Predicting the future of an endemic endangered Andean bird species with a niche-based model nested into a dynamic vegetation model.

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The slopes of the Andes are recognized as supporting the highest avian diversity in the world combined with high endemism rate but also more than 20 % of threatened species. Frugivores birds, even rare species, are known as major providers of seed dispersal service. In Bolivia, the large Red-fronted Macaw (*Ara rubrogenys* Lafresnaye, 1847) is one of the 15 endemic species of this country. Its natural habitat is mainly semi-deciduous dry forest but this habitat is most often severely degraded. Climate change is an additional threat over tropical mountain birds and this particular species, since some scenarios suggest warming as high as 7.5°C by 2080 and significant variations in the precipitation regime and available soil water.

To infer the future of bird species under warming climate, many authors use niche-based models (NBM), in which they combine effects of climate variables, alone or in combination with other environmental variables. A more elaborated approach consists in also including biotic interactions, notably the availability of particular plant species. While NBM with climate variables are now considered as a standard method to predict plant species distribution under future climate, this approach fails to consider the effect of increasing CO_2 concentration in air on plant physiology. Contrariwise, dynamic vegetation models (DVM) are commonly able to reproduce this effect, although the uncertainties on the CO_2 are large.

This study assesses the potential impact of climate change on the range of *A. rubrogenys*, by combining within a NBM climate variables, relief and biotic variables, i.e. plant species resource. Plant resource is computed with a DVM and a NBM to compare the methodologies and to evaluate potential effects of CO_2 on plant species distribution and indirect impacts on the bird.

Pour discussion

For Boyles et al. (2011) such SDM approaches are is of limited interest for modelling endotherms by contrast to mechanistic models offering the opportunity to include traits giving flexible response to changing environment and notably climate but the approach is mostly limited by rarity of data on acclimatization (genetic adaptation over generation) and acclimation (within-individual adaptation). An another way to explore the effect of climate change on bird range (but which does not include acclimatization and acclimation of birds) is to build SDM with environmental explanatory variables including plant resources. Among these, the use of SDM with climate variables only, for homeotherm-endotherm species appears simplistic because thermoregulators (see Boyles et al. a small population was observed nesting in the palm *Parajubaea torallyi* (Rojas et al. 2014)

Among these, one pitfall is that SDM models the realized (Grinnellian) niche, i.e. the suitable conditions for the species where it is not excluded by a competitor or a predator (Guisan & Thuillier 2005). Projections under new conditions are made under the assumption that the biotic environment remains unchanged. This assumption is hard to verify but moreover implausible since the biotic environment could be supposed to also respond to the new conditionsThe first one is that they rely on the assumption of equilibrium, i.e. the species have stable range, while it is now established that they are changing they range, notably with climate change as underlined by Elith et al. (2010). The use of datasets of occurrences or abundances covering several decades may produce biased ranges of larger extension. Harris et al (2012) combined with a SDM the results of a demographic model including competitor and predator influences with those of a SDM modelling the probability of presence of the single plant species giving the bird diet and three landscape variables.

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