

# GISP

The Global Invasive Species Programme



## Invasive Species and Poverty:

*Exploring the Links*

## Foreword

Invasive alien species are more often than not pigeon-holed as an environmental or biodiversity issue, and consequently – especially in developing countries – do not receive due recognition by policy-makers. Yet the reality is that they are a major threat to human livelihoods, especially to agriculture and therefore food security, and are generally undermining human well-being. Moreover, ongoing globalisation and increasing trade are escalating the problem to critical proportions. We hope that this booklet will contribute towards a better understanding of these links and to placing invasive species firmly on the development agenda.

A handwritten signature in blue ink, appearing to read 'Dennis Rangji', with a large, stylized flourish extending from the end.

**Dennis Rangji**

Chair: GISP Board

The GISP mission is to conserve biodiversity and sustain human livelihoods by minimising the spread and deleterious impact of invasive alien species.

## Contents

- 2 Biodiversity, Ecosystem Services and Human Well-being
- 4 Invasive Species as a Factor in Biodiversity Loss and Ecosystem Change
- 6 The Costs of Invasive Species Impacts
- 8 Rural Communities Bearing the Brunt
- 10 Invasive Species and Food Security in Africa
- 11 Invasive Species and the Millennium Development Goals

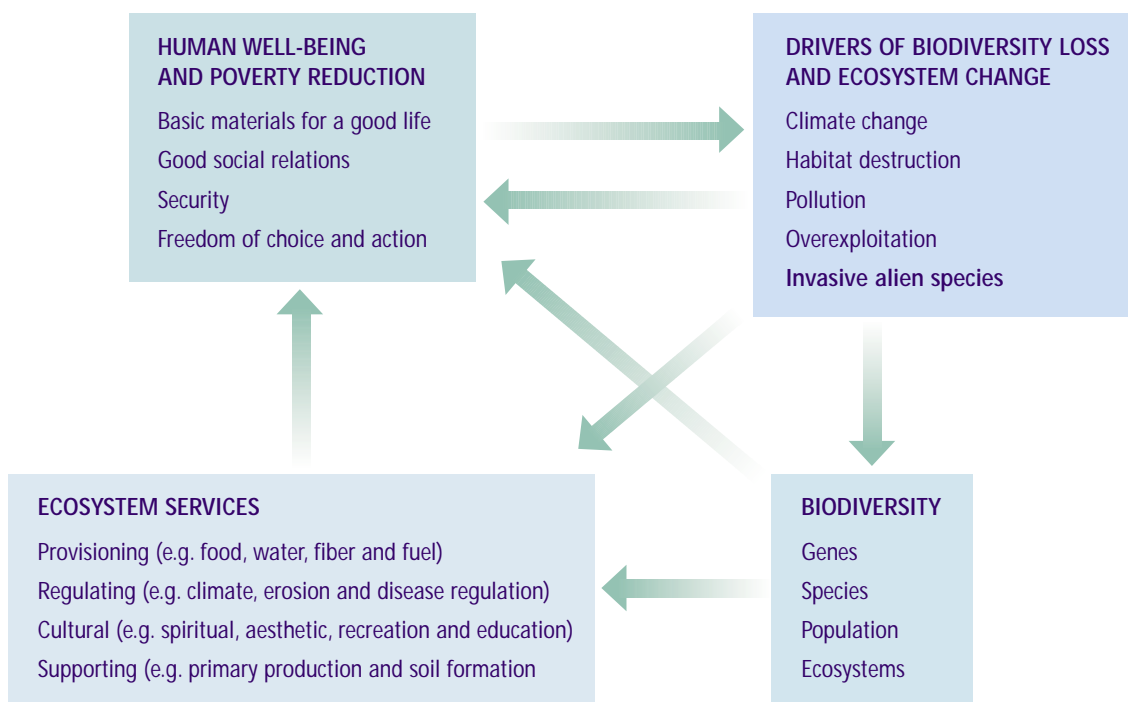


# Biodiversity, Ecosystem Services and Human Well-being

**The Millennium Ecosystem Assessment**<sup>1</sup> defined five primary components of human well-being: the basic materials for life (such as food, shelter and livelihood options); health (including clean air and water); security; good social relations; and freedom of choice and actions. And while the accessibility of these to any particular individual or community is significantly influenced by their socio-political circumstances, the availability of many is dependent on biodiversity, ecosystems and ecosystem services.

