Protecting the DRC's Forest

Protected Areas for People and Planet

This paper deploys geospatial analysis to approximate the costs associated with plans to designate as 'protected areas' 15-17% of the land of the Democratic Republic of the Congo (DRC).

The DRC is home to some of the world's most important forests and biomes, so reducing deforestation quickly and efficiently is an important part of global climate change mitigation. This paper aims to help by estimating the potential cost of compensating people affected by the proposed expansion while respecting the principles of Free, Prior, and Informed Consent (FPIC).

Finally we provide a set of basic recommendations that might help to reduce physical and economic displacement through site selection, policy design and alternatives to protected areas. By treating local peoples as partners in these protected area initiatives, those establishing and maintaining protected area networks can cut costs and speed up implementation.

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I. Overview

The protection of forests in the DRC is crucial in the mitigation of the effects of climate change. Initiatives that protect forests may make a significant contribution to global carbon sequestration.

The support of groups like the World Bank, the United Nations, the German government and the Global Environmental Facility for protected areas is therefore laudable. However, plans to expand protected areas[1] from 12% to at least 15%[2] of the DRC's land – or over ten million hectares – seem overly ambitious, particularly given problems with financing the existing protected area network.

Between 2005 and 2014, at least US$77 million was invested[3] by international donors to rehabilitate protected areas (see Appendix for detail). But a further US$134 million was committed for the period between 2013 and 2018, again for rehabilitation but also for expansion (see Appendix for further details).

Given that it costs so much just to maintain the current network, it seems unlikely that sufficient money will be available for expansion plans that may entail the compensation of hundreds of thousands of people (see below for indicative ranges).

This paper aims to help successful implementation of the DRC's forest conservation programs by providing basic answers to three key questions:

1) How many people could be affected by proposed expansion of the protected area network?
2) How much might it cost to compensate these people?
3) What can be done to reduce the cost and increase the effectiveness of forest protection?

This paper aims to help those funding protected area initiatives in the DRC – specifically the World Bank, the GEF and the German government – by deploying readily-available geospatial tools to quantify the challenges associated with expansion plans.

Our analysis suggests that the costs of expansion may be exorbitant. Reducing economic as well as physical displacement[4] will be vital to the viability of implementation, and alternative means of forest protection should be seriously explored.

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[1] According to the IUCN a protected area is a clearly defined geographical space, recognized, dedicated and managed to achieve the long term conservation of nature with associated ecosystem services.

[2] In 2009, a five-year BMUB-funded project was launched to identify new protected areas with a goal of reaching the 15% target which the DRC government has committed to a number of times (including in the 2002 revision to the Forest Code). In 2010, the DRC officially raised its goal to 17%. (http://www.impact.cd/le-wwf-face-aux-enjeux-de-la-preservation-de-la-biodiversite-en-rdc/)

[3] These are conservative figures, considering only the larger investment commitments from the largest donors.

[4] We understand that any physical displacement will be minimized as far as possible. However, protected areas may curtail livelihoods and opportunities, potentially creating considerable "economic displacement" and associated compensation costs.

II. How Many People Could Be Affected?

We can approximate the distribution of people in the DRC by using respected geospatial datasets on population (Landscan).[5] Using this data we can derive an estimated range for the number of people likely to be affected by proposals to expand protected areas from 12% to between 15% and 17% of the DRC's land (see Appendix for key details and assumptions).

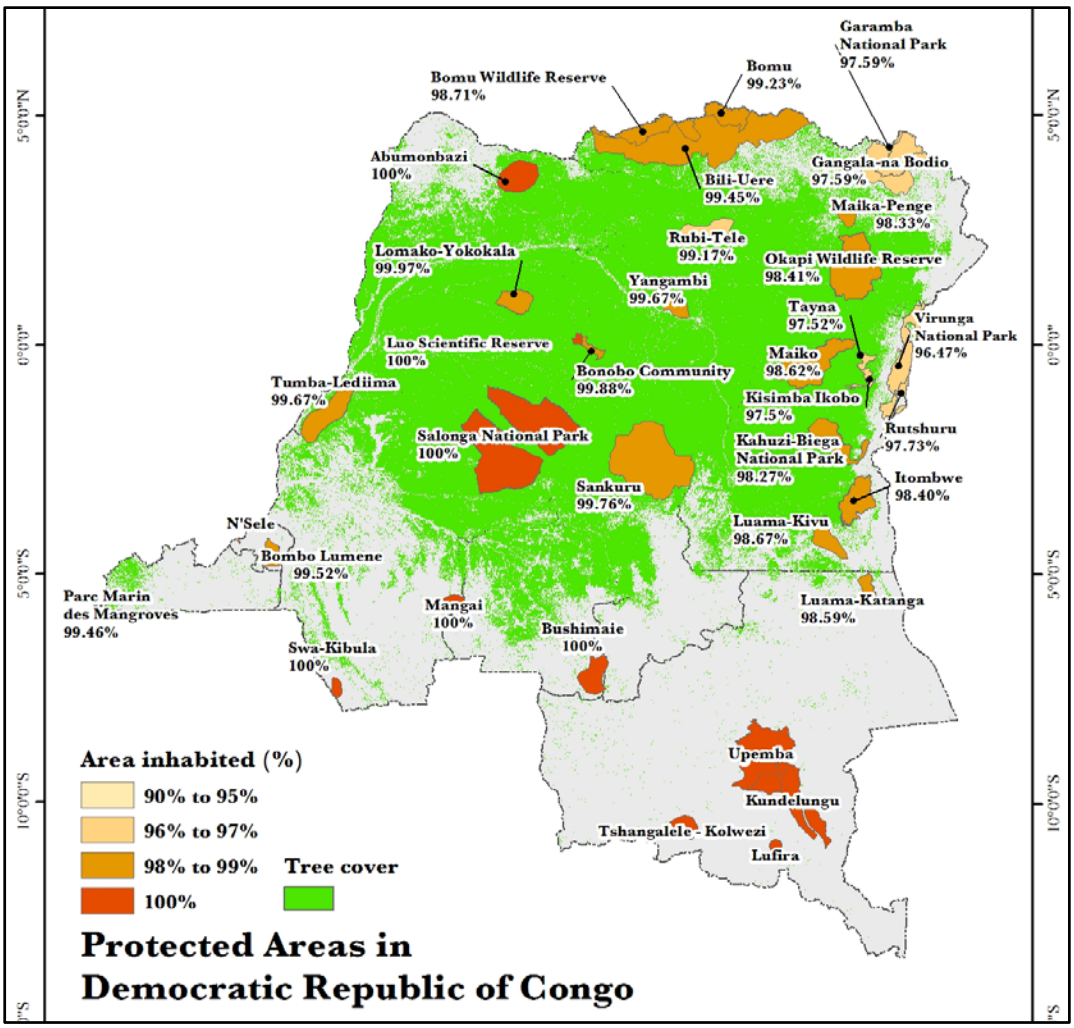
The major element of uncertainty in these affected population projections is the location of the protected areas.[6] However, the map below displays current protected areas and shows that they are predominantly populated[7], which is likely to apply to new protected area too.

