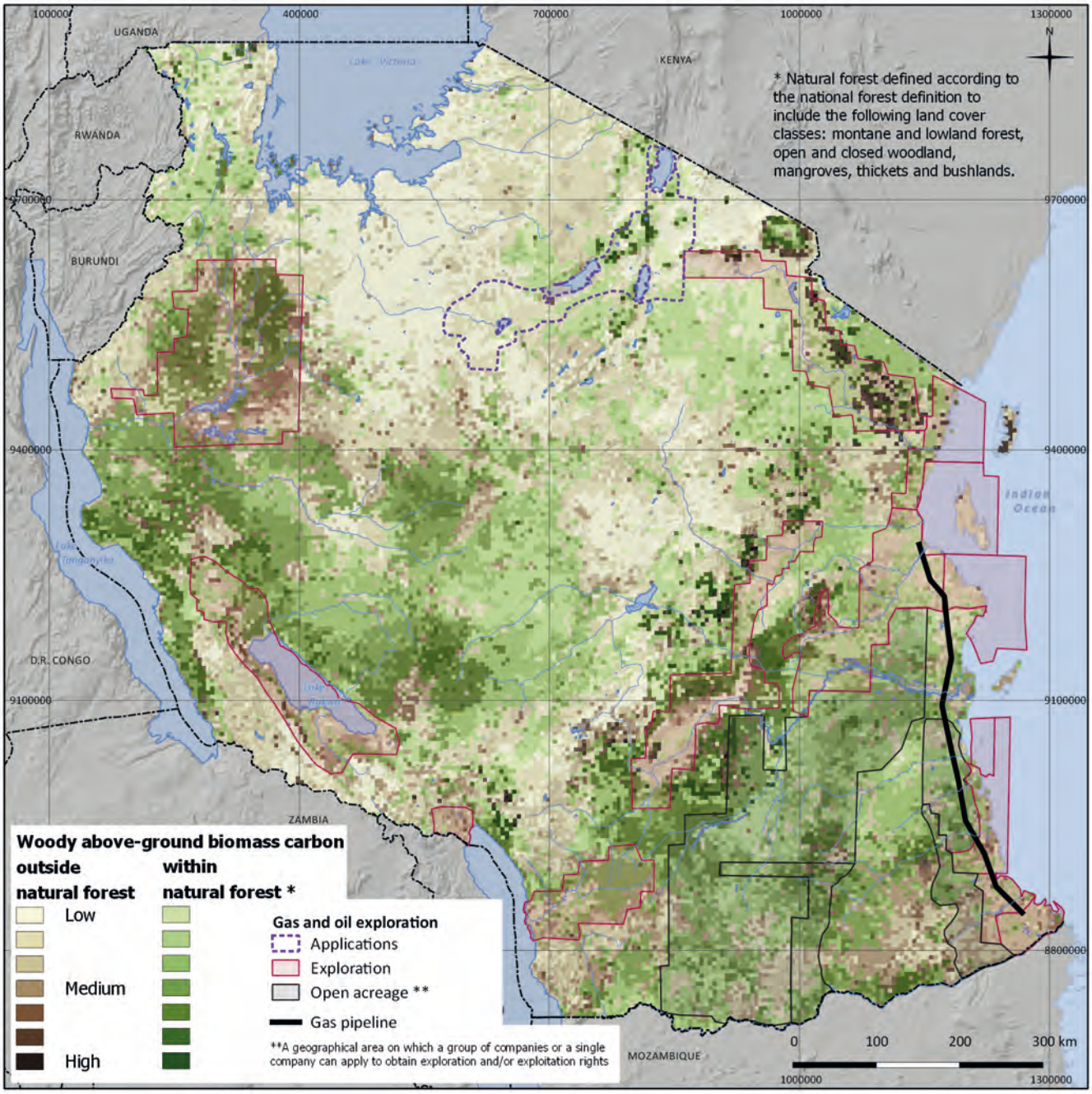


Map projection: WGS84 / UTM Zone 36S. Map prepared by Tanzanian Forest Service (TFS), UNEP-WCMC, FAO, Sokoine University of Agriculture (SUA) and Forestry Training Institute (FTI). Date: May 2013.

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.