Biodiversity is often described as 'the diversity of Life on Earth', encompassing all genes, species, populations and ecosystems. It is essential for the functioning of healthy ecosystems, which in turn provide a variety of services vital for human well-being.

These 'ecosystem services' include resources such as food, water, building material and traditional medicines; processes regulating water purification, soil formation, flood attenuation, erosion control, crop pollination and nutrient cycling, as well as cultural aspects such as recreational opportunities and spiritual fulfillment.



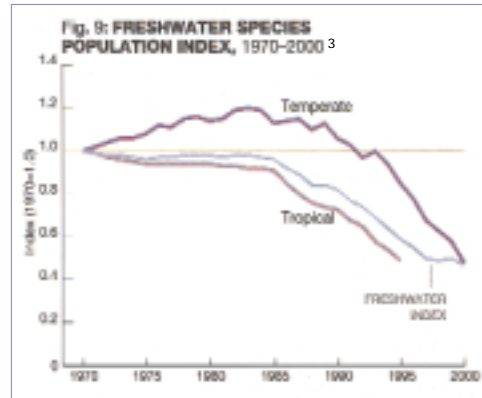
**The Millennium Ecosystem Assessment** was conducted between 2001 and 2005 to assess the consequences of ecosystem change for human well-being, and to analyse options available to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being. Carried out by some 1360 experts from 95 countries, it developed four global scenarios exploring plausible future changes in drivers, ecosystems, ecosystem services, and human well-being. It also examined the strengths and weaknesses of various response options that have been used to manage ecosystem services, and identified promising opportunities for enhancing human well-being while conserving ecosystems.



It follows that the loss of biodiversity and degradation of ecosystems inevitably affects human well-being, contributing to lower food security, harsher living conditions, worsening health, and reduced wealth. Particularly vulnerable are the poor, who, to a large extent, are directly dependent on biodiversity-based goods and the associated ecosystem services for their livelihoods. In Africa, for example, agriculture provides 60% of all employment, and 80% for populations in rural areas<sup>2</sup>.

It is of great concern, therefore, that over the past few hundred years species extinction rates have increased by as much as 1000 times, and that amongst the higher taxa, the majority of species are in decline. The Living Planet Index – an aggregate indicator of the state of biodiversity – showed, for example, a drop in the index for freshwater species of about 50% between 1970 and 2001<sup>3</sup>. The Millennium Ecosystem Assessment also found that humans have changed Earth's natural ecosystems more rapidly and extensively in the last 50 years than in any other period. About 35% of the world's mangroves have been lost over the last two decades<sup>4</sup>, while some 13 million hectares of forest are lost each year due to deforestation<sup>5</sup>.

The Millennium Ecosystem Assessment identified the main drivers of biodiversity loss and ecosystem services as climate change, unsustainable resource use in the form of over-exploitation, pollution and habitat destruction, and **invasive alien species** – all due to human activity.



The Convention on Biological Diversity defines biodiversity loss as “the long-term or permanent qualitative or quantitative reduction in components of biodiversity and their potential to provide goods and services, to be measured at global, regional and national levels”. The Convention’s member countries have committed to achieving a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth by 2010 – the so-called 2010 Target.



## Invasive Species as a Factor in Biodiversity Loss and Ecosystem Change

Invasive alien species are species that are introduced as a consequence of human activities to new geographic areas, where they become established and then proliferate and spread, to the detriment of human interests and natural systems.

While the problems caused by invasive species have been evident for many years, the issue has become increasingly important during the last half-century, as the globalisation of trade and industry has resulted in increased mobility of people and goods, and the associated transport of plants, animals and micro-organisms around the world. Furthermore, it is anticipated that the problem will be exacerbated in future by climate change, which is likely to favour species that are opportunistic – a characteristic of many invaders.