This impacts may also be felt in the "buffer zones" surrounding new Protected Areas. These areas must absorb displaced populations, which can significantly disturb regional economic stability.

[5] LandScan, developed by the Oak Ridge National Laboratory for the US DoE "uses spatial data and imagery analysis technologies and a multi-variable asymmetric modelling approach to disaggregate census counts within an administrative boundary. The US Bureau of the Census provides estimates on population data for DRC based on "statistics from population censuses, vital statistics registration systems, or sample surveys pertaining to the recent past."

[6] We understand that WWF was commissioned by the German Government to delineate these protected areas but we were unable to locate WWF's findings. We are also aware of the maps indicating future priority conservation areas for the DRC, but those have seen little development over the last eight years.

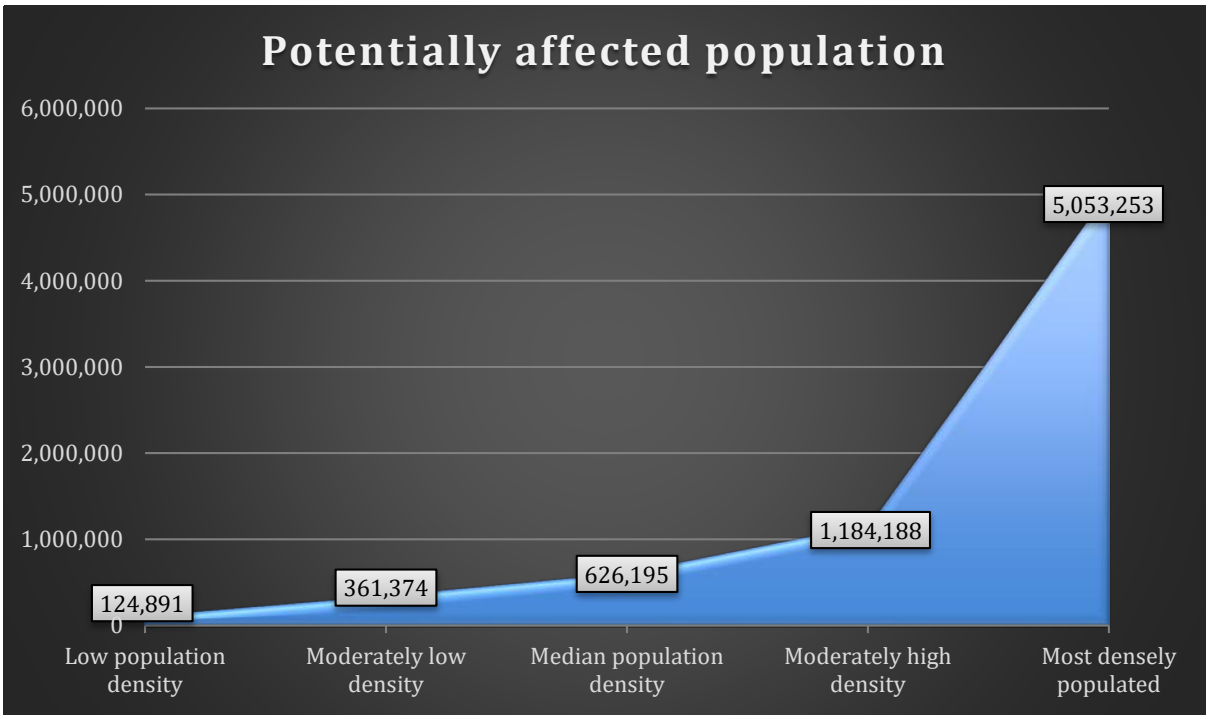
[7] This means that LandScan results show that the vast majority its 1 km^2 pixels are inhabited.