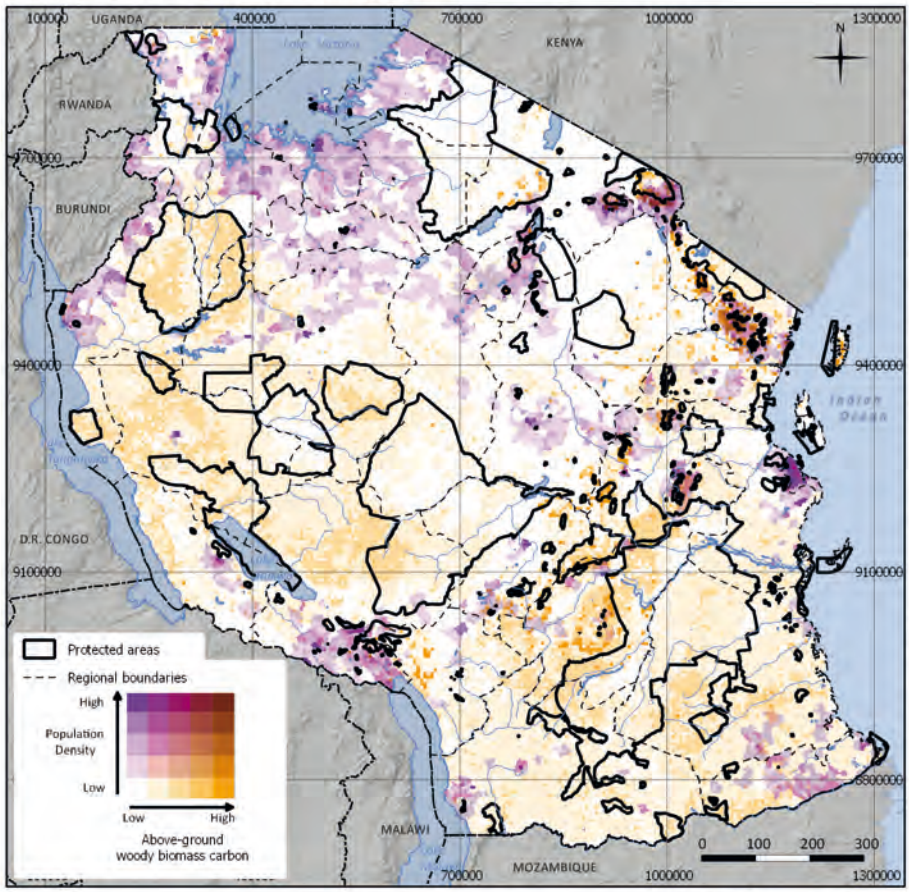
Understanding the spatial pattern of charcoal-making activities can help target REDD+ activities to increase employment opportunities, promote forest conservation and efficient resource use to address this driver of forest degradation. The Tanzania REDD+ Action Plan outlines strategic actions to address 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.

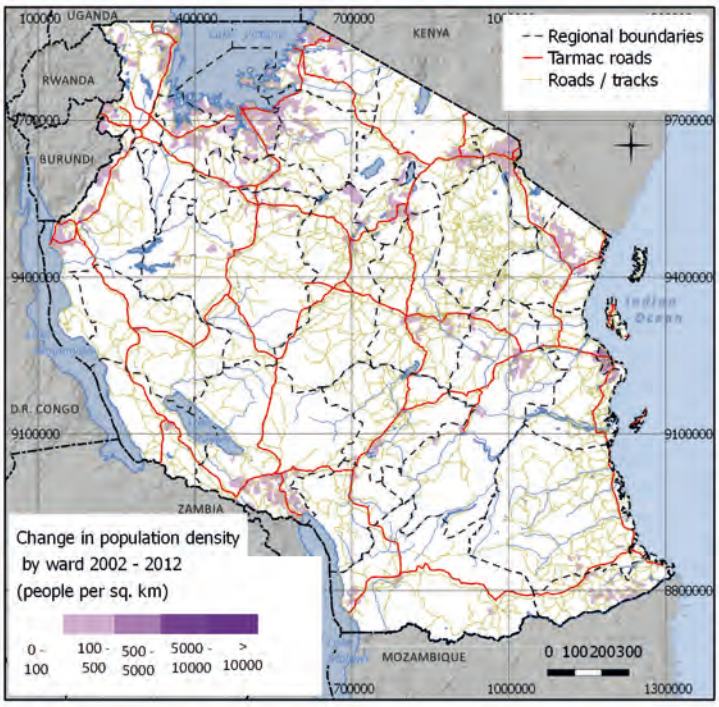
[10] This map has been prepared from the section of the NAFORMA inventory that recorded human impact on field plots in terms of disturbance or change in ecosystem composition, structure, or function. The NAFORMA biophysical survey measured 18 variables of human impact.

