**Chengdu Talk – Bamboo and Climate Change**

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**Slide 1 - Title**

This talk is based on bioclimatic modelling work carried out in the Environment Department at the University of York by Colin McClean together with a group of Masters students. The distribution data used in the modelling were compiled by Zoe Goodwin, both in the field and herbarium, in conjunction with colleagues from China. My role is simply to come to and enjoy a nice visit to China! ☺

**Slide 2 – Bioclimatic Modelling**

Bioclimatic modelling works by creating a bioclimatic envelope around the known distribution of a species. The envelope is based on climatic parameters, such as temperature and rainfall. If we assume that the distribution of a species is determined entirely by climate, then it is possible to create a map of the complete expected distribution of the species from relatively few known distribution points. It is helpful if the model also knows where the species definitely does not occur, so that those climate areas can be excluded.

It is a major assumption that species distribution is solely a function of climate because disturbance dynamics or other biophysical factors such as soil play key roles. However, if we accept the climate assumption, then it is possible to project the climate envelop forward into future climate scenarios, or backwards by 'hindcasting' into past climates.

**Slide 3 – Africa climate example, current**

Here is an example of climate modelling in Africa. This map represents the distribution of about 5000 species envelopes compiled on top of each other to create a model of species richness.

**Slide 4 – African climate example, future**

This map shows the same species envelopes projected forward into a 2100 climate scenario showing how African vegetation might react to climate change. For example, note the loss of the central African rainforests. Interestingly, this change is also thought to have happened in the past.

**Slide 5 – Bamboo data**

Zoe Godwin and the rest of the team brought together a data set of bamboo distribution based on herbarium records and field work. The field work is particularly important because it enables us to be confident about absence records. From the data set a total of 472 sites were selected to be used in the bioclimatic modelling process.

**Slide 6 – Building the model**

The next step is to start building the model. Data from the 472 sites were placed in a digital map divided into squares of about 1 km by 1 km. Ten bamboo species with more than ten records were chosen to model and it was assumed that absence of a species from the site was a 'real' absence. This assumption is problematic for herbarium records as all species may not have been collected from a site.

**Slide 7 – Species selected**

These are the names of the species selected, and they are probably familiar to many of you. But even if you know the biology of these species, from now on you have to look at these names as models rather than species. I will continue to the use the same names and will select two examples, but in the presentation I am no longer talking about the biological bamboo, but an 'in silico' bioclimatic envelope which is based on the distribution of the living bamboo but is determined by the modelling technique and climatic parameters used.

**Slide 8 – Climate parameters**

We used a limited number of climate parameters: absolute minimum temperature, total annual precipitation and a moisture index. These were derived from the WORLDCLIM climate surfaces which are created from meteorological station data. Some care needs to be taken with climate surfaces as it is possible that temperature data is created from elevation. This means that it is possible to get strong auto-correlation between variables if topographic information is included.

**Slide 9 – Modelling Approach**

Four different types of model were used on the data. Details on the modelling techniques are provided in the report so I won't discuss them here – in any case Colin McClean is the best person to talk about technical aspects. YOGA is the modelling technique developed by Colin himself – **YO**rk **G**enetic **A**lgorithm – which includes a Bayesian probability component to prevent the model fit becoming to 'hard and tight' when there are relatively few data points present. Colin tested the models using training sets in which 70% of the data was used to create a model which was then tested on the remaining 30%.

**Slide 10 – Testing the models**

Area under the curve (AUC) of the receiver operating characteristics (ROC) curve was used as the basis of model assessment.  A value of 1 means that the model has perfect predictive power, whereas a value of 0.5 suggests the model is performing no better than a random prediction.  Here are two examples from the model testing procedure. You can see that some of the models work well, but one model the 'Classification Tree' does not predict much beyond random so this model was not used any further. The other three modelling techniques performed well, especially our own YOGA technique!

**Slide 11 – Cluster analysis**

The standard ecological technique of cluster analysis was used to provide an assessment of species associations. Essentially this demonstrates a north-south replacement of species, as would be expected if species distribution is climatically determined. I am now going to show some model results for two species from either end of the clustering - *Yushania brevipaniculata* and *Fargesia nitida*.

**Slide 12 - *Yushania brevipaniculata***

This figure shows the average probability of occurrence across the three species-climate envelope modelling approaches for *Yushania brevipaniculata*. Black crosses represent survey sites. Blue squares represent observed species presence.

The colours used in these figures attempt to represent the uncertainty associated with the average values presented. The average value is represented by the degree of redness, from white through yellow to red. However, the intensity and saturation of the images is associated with the range of values from the different modelling techniques obtained for a pixel: if the range is narrow, the colour is sharp and bright; if the range is wide the colour is dulled and greyed.

**Slide 13 - *Fargesia nitida***

This figure represents the same modelling approach for *Fargesia nitida*.

From your experience – do these two models make sense? If the models shown here do not match your feeling for the natural distribution of the species then we'll have to think again, perhaps with more data. But if they are a reasonable approximation of reality then we can move on to the next step, which is projecting the bioclimatic envelopes forward into future climate scenarios.

**Slide 14 – Change over time**

Future projections were made using downscaled Hadley CM3 global circulation model climate projections for 2020 and 2080 under the high greenhouse gas emissions scenario. Change in climate suitability for the bamboo species modelled was then assessed both for the entire study area and for IUCN listed protected areas within the study area.

Interestingly, and perhaps unexpectedly, the species models show different responses. Four species (including *Yushania brevipaniculata*) have marked decreases in area, where-as two species (including *Fargesia nitida)* show increases in area. The other species have such a marked variation in response to the different modelling techniques that it is not possible to say what is happening with any degree of certainty.

**Slide 15 - *Yushania brevipaniculata***

This figure shows the average proportional change in climate suitability by 2080 for *Yushania brevipaniculata* across three species-climate envelope modelling approaches. Black crosses represent survey sites. Blue squares represent observed species presence.

Once again, the colours used in these figures attempt to represent the uncertainty associated with the average values presented. The average value is represented by the degree of red (decease in climate space) to blue (increase in climate space), through white (zero change). However, the intensity and saturation of the images is associated with the range of values obtained for a pixel: if the range is narrow, the colour is sharp and bright; if the range is wide the colour is dulled and greyed.

The degree of red here shows that the potential area available to *Yushania brevipaniculata* decreases.

**Slide 16 - *Fargesia nitida***

This slide shows the same analysis for *Fargesia nitida.*

In contrast, the degree of blue here shows the potential area available to *Fargesia nitida* increases.

**Slide 17 – Conclusions**

First of all, please remember that these are only models created using some key assumptions. The main one is that distribution of the species is determined solely by climate. As botanists we know that this is not true – but it is hard to model everything.

Secondly, the models suggest that some species will decrease their area under conditions of climate change, where-as the ranges of other species will expand. The impact of climate change on bamboo habitat might be rather complex with a re-adjustment of species associations and dominance.

Finally, these preliminary results demonstrate that the models work well with limited data. They would work better with more data and further research.

It is also worth saying that it is not only Pandas that might be affected by climate change. The bioclimatic modeling approach could be useful for developing policy on a much wider scale.

Thank you for your attention.