We have assumed that new protected areas will be located, overwhelmingly, in the forest estate because of the importance of these areas for meeting global climate change mitigation goals, as enshrined in the unprecedented agreement at COP 21.[8] We have also excluded mining and logging concessions and existing protected areas (see Appendix for further detail). Finally, we have worked under the premise that the smallest protected area would be at least 2,000 hectares.

The graph below provides estimates of the number of people who may live in areas affected by the proposed expansion of protected areas. We provide estimates based on five ranges of population density under the assumption that protected areas will be expanded to 15% of the forest estate (see Appendix for further details).

[8] At COP 21 in Paris (December 2015), Parties to the UNFCCC reached a historic agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. Learn more here: http://unfccc.int/paris_agreement/items/9485.php



We estimate that the population currently living in protected areas comes to over 4.1 million people. Therefore, an expansion from 12% to 15% of land, or an area larger than Austria and scarcely smaller than England, could easily affect a million people.

The top and bottom ends of this range therefore seem unlikely. But the median estimate may be on the conservative side of representative, given that estimates suggest that as many as 17 million people have already been affected by conservation-induced economic and physical displacement in the DRC.[9] As we see in the next section, compensating this number of people for economic, let alone physical, displacement would be expensive.

[9] Schmidt-Soltau, Kai. 2010. Forced Migration Review. Issue 36. http://www.fmreview.org/en/DRCongo/23.pdf

III. How Much Might It Cost?

Compensation varies according to prevailing local conditions and the way in which people are affected by a project. Another key factor is whether implementing parties respect FPIC principles.[10] Looking at resettlement costs[11] from analogous projects can help us to develop a reasonable estimate of adequate compensation per project affected person (PAP).

The table below provides information on both physical and economic resettlement costs[12] for a series of comparable projects.[13] We understand that physical resettlement at scale can be reduced. However, considerable economic displacement seems to be significantly less avoidable under current proposals.

Name	Date	Project Location	Cost/PAP (physical)	Cost/PAP (economic)
Central Africa Backbone	2015	Cameroon	US$1,264.58	US$3,504.83
Batshamba-Tshikapa Road	2014	The DRC	US$180.65	US$182.21
Bumbuna Hydroelectric	2008-2010	Sierra Leone	US$1,539	US$2,637
Kingamyambo Musonoi tailings project	2008	The DRC	US$1,696.88	US$187.50

The Batshamba road project stands out here because its resettlement costs are considerably lower than the other projects.[14] This reflects the fact that the road could be rerouted, to some extent, to reduce the local impact. But the smallest protected area in the DRC is 3,475 hectares, meaning that impacts are much harder to mitigate.

[10] We understand that FPIC has not been typical in the establishment of previous protected areas in the DRC. But we assume that donors will require any further expansion to adopt these principles, which require considerable amounts of time and resources.

[11] We have chosen to focus on resettlement rather than broader compensation costs because the data is more reliable and more detailed.

[12] Our definition of physical resettlement reflects World Bank's Involuntary Resettlement Policy's discussion of "relocation or loss of shelter". Similarly we consider that economic displacement includes "[loss] of assets or access to assets; or (iii) loss of income sources or means of livelihood, whether or not the affected persons must move to another location." http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTOPMANUAL/0,,contentMDK:20064610~menuPK:64701637~pagePK:64709096~piPK:64709108~theSitePK:502184~isCURL:Y,00.html

[13] For an addition set of examples, see our recent paper assessing protected area proposals in Liberia. http://rightsandresources.org/wp-content/uploads/Protecting-Liberias-Forest.pdf

[14] African Development Bank Group. 2008. Summary of the Resettlement Action Plan: Batshamba-Tshikapa Road – Lovua-Tshikapa Section Rehabilitation. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/DRC%20-%20Batshamba-Tshikapa%20Road%20%E2%80%93%20Lovua%20-Tshikapa%20Section%20Rehabilitation%20-%20RAP%20Summary.pdf

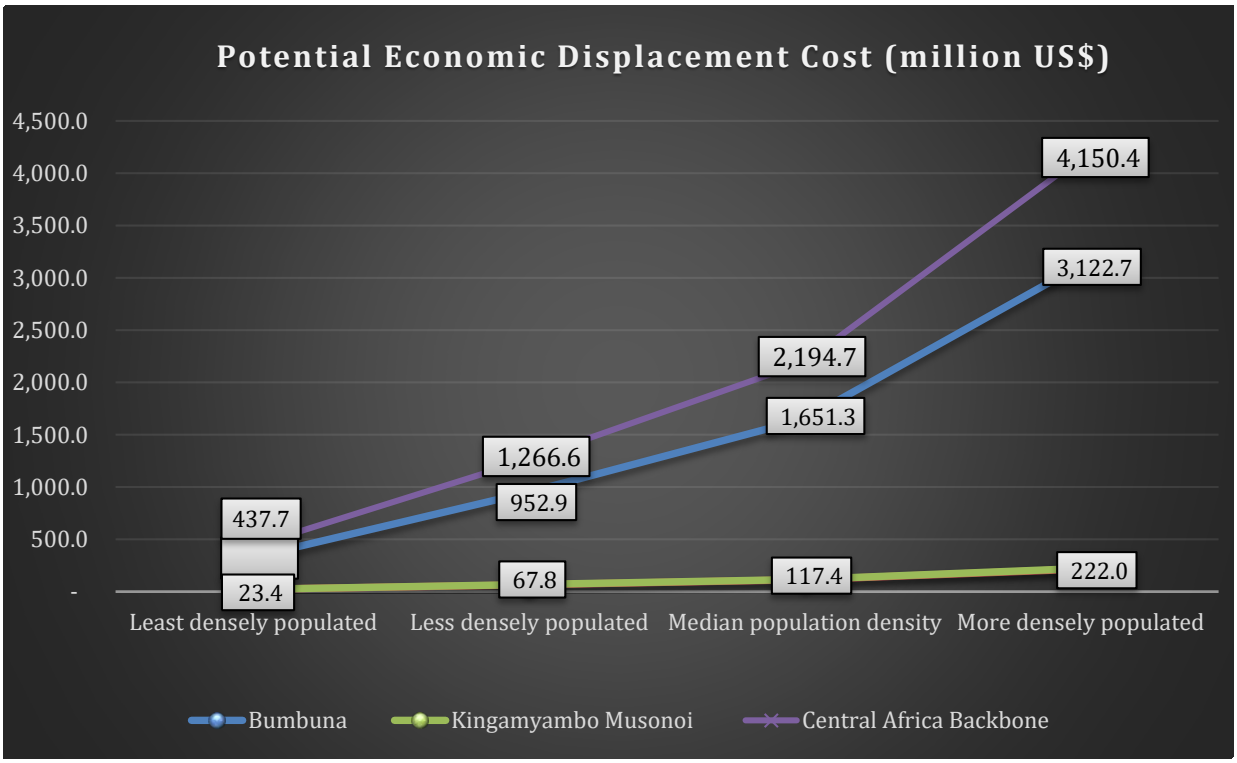
The Kingamyambo Musonoi project provides a more relevant comparison.[15] This project involved the IFC and explicitly sought to adhere to Performance Standard 5. As a result of the mine's expansion, informal farmers – who would otherwise have lost their livelihoods, if not their homes – were resettled.

