**Discussion**

*Opening paragraph*

Global funding for nature conservation is far below what is required. To maximise conservation gains, it is therefore necessary to provide conservation managers with insights into the trade-offs between different approaches to long-term investment of limited resources in the context of increasing anthropogenic pressure on natural resources. To our knowledge, no studies have investigated the potential long-term consequences of existing funding mechanisms for conservation projects and organisations. Our results therefore provide crucial quantitative evidence that funders, conservation bodies, and landscape managers can use to develop more effective long-term investment strategies.

*Primary scenarios (scenarios 1 to 3)*

Our results have demonstrated that in a situation where human pressure on a landscape is increasing over time, and assuming that managers across all scenarios have access to the same total budget, the most effective funding strategy for a conservation manager is a stable, predictable budget. A constant budget is preferable to an increasing budget that starts too low, even when that budget increases beyond the value of the stable budget halfway through the study period. If a manager’s budget is too low at the start of the study period, initial forest loss is very high. The manager is able to reduce the rate of forest loss as their budget increases over time, but they are not able to make sufficient gains over 50 years to render the strategy better than a stable budget. Likewise, a fluctuating manager budget that reflects predictable grant cycles performs worse over 50 years than a stable budget. During periods of high budget, managers can develop effective policies that reduce forest loss, but these periods are not sufficiently long, and budgets not sufficiently high, to offset the damage that is done during periods of low funding. Furthermore, the rate of forest loss during periods of low funding increases over time, as community resources increase. If the manager was focussed on the conservation of a wildlife population that exhibited reproduction and thus population growth, the periods of high budget, and therefore more effective protective policies, may be sufficient to maintain a healthy population. However, we assumed that the loss of primary forest could not be effectively reversed over a period of 50 years (refs). These simulations could be further parameterised to include realistic forest regrowth or regeneration based on a specific landscape or ecosystem, but this would decrease the generality of the results and therefore was not attempted here.

Providing a manager with a stable budget that allows the development and maintenance of policies that minimise deforestation over the long-term is the optimal approach. Stable, predictable budgets in the real world allow conservationists and landscape managers to maintain staffing levels, invest in long-term relationships and partnerships with stakeholders, maintain enforcement levels, and design policies and interventions that are strategic and adaptive over the long-term. Conservation projects that are initially underfunded yet receive increasing resources will still spend many years working to reach the same levels of protection as they would have had, had they been provided an adequate, stable budget at the start. Our results suggest it could be several decades before the deforestation trajectories of the two alternative projects meet, and the increasing budget starts to have an effect. Projects that continually experience severe funding shortages due to grant cycles will not have the same capacity for long-term investment and strategic planning as projects with stable funding, resulting in greater losses for biodiversity.

*Uncertainty and unpredictability in funding*

Scenarios 4 and 5 highlight two common funding situations for conservation organisations and projects. Scenario 4 represents a situation where the management authority has some level of core funding that ensures the operational budget does not drop below a certain level, despite budget uncertainty over time. This is a common scenario for large, international conservation organisations or statutory authorities, which have long-term support for core operational budgets. They can increase their budgets at any given time through grant applications which can be used to support existing activities, initiate new programmes, bolster enforcement, or extend engagement and collaboration with stakeholders, all of which will have a positive effect on biodiversity conservation on the landscape. Likewise, grant funding will inevitably end within a few years, and there is no guarantee that future bids will be successful, resulting in decreases in overall budgets. However, the maintenance of budgets above a certain level means that core conservation activities do not cease, and the manager is able to minimise forest loss to a similar level to the manager in scenario 1. Conversely, scenario 5 represents a situation where the management authority has no core budget and is therefore entirely reliant on uncertain and unpredictable grant funding over time. This is the reality for many small organisations, grass roots projects, or poorly supported statutory authorities, often in the global south, which rely on the ability of other partner organisations to leverage external funding. In this study, the manager in scenario 5 has the same cumulative total budget over the 50 years as the other scenarios, yet the shape of the budget curve is random. This leads to large and highly unpredictable positive and negative peaks in some cases. Our results show that there is large variability in the overall success of the manager from scenario 5 to minimise forest loss. In some cases, they can maintain a forest loss trajectory similar to scenarios 1 and 4, yet more often the rate of forest loss is worse, regularly leading to extinction.

The results from scenarios 4 and 5 translate logically to the real world; if a conservation project or organisation has no core budget support, it is entirely reliant on the success of fundraising efforts to leverage external funding. Winning sufficient funding via short-term grants to support adequate long-term conservation management is neither reliable nor straightforward. When long-term budgets are unpredictable, uncertain, and highly variable, landscape managers are often unable to maintain core activities, guarantee continued support for communities and other stakeholders, plan investments strategically, or target investments at the most relevant drivers of biodiversity loss. In contrast, when core budgets are guaranteed, managers can maintain core activities and investments over the long-term which provides stability and minimises biodiversity loss.

*Key messages*

The dominant funding mechanisms in the real world today – ie grant cycles, are not optimal for conservation investment in landscapes. Large dips in funding, and uncertainty around funding, reduce the managers ability to set policy that benefits nature over the long-term. Short term bursts in funding only allow short term success. For longer-term success, stability and predictability in funding, at a certain level (i.e. not massively underfunded) maybe preferable to funding cycles and even increasing budgets that start too low. Simulation studies like this allow us to see possible outcomes over time period longer than we generally have data for in the real world. Monitoring data for conservation projects very rarely exist over time frames such as 50 years, and so short term monitoring can actually be misleading us. If you were to monitor a conservation project with scenario 1 funding between year 1 and year 6, or between years 11 and 19, you would conclude that the project was having success in reducing forest loss.

*Conclusions – what can be done?*

It is no secret that global conservation requires a huge increase in funding if we are to halt the decline in biodiversity and reduce the worst impacts of climate change. This study has provided crucial insights into existing funding models, and suggests that funding mechanisms need to be carefully considered. Our results suggest that increasing the number of grants available for projects and organisations to apply for, may not be the optimal solution over the long term. New funding mechanisms that provide secure, stable, long-term budgets that allow for strategic investment in nature conservation over periods much greater than five years, are required.

Examples of such mechanisms? Trusts? Commitments from international bodies, financial institutions, and statutory agencies?