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.



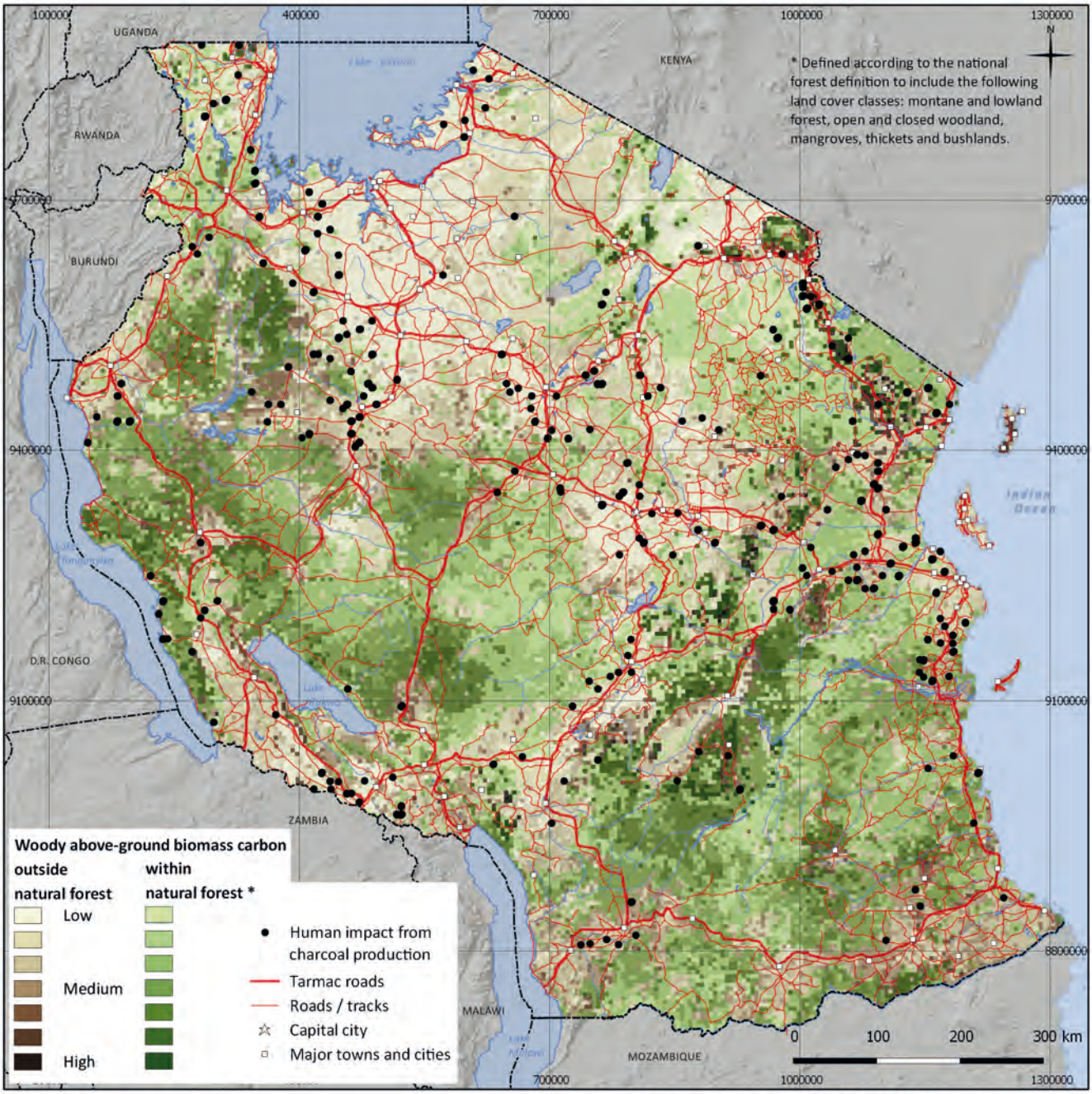
Map 17 (left): Change in population density in Tanzania between 2002 and 2012 (increase in persons per square kilometer)