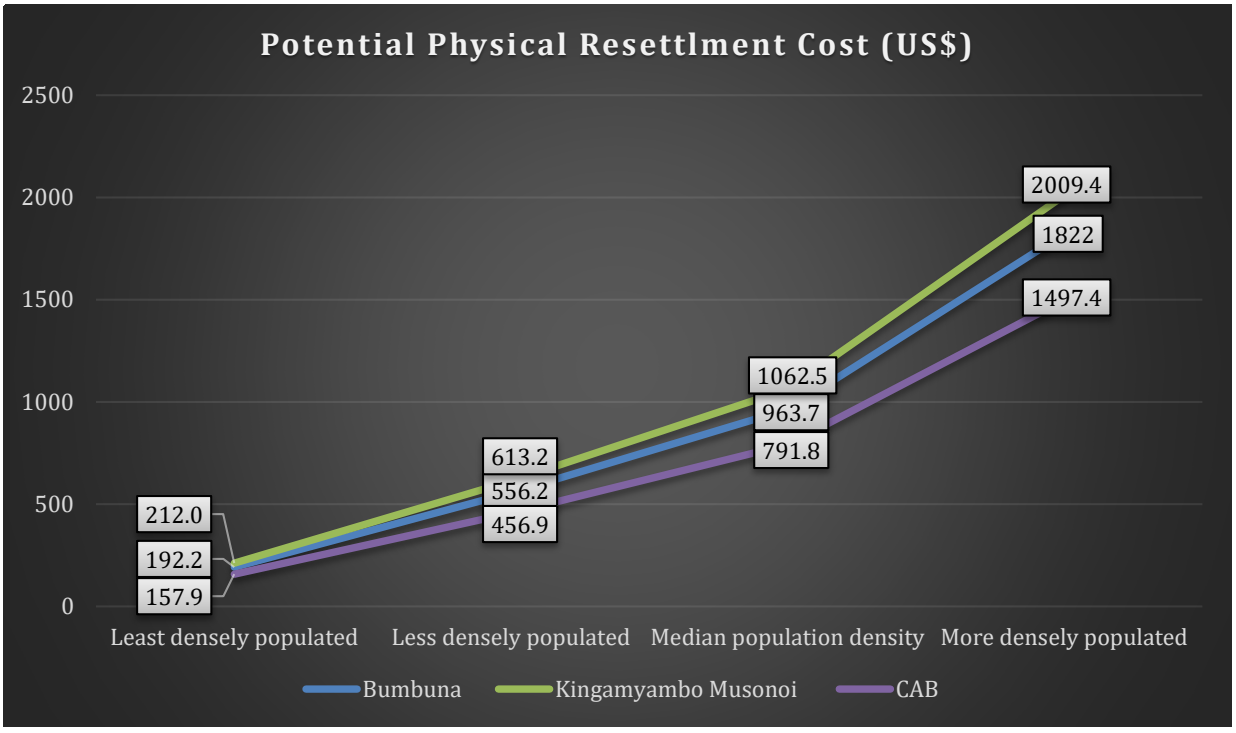
The Central African Backbone (CAB) project and the Bumbuna hydroelectric projects each show that compensation for livelihoods can exceed physical resettlement costs for a variety of livelihoods. The African Development Bank-backed CAB project affected some urban as well as rural areas, but the WorldBank-funded Bumbuna hydroelectric project primarily affected farmers and forest-dependent peoples.

By combining the above figures with the estimates for the PAP count from the previous section – excluding the highest population count – we can provide a rough sense of the possible distribution of compensation costs. We realize that not everyone in a protected area will be affected, but the below figures do provide an indicative sense of overall costs.

These graphs show the potential costs if each person that may be economically and physically displaced by the protected area proposals were to be compensated as PAPs have been in three comparable cases: the Kingamyambo Musonoi tailings project, the Bumbuna dam, and the Central Africa Backbone.