**AQUACULTURE** – primarily based on species introduced **intentionally** – is one of the fastest growing sectors of the global food economy, increasing by more than 10% per year and currently accounting for over 30% of all consumed finfish and shellfish. While there are clearly benefits in terms of food availability, there are many examples of cultured species – or their parasites – becoming invasive, with consequent negative effects outweighing the benefits.



**SHIPPING** is a major pathway for the **unintentional** introduction of aquatic invaders, which may be carried in ballast water and/or as fouling organisms on the hull and other parts of the vessel. The value of worldwide exports grew from US\$192 billion in 1965 to \$6.2 trillion in 2000. As the primary mode of transport for these goods, it is estimated that the global shipping industry will more than double by the year 2020.

Invasive species have now affected nearly every ecosystem type on the planet and pose one of the biggest threats to biodiversity worldwide<sup>6,7</sup>. They impact native species both directly – for example, by preying on and competing with them for resources such as food and breeding sites – as well as indirectly by altering habitat and modifying hydrology, fire regimes, nutrient cycling and other ecosystem processes. Together these impacts are resulting in the loss of biodiversity and dramatic changes to ecosystems, confirmed by a recent global assessment showing invasive alien species to have affected 30% of threatened birds (but as much as 67% on islands), 11% of threatened amphibians, and 8% of threatened mammals<sup>8</sup>.

The loss of biodiversity and the associated ecosystem services precipitated by invasive species – amongst other things – are, however, important not only in their own right. They clearly also have consequential impacts on human well-being.



Infestations of invasive plants tend to modify **fire** regimes by increasing the frequency and intensity of wildfires. Their dense growth adds to the fuel load, while some species contain highly flammable compounds. Very hot fires may destroy the seeds of indigenous species, leading to a loss of biodiversity.

Invasive species negatively impact biodiversity by altering ecosystem processes. For example, in South Africa's Cape Floristic Region – world renowned for its rich biodiversity – the **Argentine ant** has invaded fynbos communities, where it interferes with pollination and seed dispersal. Its aggressive behaviour deters some insect pollinators of fynbos plants, and also displaces native ants that disperse fynbos seeds. While the native ants carry seeds into their underground nests to consume the attached food body, Argentine ants leave the seeds on the surface, where they are exposed to fire and predation by rodents. Although fire is vital for germination of most fynbos plants, seed burial provides a buffer against intense heat, which destroys many seeds.



**Pine trees** are invasive in most southern hemisphere countries where they were introduced, primarily for forestry purposes. In open ecosystems such as grasslands and savannas their higher water requirements have a dramatic effect on hydrology, particularly in catchment areas and along watercourses, where they reduce runoff and hence river flow. Dense stands of pines also lower the water table, displace native species, alter nutrient cycling and increase the risk of fire.

**Rats** have a devastating impact on biodiversity. By preying on other species and competing with them for food, they have caused the decline of many small mammals, birds, reptiles and invertebrates. Their effect has been particularly severe on islands – they are responsible for more island extinctions of birds, snakes and lizards than any other predators.



## The Costs of Invasive Species Impacts

Apart from their threat to biodiversity and ecosystem services, invasive species have a significant socio-economic impact. They reduce yields from agriculture, forestry and fisheries, decrease water availability, cause costly land degradation, block transport routes and contribute to the spread of disease. They also reduce the effectiveness of development investments by, for example, choking irrigation canals, fouling industrial pipelines and threatening hydroelectric schemes. Invasive species therefore contribute to social instability and economic hardship, placing constraints on sustainable development, economic growth, poverty alleviation and food security.

In 1993, the Office of Technology Assessment<sup>9</sup> of the US Congress estimated that the 79 most harmful invasive species had caused damage of \$97 billion in the USA since 1906<sup>10</sup>. Pimental and colleagues<sup>11-14</sup> subsequently updated and extended these estimates to other countries. Annual losses to pests were estimated at US\$ 6.24 billion in Australia, US\$ 42.60 billion in Brazil, US\$ 78.50 billion in USA, US\$ 5.56 billion in the UK, US\$ 91.02 billion in India and US\$ 4.30 billion in South Africa. Globally, the costs of damage caused by invasive species has been put at US\$ 1.4 trillion per year – close to 5% of global GDP<sup>12</sup>.

