It is clear that anthropogenic climate change and IAS are individually two of the greatest threats to ecosystem structure and function, but their synergistic impact has only recently been considered.

In a recent World Bank commissioned report the authors referred to the “combined punch” of these factors and the need to consider them in a holistic manner.

Invasive alien species come in many forms and from a wide range of taxa, from zebra mussels to giant hogweed and Japanese knotweed (pictured), and predicting which ones could establish and go on to become invasive has been beyond most scientists. Be it reproductive strategy, propagule pressure or vacant niches, the one thing that seems clear is that climate change will favour this subset of species and impact negatively on the majority of endemic species.

It is ironic that the main drivers behind climate change are also the root cause of IAS impacts.

Transport and global trade both increase carbon emissions as well as facilitating the arrival of species to new habitats.

Historically, geographical barriers such as mountain ranges and oceans meant that regional ecosystems evolved to fit their environment, and potential invasive species co-evolved with their respective natural enemies, leading to some form of equilibrium. In recent times this isolation has broken down, with catastrophic results. Indeed, the only trait that all IAS share is the loss of natural enemies – a fact that is exploited by biological control scientists in controlling weeds and plant pests.

The range of all species, except perhaps humans, is limited by temperature and rainfall, and IAS are similarly constrained. As native species move out of their previous geographic range into their new climatic range they leave vacant niches to be exploited by IAS which were previously limited by niche availability. There is a natural assumption that, as temperatures rise, the British Isles will become vulnerable to exotic species native to more southern regions in continental Europe. While it is true that many species currently not common in the British Isles may be able to establish in the future, that will not happen at such a pace that their natural

enemies are left behind. What we need to concentrate on are species with ‘form’; ie those known to be invasive elsewhere in a similar eco-climatic range to those now predicted.

A classic example of this is one of the worst weeds in the world – water hyacinth – which has devastated aquatic habitats in tropical and subtropical areas of the world from Sri Lanka to Kenya. This weed would never previously have registered on our invasives radar, but anyone who has witnessed the extent of its impact in Portugal and its continued move northwards would urge caution. Of course, the frantic efforts of the horticultural industry to produce cold-tolerant varieties will probably accelerate the process.

While it is appropriate to concentrate mainly on plants as the primary drivers of ecosystems, with the biggest impacts as invaders, pests and diseases may also benefit from climate change.

A doubling of suitable ‘climate space’ by 2060/70 is predicted for the Colorado potato beetle, with obvious impacts on agriculture, while the rapid expansion in range of the chestnut leafminer could lead to ‘leaves on the line’ problems for our railways in summer.

One overlooked but important and vulnerable ecosystem is temperate peatlands, which account for 25% of the total soil carbon on earth and are a major carbon sink, absorbing around 12% of current human emissions. Unfortunately, they are not immune from climate change, as increased temperature and nitrogen deposition both increase productivity and decomposition, leading to bogs moving from carbon sink to carbon source and becoming susceptible to IAS.

Climate change has impacts other than climatic ones. Most plants in the world are limited by CO_2 availability, which is currently 30% higher than in pre-industrial times. Elevated CO_2 makes plants more efficient at fixing carbon or utilising nitrogen. This fertilisation effect will make plants grow faster and it is possible that faster-growing species will benefit more.

Thus, invasive species are likely to gain yet another advantage over their new neighbours, and that could become manifest simply through a faster rate of invasion or even the eventual conversion of the whole ecosystem. The latter would be particularly so for woody invaders that are likely to benefit the most, resulting in subdued grass fire regimes in some regions and a complete conversion of plant functional type dominance in others. However, invasive C4 grasses are actually accelerating fire cycles and causing forest loss in Asia, Africa and the

Americas.

That shows how difficult it can be to predict the combined effects of climate change and IAS.

Although not a prerequisite for successful invasion, disturbed areas tend to be more susceptible to invasion than undisturbed ones. One likely outcome of climate change – an increase in extreme weather events such as hurricanes and wildfires – will dramatically alter previously invasionresistant communities.

Although the UK is not as vulnerable to the combined impacts of climate change and IAS as Mediterraneantype ecosystems and southern oceanic islands, there is no room for complacency. While reducing climate change must be a global activity, reducing the threat posed by IAS can be achieved nationally. The most successful intervention is prevention.

Despite the voluntary Horticultural Code of Conduct, of which most customers and suppliers seem unaware, known invasive species like Himalayan balsam and crassula helmsii (cunningly renamed as tillea recurva) are still for sale. In anticipation of climate change the gardening press has been covering new tolerant species, and a direct consequence is the appearance of Mediterranean invaders like tree of heaven, goldenrods and bamboos outside the confines of the British garden.