[15] International Finance Corporation. 2008. Framework Resettlement Action Plan for the Kingamyambo Musonoi Tailings Project, Katanga Province, Democratic Republic of Congo. http://ifcext.ifc.org/ifcext/spiwebsite1.nsf/0/5d1d7a8ea4a78935852576ba000e2c7d/$FILE/Annex%20B%20Final.pdf; and International Finance Corporation. 2009. KMT Samukonga Resettlement Action Plan. http://ifcext.ifc.org/ifcext/spiwebsite1.nsf/0/68E19E5FEF74BA93852576BA000E2D56/$File/Samukonga%20RAP.pdf





As discussed, the median population count is probably the most reliable guide, meaning that over 600,000 people may be classified as PAPs. Under this assumption, and if FPIC principles are followed, compensation costs could range from US$117 million to almost three billion dollars.

But we can provide a little more accuracy in this range. If we take the Kingamyambo project as the most representative and assume that no more than one in ten inhabitants will be physically displaced while four in five are economically displaced, the compensation budget for the project would have to exceed US$200 million. This seems well in excess of finance available for the purpose, even discounting ongoing maintenance costs.

IV. What Are The Key Factors To Consider When Planning Implementation?

Our cost projections are approximate and do not account for some key variables. We do not model the impact of such factors here. Rather, we aim to identify them so that they are factored into implementation planning. By taking proper account of these issues, the costs of the project can be depressed and the speed of implementation increased.

Ongoing Costs:

The estimates above do not account for the long-term maintenance of protected areas. This could cost US$1-3/hectare/annum[16] or as much as US$35-105.5 million per annum if the proposals are followed. According to some expert commentators, the cost should be as much as three times higher than the top end of this range.[17]

Given that the DRC already faces considerable challenges financing the maintenance of existing protected areas, it seems unrealistic to expect better performance across an area expanded by at least 25%.

Social Conflict

An effective local engagement process enables rapid and low-cost implementation. In its absence, a lack of trust can escalate into significant delays. Direct recognition and respect of local interest and tenure rights is the most effective way to reduce the chance of problems like protests, picket lines, threats, and illegal occupations, which can significantly inflate the costs of establishing and maintaining protected areas.

Defining Protected Areas

The number of people that will be economically displaced by protected areas depends heavily on the activities that are licensed within them. Allowing the likes of community forest enterprises (CFEs) and smallholders to continue existing, low-impact economic activities may considerably reduce cost and difficulty of implementation.[18]

[16] Research indicates that the actual costs of running protected areas in Zambia was $0.87/hectare/annum but that the necessary spend should be more like $6.28-10/hectare/annum. http://fsg.afre.msu.edu/zambia/resources/Economic%20Analysis%20of%20Protected%20Areas1%20%20zambia%20report.pdf Similarly, a global review of 196 protected areas (of which 126 were in Africa) suggested running costs of $0.90-9/hectare/annum. (http://bioscience.oxfordjournals.org/content/54/12/1119.full

[17] http://bioscience.oxfordjournals.org/content/54/12/1119.full; http://fsg.afre.msu.edu/zambia/resources/Economic%20Analysis%20of%20Protected%20Areas1%20%20zambia%20report.pdf

[18] The DRC's Land Rights Policy (2013) does make special allowance for "Customary Protected Areas" which may provide a means of reducing the number of PAPs.

Recommendations

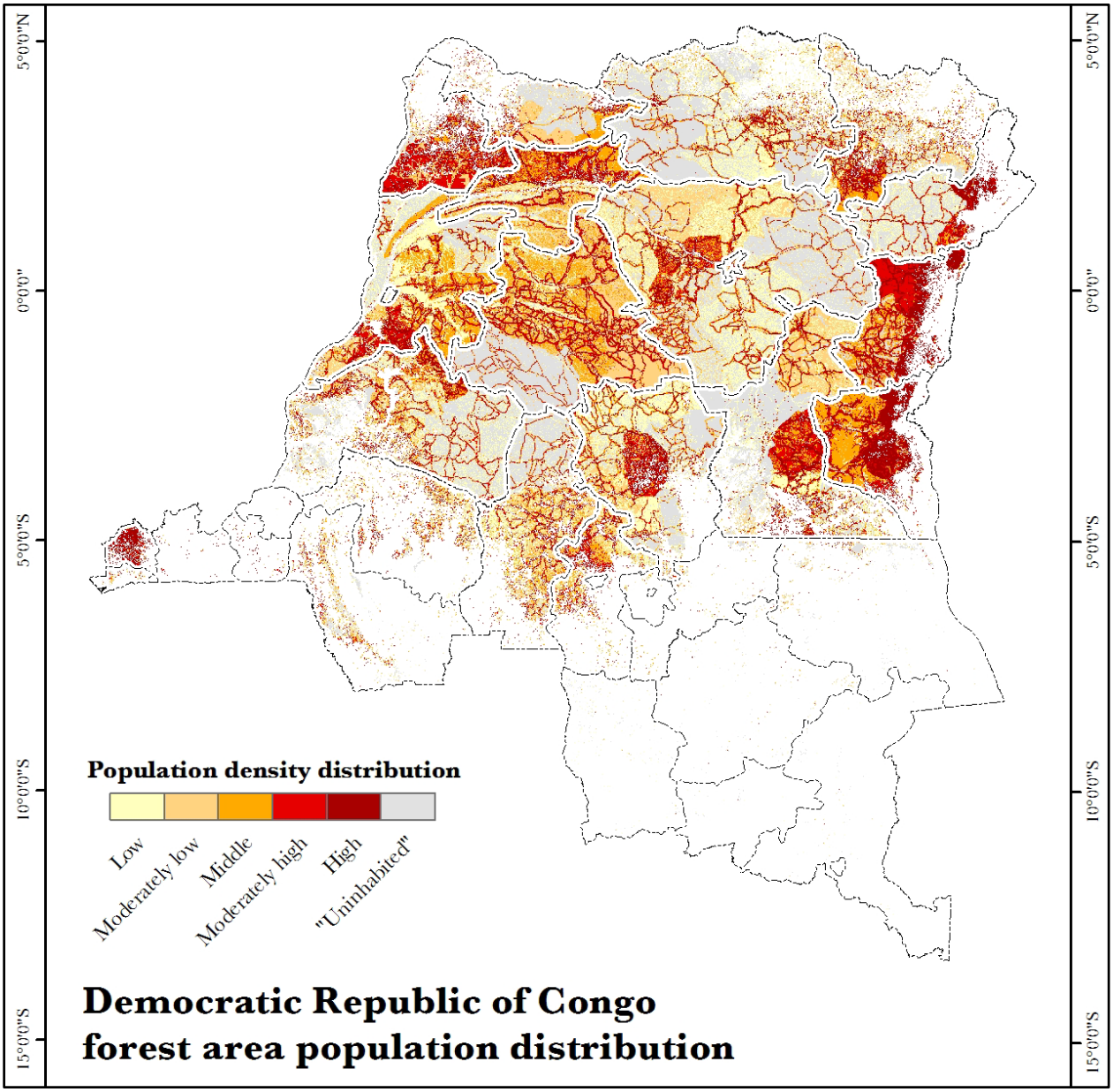
The approach we have used to estimate population counts and resettlement costs is approximate. We are simply providing a representative picture. This picture provides enough detail to suggest that the protected area proposals may be difficult to implement, especially given the proposed budget. The following recommendations are designed to help the proposals to achieve vital climate mitigation impacts:

