Managing lippia in the Murray Darling Basin under climate change

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Because of potential effects on temperature and rainfall, climate change will not only affect humans but also the plants and animals they live with. Of concern to rural communities is how changes in temperature and water availability will impact on the distribution and abundance of pests, both plant and animal.

Researchers from CSIRO and the Australian Defence Force Academy (ADFA, University of New South Wales) have been developing generic methods for assessing the effects climate change could have on weed invasions along rivers in the Murray-Darling Basin (MDB). They also looked at the implications of their results for weed management.

They chose lippia (*Phyla canescens*) as their test case for exploring the different modelling methods that could be used to predict the weed's distribution and the potential effects of change. Lippia is a severe environmental and agricultural weed which is widespread throughout the MDB.

Lippia is native to the Americas, where it is distributed from California to Argentina and Chile. The plant was introduced to Australia as a lawn species and has also been used in attempts to stabilise soil and prevent erosion on the banks of irrigation canals and around weirs. Floods and disturbance spread lippia down waterways and allow it to colonise new areas along the edges of waterways (the riparian zone).

Lippia now threatens native vegetation and soil stability on river banks. The weed has limited forage value and appears to suppress the growth of neighbouring plants.

Lippia in flower. (Photo by Andrew White, CSIRO Entomology)

Climate change and new water agreements will change the frequency and intensity of water flows, temperature and water quality in the MDB, but the affects of this on the spread of riparian weeds such as lippia are not yet understood.

THE TOOLS

Computer simulation models were used to predict the future distribution of lippia at different spatial scales.

At the largest spatial scale, a climate-matching model (Climex) was used to predict which geographic areas in Australian are climatically suitable for lippia. Climex uses global information on where the plant currently grows to predict areas in Australia which are climatically suitable for the weed.

Under current climate conditions most of the MDB appears suitable for the establishment of lippia but the Condamine, Border Rivers, Gwydir and Namoi catchments appear especially suitable. Parts of the more southern catchments are also classified as climatically suitable for lippia establishment, including the Lachlan, Murrumbidgee, Murray and the Central West (including Castlereagh, Macquarie and Bogan catchments), as well as Victorian catchments such as the Mallee and the Wimmera.

To explore alterations in these potential distributions under climate change, the researchers used OzClim, a future climate scenario generator developed by CSIRO Marine and Atmospheric Research and the International Global Change Institute.

Climex indicated that the main factor limiting the spread of lippia is moisture availability, and the scenarios generated by OzClim indicated that the changes in moisture due to climate change are unlikely to be sufficient to change the potential spread of lippia.

While these models provide useful information on the potential overall distribution of lippia they don't predict how quickly the weed will spread to occupy its potential

The Murray River in flood. Flood height and duration are key drivers of lippia spread throughout the MDB. (Photo by Willem van Aken, CSIRO Land & Water)

Lippia infestation in pasture near Somerset Dam in south east Queensland. (Photo by Andrew White, CSIRO Entomology)

range from an initial point of introduction.

This is an important question because in the early stages of invasion the distribution of a weed depends more on the number of offspring it can produce and the ability of these offspring to disperse, rather than habitat suitability.

So the researchers used a population simulation (PlantSim) model to look at how environmental variation affects the biology and growth of the plant over a small area. The model used experimental and field based observations on the performance of lippia under different soil moisture and temperature regimes.

When they looked at the response of lippia to flood duration, depth and frequency, they found that flood height and duration are key drivers of the growth and spread of lippia.

WHAT THEY FOUND

It appears that the geographic spread of lippia is clearly related to flood events. Although the weed can grow over a wide range of soil moisture conditions, it only flourishes over a narrow soil moisture range. Future climate predictions indicate that the greater part of the MDB will be drier and warmer under the enhanced greenhouse conditions.

But this does not necessarily mean that sudden extreme rainfall events will become less frequent or severe. In fact, increases in the volume of extreme rainfall and consequent extreme flood events have been predicted for the MDB despite overall decreases in mean annual rainfall.

THE WEED

Lippia seed can survive for many years in the soil, long after the parent plant has gone. Because the seeds remain viable for so long, they can take advantage of any extreme flood or rainfall events and an increase in the frequency of these could lead to more frequent sudden explosions in weed populations.

This problem is compounded by the overall reductions in overland flows in the MDB. For example, in a future scenario of generally lower flows but more extreme flow events, lippia is likely to increase sporadically. This is despite the fact that declines in annual rainfall, coupled with increases in annual temperature imply a general decrease in soil moisture.

In addition, increased temperatures and lower rainfall cause widespread drought, leading to increases in the area of bare ground available for lippia to colonise when there is a flood.

WHAT MIGHT HAPPEN?

In recent years prolonged drought, combined with overgrazing by livestock, has suppressed the growth of potentially competitive native pasture plants, increasing the amount of bare ground present over much of the inland floodplains of the MDB. Under these suboptimal drought conditions, lippia may not necessarily increase in density and distribution with time. But it continues to pose a severe threat due to its latent ability for population explosions following flood events of suitable duration and depth.

It is difficult, therefore, to forecast how big a risk lippia is to agriculture and the environment but it appears that reducing seed numbers is the best management option. This will decrease its potential to rapidly regenerate when optimal environmental conditions arise.

The methods developed by the researchers to explore the effect of climate change on a riparian weed will also be applicable to other riparian and floodplain weeds in the MDB and other catchments.

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