While the methodology of these studies has been questioned, the figures provide an interesting comparison between developed and developing countries. Estimated damage caused by invasive species was equal to 53% of agricultural GDP in the USA, 31% in the UK and 48% in Australia. By contrast, the damage in South Africa, India and Brazil amounted to 96%, 78% and 112% of agricultural GDP of these developing countries respectively<sup>12</sup>.

Given that agriculture accounts for a higher share of the GDP in developing countries, the impact of invasive species on overall economic performance is proportionately greater in developing countries. In India, for example, Pimentel's estimates imply that the annual costs associated with invasive species control and damage amounted to 20% of GDP in 1999, compared to less than 1% in the USA<sup>12</sup>. Apart from directly affecting the performance of these sectors, by impacting on the GDP, invasive species also reduce the ability of the affected Governments to allocate the funding required to address the problem, making them more prone to bioinvasions. Compounding the issue, these countries are then more vulnerable to trade embargoes based on the presence of invasive species.

SPECIES	ECONOMIC VARIABLE	ECONOMIC IMPACT	REFERENCE
Introduced disease organisms	Annual cost to human, plant, animal health in USA	\$41 billion per year	Daszak et al., 2000 <sup>15</sup>
Coypu/nutria (aquatic rodent)	Damages to agriculture and river banks in Italy	\$2.8 million per year	Panzacchi et al., 2004 <sup>16</sup>
Zebra mussel	Damages to US and European industrial plants	Cumulative costs 1988-2000 = \$750 million to 1 billion	National Aquatic Nuisances Species Clearinghouse, 2000 <sup>17</sup>
Six weed species	Costs in Australia agroecosystems	\$105 million per year	Watkinson, Freckleton & Dowling, 2000 <sup>18</sup>
Pines, hakeas and acacias	Costs on South African Floral Kingdom to restore to pristine state	\$2 billion	Turpie & Heydenrych, 2000 <sup>19</sup>
Water hyacinth	Costs in 7 African countries	\$20-50 million per year	Joffe-Cooke, 1997 <sup>20</sup>
Varroa mite	Economic cost to beekeeping in New Zealand	\$267-602 million	Wittenberg & Cock, 2001 <sup>21</sup>
Comb-jelly	Lost anchovy fisheries in Black Sea	\$17 million per year	Knowler & Barbier, 2000 <sup>22</sup> Knowler, 2005. <sup>23</sup>
Golden apple snail	Damage to rice agriculture in Philippines	\$28-45 million per year	Naylor, 1996 <sup>24</sup>

(adapted from McNeely, 2004<sup>25</sup>)





**Water hyacinth** is the world's worst aquatic weed. Its dense growth blocks waterways and inhibits boat traffic, disrupting trade, fishing and recreational activities. The plant is a weed of wetland crops such as rice and jute, and often clogs irrigation canals and pumps, so it also impacts agricultural production. The floating mats threaten hydroelectric schemes, pose a health risk by creating suitable habitat for mosquitoes, snails and other vectors of disease, and can damage road and rail bridges when swept downriver during floods.

**The South American nutria, or coypu**, was widely introduced for its thick, soft fur, but is now considered a pest because of its burrowing and feeding habits. It causes considerable losses in crops such as rice, sugarcane, corn and soybean, as well as some fruit and vegetables. Its burrowing weakens the banks of rivers, dams and irrigation canals, and may undermine building foundations and road beds. By gnawing on wooden structures, nutria also damage buildings and jetties.



**The European wasp**, also known as the German yellowjacket, has a severe economic impact in many invaded regions as it causes losses to beekeepers and fruit farmers. It attacks beehives to prey on bees and steal pollen and honey, and damages soft fruit, reducing their market value and making them more susceptible to infection.

**Invasive mussels** typically cause massive fouling problems. They clog the intakes, pipes and filters of water treatment facilities, industrial plants and power stations, thereby reducing flow velocity, compromising efficiency and disrupting cooling systems. They impact aquaculture production by fouling cages and nets, and competing with other filter-feeders for planktonic food. Fouling on boat hulls increases drag, which reduces speed and increases fuel expenses, while clogging of the cooling intakes may cause the engine to overheat, with costly results.