1) Use geospatial tools to minimize physical and economic displacement through careful site selection and detailed implementation planning;
2) Ensure that protected area policies allow smallholders and CFEs, among others, to continue with low impact productive activities;
3) Consider alternatives to protected areas – such as demarcated community land – which may provide equivalent climate change mitigation impact at a much lower cost;
4) Develop means of financing ongoing maintenance of protected areas, perhaps through innovative means like community management;
5) Extending the timeframe for implementation, which may help to ease the excessive burden on the DRC's limited bureaucratic capacity; and
6) Test and deploy effective and scalable means of local engagement to reduce social conflict and improve planning.

Protecting the DRC's forests is a global priority. We hope that this paper will be helpful in furthering this effort.

Appendix: Population Distribution in The DRC's Forests

The map below picks out the DRC's forest land and provides a gradient of population density. It also indicates areas which are marked as "uninhabited". Even where this is the case much of this land will be used by local forest-dependent peoples.



Appendix: Cost of Compensation

We reviewed a number of recent case studies of involuntary resettlement relating to projects in West and Central Africa, to calculate approximate costs per "project affected person" (PAP). We further attempted to disaggregate the physical and economic costs of relocation and resettlement.

We made our calculations based upon publicly available data (as detailed below). While our data and calculations should not be viewed as precise, we are confident that they provide a range of costs that is generally reliable, being based on underlying data that is relatively detailed and transparent.

The caveats to our calculations relate to the sheer variety of projects we reviewed. First, none of them were national parks. There is a notable lack of detailed cost information relating to relocations stemming from the establishment of national parks – and this is by no means restricted to the DRC.

Second, there is a significant range of costs among the case studies. This is particularly evident when looking at economic costs, and is related to the third caveat: size. Smaller projects affect fewer people, and these small groups are more likely to be a narrower demographic. So in taking a handful of small projects, there tends to be a wide variation between the financial values of the economic activities that affected people are engaged in, and thus between the amount of compensation they require.

For the establishment of national parks on the scale that the DRC is considering, this variation of incomes will mean that costs may be higher than the range we have encountered – and that it is unlikely that the overall cost per person will be lower than our average.

1. *Central Africa Backbone (CAB) Project – Cameroon component - phase 1*[19]

This infrastructure project was financed by the African Development Bank (AfDB). A resettlement plan was published on May 2015.

The project involves the installation of a 206km fiber optic cable line in Cameroon (Bertoua-Batouri-Kentzou). It directly affects 30 business and property owners, which either will lose part of their property permanently or have restricted access to it during the installation.

- Among affected parties, there are 5 petrol stations and 22 business owners (shops/bars/hotels/restaurants)

As of May 2015, eligible recipients of compensation were surveyed and registered, but payments were not made at that point. The rehabilitation and compensation of this section of the project has a total cost of FCAF $84,568,880 (128,903 Euro).