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

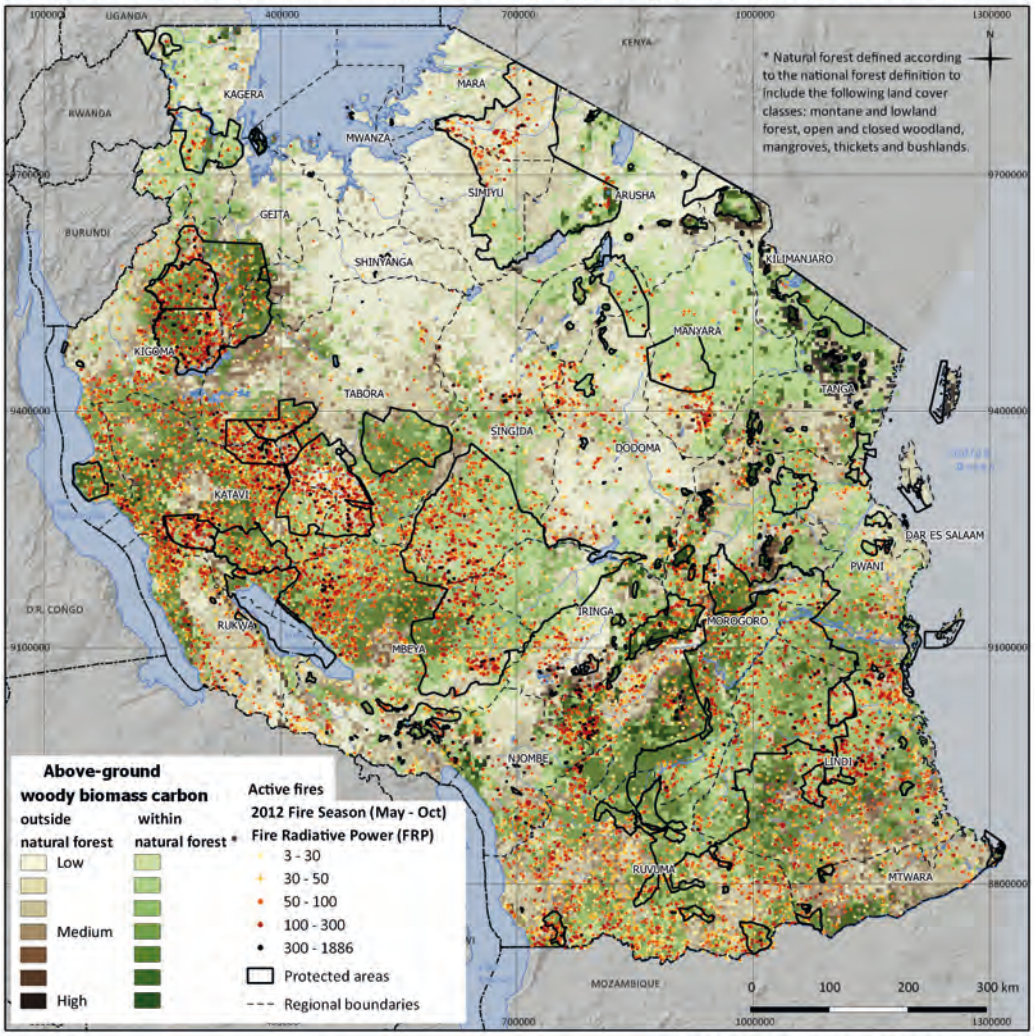
The uncontrolled spread of fires set by people has become a common phenomenon in the dry season, particularly in the miombo woodlands. Fires occur also in plantations and even in catchment forests, and have become a significant driver of forest degradation in Tanzania (Pfeifer et al. 2012). The main 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).
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