## Rural Communities Bearing the Brunt

Developing countries are particularly vulnerable to the threats posed by invasive species because their economies typically rely heavily on agriculture, forestry and fishing. Moreover, within these countries it is generally the rural communities who are most at risk, as their livelihoods are almost solely based on these economic sectors, while the poorest people may be dependent on biodiversity-based products for food, fuel and construction material. In contrast, urban and/or wealthy people tend to be buffered from the effects of loss of biodiversity and ecosystem services by their increased access to alternate resources and their stronger purchasing power.

Since the majority of studies on economic impacts of invasives have been done at the macro level, the Global Invasive Species Programme (GISP) – in an effort to gain a broader understanding of these impacts – recently commissioned a study on the effects of invasive species on the livelihoods of poor, rural communities. The project used a variety of techniques to gather qualitative and anecdotal evidence of such effects in communities around the world. It soon became evident that the effects of invasive species on rural livelihoods are complex and varied. While many invasive species inflict a heavy burden on rural people, others are integrated into their livelihoods, either as cultivated species or through exploitation of wild populations for food, construction material, fuelwood and even traditional medicine.

The following conceptual framework was therefore devised<sup>26</sup> to categorise invasive species based on the degree of their invasiveness, and their use to society.

		AGGRESSIVENESS	
		LOW	HIGH
BENEFICIAL TRAITS	HIGH	<p><b>Undesirable, docile species</b></p> <p>The species has negligible or low impact on rural people, because its invasivity is low. Hence it is easily controlled, although such control does represent a cost. It currently has no known direct or indirect use.</p>	<p><b>Undesirable, aggressive species</b></p> <p>The species has no or limited direct or indirect benefits to people. It invades rapidly, and is often difficult to control. The impacts on rural livelihoods will be most severe in the later phases of invasion. Rural communities are frequently unable to control the species without external help.</p>
	LOW	<p><b>Useful, docile species</b></p> <p>Not very invasive, the species is easy to manage. Benefits can be extracted from it, so rural people with limited livelihood options will exploit it to maximum benefit. Such exploitation will be sufficient to keep it in check in most situations.</p>	<p><b>Useful, aggressive species</b></p> <p>The species invades habitats rapidly, and may be difficult to control. It is useful to the invaded society and hence there is resistance to its complete removal. Harvesting by dependent communities is an inadequate control measure, so abundance and concomitant ecological costs increase with time.</p>

Nevertheless, although some invasive species may be considered ‘useful’ by particular groups of rural stakeholders, their presence is likely to have negative consequences for others, creating the potential for conflict. In the Eastern Cape of South Africa, for example, the prickly pear *Opuntia ficus-indica* provides a source of food and income for poor local communities, but negatively impacts subsistence farmers by reducing the carrying capacity of land for livestock. Such complexities must be considered when developing strategies on how best to tackle the invasive species problem in developing countries.



## CASE STUDY: UNDESIRABLE AND AGGRESSIVE INVADER



The triffid weed *Chromolaena odorata* is an aggressive invader in Swaziland, where close to 70% of the population relies on subsistence agriculture. The weed negatively affects subsistence farmers by reducing the size of arable land and grazing pastures, limiting the availability of water for crop irrigation, increasing the cost of land clearing, and forcing the closure of cattle-fattening ranches.

Invasion by *Chromolaena* has also impacted traditional healers, who report difficulties in collecting medicinal plants in infested areas, as well as a commercial

plantation in the Highveld region, which has had to implement costly chemical spraying to control encroachment of the weed.

Together these impacts translate into loss of income, employment and food security in a region that is already struggling to cope with high levels of poverty and HIV/AIDS.

## CASE STUDY: USEFUL BUT AGGRESSIVE INVADER



*Lantana camara* is regarded as one of the world's ten worst invasive alien species, but in India it is used as a hedge plant, as a source of paper pulp, fuelwood and traditional medicine, and even as a craft material for weaving baskets and making furniture.