[19]African Development Bank Group. Central African Backbone (CAB) Project – Cameroon Component – Phase I; Summary of the Abbreviated Resettlement Plan (ARP). http://www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/Cameroon_-_Central_Africa_Backbone__CAB__Project_%E2%80%93_Cameroon_Component_%E2%80%93_Phase_1_%E2%80%93_Summary_of_the_Abbreviated_Resettlement_Plan__ARP__-_05_2015.pdf

- Compensation costs were determined based on loss of income, by offering FCFA 25,000 per owner per day. Twenty six business owners fit into this category, totaling FCFA 6,500,000 (9,909 Euro) for all 10 days of construction
- The construction will remove several concrete walls and obstructing short road sections, and the rehabilitation of these areas were also accounted for. Rehabilitation expenses total FCFA 20,380,000 (31,070 Euro)
- Different committees were created to evaluate losses, observe proceedings and implementing communication plans. Four committees in total, with individual budgets ranging from FCAF 10 million to 15 million, totaling FCAF 50,000,000 (76,204 Euro)
- Contingency costs were expected to total 10% of the budget, FCFA 7,688,080 (11,718 Euro)

Physical costs represent 27% of the total budget (34,177 Euro), while economic costs represent the remaining 73% (94,725 Euro).

- Total costs per PAP amounts to 4,296.77 Euro

2. *Batshamba - Tshikapa Road* – Democratic Republic of Congo[20]

The project was financed by the AfDB between 2013 and 2014. The road extends through a large portion of the country, but AfDB is financing just a portion of it. This section of the road runs from Lovua to Tshikapa, representing a distance of 53km. It is entirely located inside the Western Kasaï province, mostly in an urban area.

Of 1,502 PAP, 309 of are property owners, and the remaining 1,193 are employees of small and medium of the impacted businesses.

Compensation was determined on a case by case basis, but all cases involved one or more of the following damages:

- Total or partial loss of land
- Loss of built assets, total or partial agricultural assets and infrastructure
- Loss of income
- Loss of rental rights

The total budget of CDF 495.97 million (US$ 545,021.00) includes a 5% margin for contingencies on top of all expenses described below:

Physical costs

- 309 properties impacted in different degrees total US$ 203,474.00
- Agricultural assets lost during the project amount US$ 54,945.05

Economic costs

- Several validation workshops were created, involving expert consultants, local leadership, and the local population. Including logistics and operational costs, these workshops had a budget of US$ 173,911.89
- Payments for loss of income for all 1,193 employees total US$ 26,296.70

[20] African Development Bank Group. 2008.

- Operating costs and allowances for external evaluators amount to US$ 73,626.37

Physical and economic costs each represent approximately 50% of the overall budget.

- The total cost per PAP is US$ 362.86

3. *Kingamyambo Musonoi tailings project* – Democratic Republic of Congo[21]

The project is located in the Katanga province, 240 km west of Lubumbashi, the province capital. The mine has been operating for more than 50 years, and has processed over 110 million tonnes of ore. Significant concentrations of copper and cobalt in the accumulated tailings made reprocessing viable. After publishing an environmental impact assessment, the developers (Kingamyambo Musonoi Tailings - KMT) surveyed the area and analysed the impacts and costs of resettlement and compensation.

The published RAP report does not define the total number of PAPs, but gives the range of 77 to 80 from 12 households. For our calculations, we use the highest expected number.

Impacted people were displaced, losing monetary and non-monetary sources of income. In communities surrounding the project site, non-monetary sources represent up to 49% of the household's income. KMT had to survey all of them and identify the exact loss.

Physical costs

Amounting for 90% of the total budget, it includes:

- US$116,000 for replacement housing
- US$5,000 for a borehole
- US$2,250 for outdoor latrines
- US$6,000 for moving allowances
- US$6,250 for preparation of replacement fields
- US$250 for compensation for fruit trees

Economic costs

The remaining 10% of the budget is dedicated to economic costs:

- US$5,000 for the livelihood restoration programme
- US$10,000 for monitoring activities

Using 80 as the highest expected number of PAPs, we reach a total of US$ 1,884.37 per PAP.

4. *Sierra Leone Bumbuna Hydroelectric*[22]

The project involved some 38 villages and 5,033 individuals.

- 41 households (186 people in five villages) that will be relocated

[21] International Finance Corporation. 2008.

[22] World Bank. 2009. Government of Sierra Leone – Bumbuna Hydroelectric Environmental and Social Management Project – Updated Resettlement Action Plan. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/08/25/000334955_20100825031100/Rendered/PDF/RP9920v10P086810Info0Shop0Aug02010.pdf

- 95 farm plots which are farmed by 171 farmers covering a total area of 117 hectares that will be partially or fully inundated (104 hectares of these lands will be lost but will need 137 hectares in replacement due to the lower productivity of dry land compared with wet land)
- 4,956 commercial value oil palms and 3,715 other economic trees
- Some villages where footpaths will be lost, plus 48 sacred sites flooded

A total number of 1,579 respondents were recorded as eligible recipients of the moving transition allowances.

2 programs for income restoration and livelihood related activities:

- Livelihood Assessment and Income Restoration (LAIR) program and the Stabilized Agriculture Program (SAP)
    i. Short-term (emergency) phase
        - Food support
        - Foot path construction
        - Sustainable agricultural support (formation of farmer field schools) (FFS)
        - Agribusiness units
        - Life skills programs & youth reintegration programs
    ii. Long-term (post-commissioning phase)

The Total cost of the RAP is US$ 4,450,272;

- Comprising Resettlement US$ 286,370
- Compensation US$ 1,399,250
- Community Development US US$2,764,652

Net cost = US$884.22/PAP (US$4,450,272 / 5,033 PAPs)

- Resettlement and compensation (R and C) = US$1,685,620
- R and C / “eligible recipients of the moving transition allowances” (1,579) = US$1,067.52/person
- R and C / relocated households + inundated fields (357) = US$4,721.62/person

<u>Physical and economic resettlement</u>

- Physical: Resettlement alone = US$1,539.62/relocated person (US$286,370/186 relocated people)
- Economic: Compensation and Community development = US$2,637.05/eligible recipient (US$4,163,902 / 1,579 eligible recipients), or US$827.32/PAP (US$4,163,902/5033 PAPs)

Appendix: Spending on DRC's National Parks network, 2005-2018

Between 2005 and 2015, DRC's parks received US$22 million in funding from the Global Environment Facility (GEF). This came from two projects, one aimed solely at the rehabilitation of DRC's protected areas (GEF project #248[23]), and one larger "Forest and Nature Conservation Project" (#3772[24]), of which US$4.1 million was allocated for the maintenance of National Parks. Of the US$18 million park rehabilitation project, US$7 million was set aside purely for maintenance of existing parks.

