# Predicting the Impact of Climate Change on the Distribution of Wild Peanut Genetic Resources





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### **ABSTRACT**

We present the results of an analysis of the possible changes in the geographic distribution of selected wild peanut species under the influence of projected climate change. A dataset of geo-referenced germplasm collections and herbarium records was used to define a climatic envelope for each species in Arachis sect. Arachis. This was then extrapolated across the whole of the South America continent using a 10-minute grid of present-day climate and of predicted 2040-2069 climate (using the results of the HADCM2 model). The result ant shifts in species distributions are examined to assess the threats that climate change presents to wild peanut genetic resources in situ. Of the 17 species studied, 12 are predicted to be extinct in 2040-2069. Only three species can be considered geographically stable. The conservation implications for wild peanut genetic resources are discussed.

#### The Importance of Wild Relatives to Secure Food Security Now, and in the Future

Some wild Arachis species have already proved useful in peanut breeding A recent example of this is a new variety released by Simpson and Starr (2001), which incorporates germplasm from three wild relatives (A. cardenasii, A. diogoi, A. batizocoi) to reduce infestation of root-knot nematodes by >90% over nonresistant varieties. Groundnut is on of the few crops in which nematodes reduce crop yield directly by damaging pegs, pods and seeds and indirectly by feeding on roots and weakening the plants. On a worldwide basis, annual groundnut yield losses caused by nematodes are estimated at approximately 12%, while monetary losses are estimated at just over one billion US dollars &asser and Freckman, 1987).

It is important to note that there are just 17 conserved accessions of A. cardenasii, five for A. diogoi and 12 for A. batizocoi. This is a clear demonstration of the importance of conserving wild relatives to respond to the ever-changing attacks of pests and diseases and needs of farmers and consumers. It is important that germplasmcollections are sufficiently complete to anticipate these needs

The term "global warming" confuses the issue of climate change, insinuating that it involves an absolute change in temperature and rainfall across

We have calculated the number of stress-free days

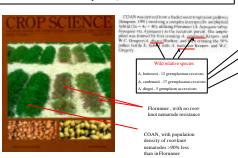
(Ea/Et>0.7 - discussed at length in Jones, 1987). The predicted change demonstrates that some regions

may benefit from climate change (the Colombian

of the Bolivian Altiplano), while most of South America sees a predicted decrease in stress free days.

Llanos, eastern Brazil and the Lake Titicaca region

the globe. In fact, it is a spatially complex phenomenon. The figures to the right highlight the spatial variation in the HADCM2 scenario for 2040-2069.



Predicted distribution of species richness in wild peanuts (whole genus Arachis). A total of 2175 geo -referenced germplasm accessions and herbarium records were used to produce potentia distributions of each species. These were then synthesised to give a prediction of species richness across the whole region. Hotspots are found in Mato Grosso do Sol in Brazil and in the Brazilian

Species	Change in area of distribution (%)	Predicted state in 2055
batizocoi	-100	Extinct
çardenasii	-100	Extinct
correntina	-100	Extinct
decora	-100	Extinct
diogoi	-100	Extinct
duranensis	-91	Threatened
glandulifera	-17	Stable
helodes	-100	Extinct
hoehnii	-100	Extinct
kempff-mercadoi	-69	Near-Threatened
kuhlmannii	-100	Extinct
magna	-100	Extinct
microsperma	-100	Extinct
palustris	-100	Extinct
praecox	-100	Extinct
stenosperma	-86	
villosa	-51	Near-Threatened

free days

Present distribution of species richness in section Arachis



Predicted 2055 distribution of species richness in section Arachi-

## Potential impacts of climate change

We used results from the Hadley Centre (HadCM2 model assuming 1% greenhouse gas increase per year to the period 2040-2069) obtained from the IPCC data distribution web site at http://ipcc-ddccruuea.ac.uk, These differentials were applied to a present day climate grid using inverse square distance weighting to interpolate to the grid pixel size of 10 arc minutes.

We then took geo -referenced data on genebank accessions and herbarium specimens from the "Catalogue of Arachis Germplasm Collections" compiled by Stalker et al. (2000), representing the known distributions of Arachis species. These data were used in FloraMap (Jones &Gladkov, 1999) to assess the climatic envelope of each species, or its current "potential" distribution. The results were then mapped across South America, for both present-day climate and the 2040-2069 climate scenario, to examine possible changes in distribution.



Here we see an example of the results, using the species Arachis stenosperma. The present "potential distribution ranges across various regions of Brazil, including Acre. In 2055, this distribution has shifted exclusively to Southern Brazil. The regions of overlap in the distributions are highly fragmented, and found

In fact, A stenosperma is endemic to the Cerrados and the Atlantic Highlands, Slow migration rates mean that not all climatically suitable areas have been reached by the species, eg in Acre. The region of possible survival of

Unless carried downstream by moving water, migration rates of wild peanut species rarely exceed Im per year. This means that populations are unlikely to survive unless they can adapt rapidly in situ to changing conditions.

Of the 17 species studied, we found that 12 have climatic envelopes with no overlap between the present and the 2040-2069 distribution scenarios. An additional two show significant reductions and fragmentation of their projected distributions, while only three species can be considered stable. The projected changes in Arachis species richness across South America alters current hotspots found in Brazil - where as many as five species presently occursympatrically - to eight isolated islands of one single species.

Davis et al. (1998) caution that predicting future distributions from climate envelopes is not straight-forward, but the results obtained thus far at least show us where to look for potential problems. It is suggested that field work be conducted to test the adaptation of some of the more highly threatened species to climates similar to those they are likely to encounter in the future in their current areas of distribution.

#### Implications for conservation

The implications of this analysis for both ex and in situ conservation include:

- · Prioritisation of those species most threatened with extinction in situ due to projected climate change
- · Identification of potential refugia for wild Arachis species under a changing climate (target sites for in situ
- · Identification of presently under-conserved hotspots, which are under threat of extinction from climate change (for rescue efforts through ex situ seed conservation)
- · Identification of areas showing potential for species relocation to enable long-term conservation in situ

### **Future Perspectives**

These results on Arachis illustrate the threat of climate change on the genetic foundation of a major food crop. It provides an imperative for concerted action to conserve germplasmof other major food crops. What is now needed is:

- . Expand this study to other major wild crop relatives (prelimin ary studies have been made for beans and rice, but
- · Investigate the ability of species to adapt to climate change using field-based experiments
- . Work with national programs and conservation NGOs so that spatially targeted conservation actions can be made to secure the status of these important genetic resources.

## Distribution of wild peanut species in South America

Climate change in South America

The genus Arachis consists of 69 described species, all endemic to South America, and includes the progenitors and closest wild relatives of the cultivated peanut (Arachis Inprogaea L.). Germplasmof wild peanuts is valuable as a source of traits for improving cultivated varieties, and is therefore high on the international agenda for conservation. We studied 17 species of wild peanuts from section Arachis to assess the potential impact of climate change on their distribution, and its implications for genetic resources conservation.

### FloraMap and its Users

The Users Group

FloraMap has a Web site at ht on the product, examples of its use and a growing list of Freque ntly Asked Questions with their answers. The solution to your difficulties with FloraMag

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