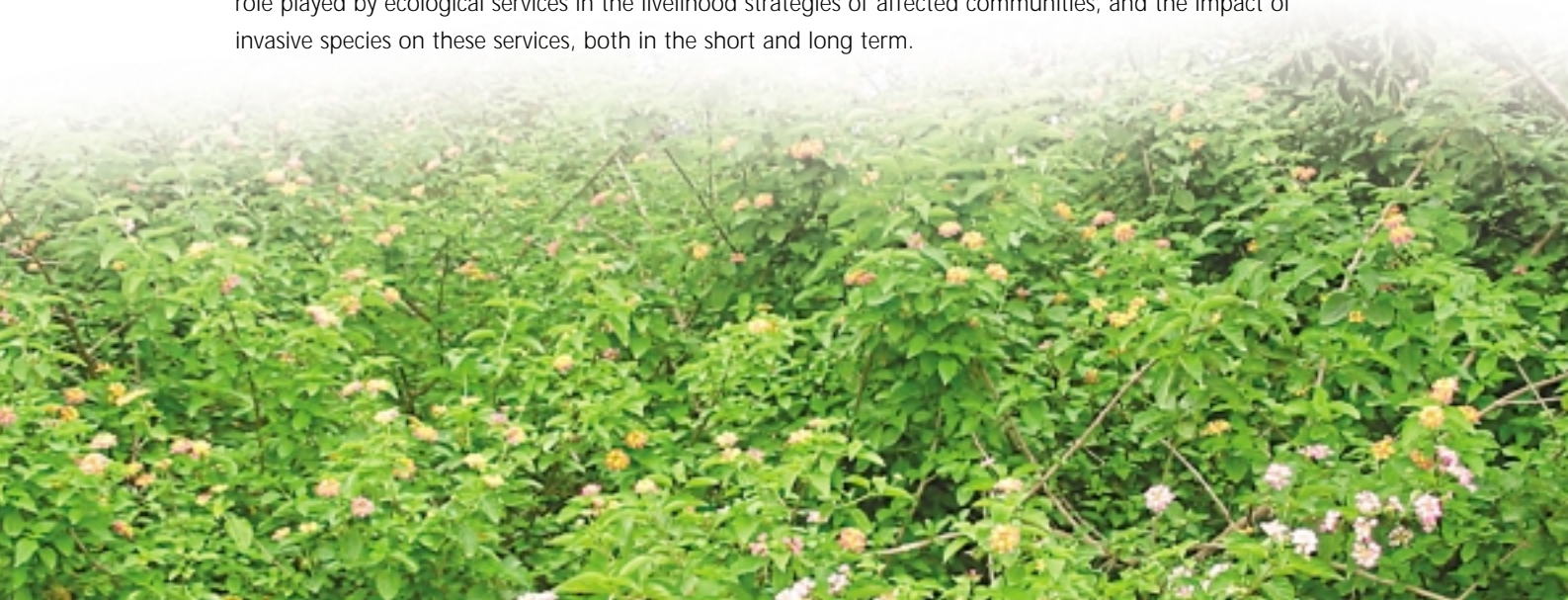
Invasion by *Lantana* is known to cause significant changes in the structure and function of forests by obstructing potential succession processes, interfering with fire regimes and pollination services, and displacing native flora and fauna. However, in recent

years several local communities have begun using *Lantana* as a craft material in place of bamboo and rattans, which have dwindled due to overextraction.

Encouraging people to use *Lantana* in this way not only reduces pressure on native resources, but also creates options for improving rural livelihoods. Large-scale harvesting may even help control the spread of the species, and allow native biodiversity to regenerate and recover.