From 2013 to 2018, an additional US$85 million has been made available via the World Bank and the GEF. This came from two projects. One was a relatively small amount (World Bank Project ID P083813, totalling US$10 million[25]) aimed at supporting the Congolese Institute for Nature Conservation (ICCN), who oversee management of DRC's parks. The larger one (#4640, totalling US$73.6 million), seeks to establish a conservation trust fund to provide a stable source of income for the parks network. The countries that contributed most to these funds were Germany and Belgium.

In addition, there is funding that comes to the DRC's parks via regional funds. In 2014, Rainforest Foundation UK reported that three major programs contributed over US$320 million to national parks from 1992 to 2013.[26]

[23] GEF Project #248 Overview. "Rehabilitation of Protected Areas in the Democratic Republic of Congo", Available at: https://www.thegef.org/gef/project_detail?projID=248

[24] World Bank Project P100620 Overview. "Forest and Nature Conservation Project", Available at: http://www.worldbank.org/projects/P100620/forest-nature-conservation-project?lang=en

[25] This came from two grants: a World Bank grant of $3m (project overview available at: http://www.worldbank.org/projects/P083813/support-rehabilitation-protected-areas-system?lang=en), and a GEF grant of $7m (project appraisal available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/03/23/000333038_20090323003223/Rendered/PDF/476350PAD0ZR0P101Official0Use0Only1.pdf)

[26] Rainforest Foundation UK. 2014. Protected areas in the Congo Basin: failing both people and biodiversity? Available at: http://webapi.acceleratemediahub.com/api//simpleFile/DownloadSimpleFiles?applicationToken=rainforestfoundation&authenticationToken=&simpleFileIds=0661a322-7ae8-436a-b87f-494ca3262680

Appendix: Key Assumptions

This Appendix provides the key assumptions in our geospatial analysis. It also explains the datasets that we used and provides a general overview of the process we followed.

- For DRC land area which is the based figure for all of our estimates, we used the figure published in Protected Planet.[27]

- For the network of current protected areas, we utilized data from Protected Planet. We found some issues with the data such as overlapping boundaries and duplicated entries. To avoid over estimation, we addressed these issues first before approximating the area of current protected areas. We assumed that the data from Protected Planet were the most recent available.

- We then computed the equivalent area of the 15% and 17% targets for proposed expansions to estimate how much more is required to achieve those expansions.

- In order to identify potential areas of expansion, we considered areas that are 'forested' using definitions from the University of Maryland.[28] We considered at least 75% tree cover which is the value normally considered for biological significance. We also removed those areas classified as concession areas.[29]

- We also disqualified candidate areas area of less than 2000 hectares,[30] an area smaller than any existing protected area in the DRC. Our assumption is that protection effort is more effective and efficient in contiguous area of forest.

- For the population value, we used the definition and value as described and distributed by LandScan.[31]

[27] http://www.protectedplanet.net/country/CD

[28] Tree cover in the year 2000, defined as canopy closure for all vegetation taller than 5m in height. Encoded as a percentage per output grid cell, in the range 0–100. "Tree cover" is the biophysical presence of trees and may take the form of natural forests or plantations existing over a range of canopy densities.

[29] Areas where there is a legal claim on natural resources. In our analysis we have included concessions of logging and mining. Data is publicly available from Global Forest Watch. http://data.globalforestwatch.org/datasets/535eb1335c4841b0bff272b78e2cc2f4_4.

[30] The smallest protected area in DRC is 3475 hectares

[31] http://web.ornl.gov/sci/landscan/landscan_documentation.shtml

Limitations

For forest cover data, we did not perform any ground truthing or verification. We relied on data distributed by the University of Maryland for year 2000. The analysis would benefit greatly from more recent forest cover data.

Datasets

Data set	Description	Availability
World Database on Protected Areas	The most comprehensive global spatial dataset on marine and terrestrial protected areas available. Protected areas are internationally recognized as major tools in conserving species and ecosystems. Up to date information on protected areas is essential to enable a wide range of conservation and development activities.	Protected Planet
Tree cover	Tree cover in the year 2000, defined as canopy closure for all vegetation taller than 5m in height. Encoded as a percentage per output grid cell, in the range 0–100.	University of Maryland
LandScan 2014 Global Population	The LandScan 2014 Global Population Database was developed by Oak Ridge National Laboratory (ORNL) for the United States Department of Defense (DoD).	Landscan
Logging concessions	Represent geographic areas permitted for exploitation of timber by selective logging. This data set was produced through a collaboration between the DRC Ministry of Environment, MECNT, and WRI.	Global Forest Watch
Mining permits	Provides the boundaries for mining permits in the Democratic Republic of the Congo. This data set is available from the Ministry of Mines Mining Registry (CAMI), for purchase and could not be made available for public download. For more information, see the DRC's mining cadaster portal.	Global Forest Watch