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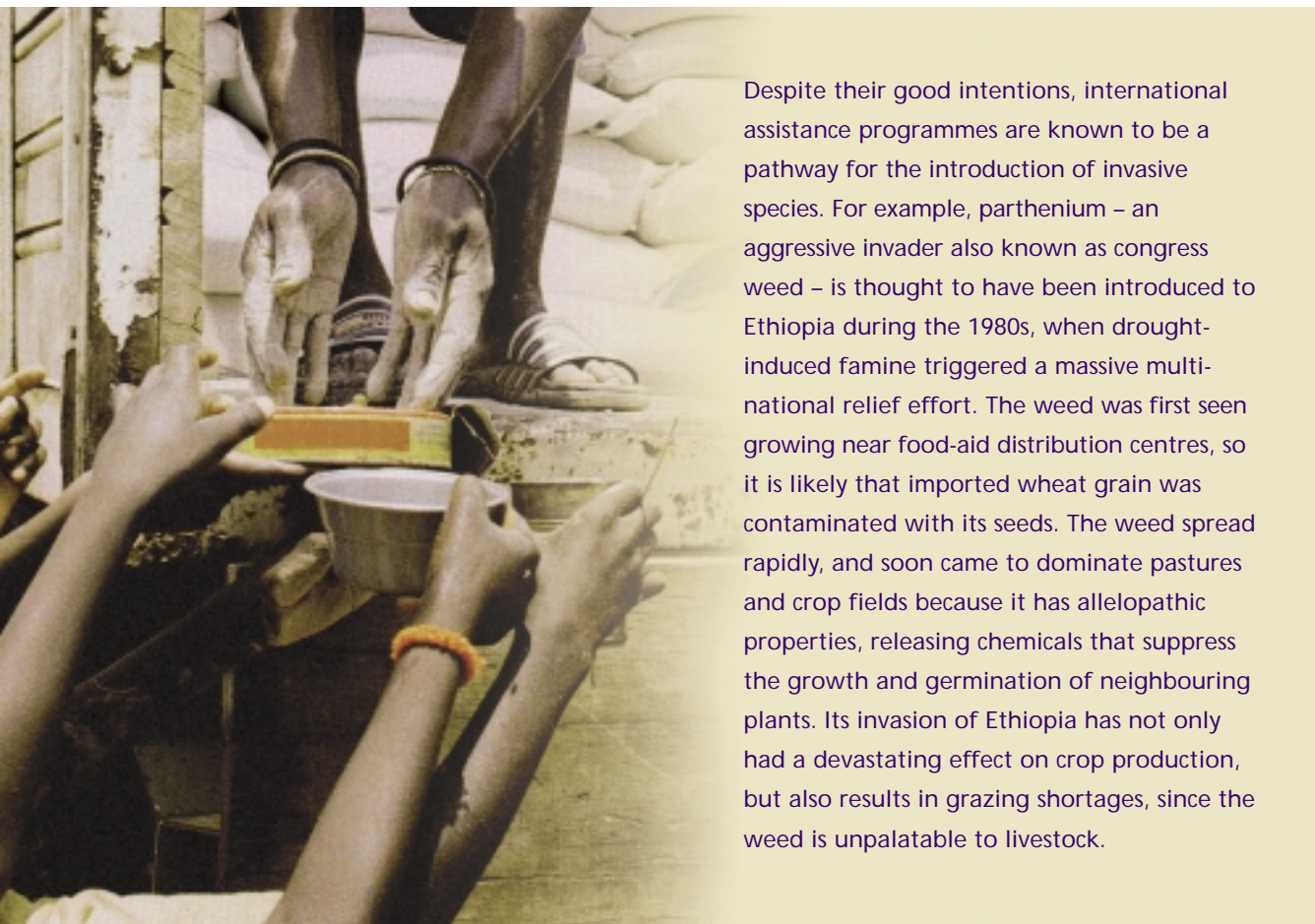
Clearly, gaining insight into the impact of invasive species on rural livelihoods requires an understanding of the causes, consequences and economic forces that drive invasions. It also requires an understanding of the role played by ecological services in the livelihood strategies of affected communities, and the impact of invasive species on these services, both in the short and long term.



## Invasive Species and Food Security in Africa

In Africa agriculture provides 60% of all employment and is the mainstay of most national economies<sup>2</sup>. As a sector it also generates more than 40% of the continent's foreign exchange earnings. In rural areas it is even more important, supporting 80% of the population, including 70% of the continent's impoverished and undernourished people. Agriculture and food security are therefore critical to the livelihoods and survival of individuals, communities and countries in Africa.

Two of the most important crops in Africa are maize and cassava. In sub-Saharan Africa – where an estimated 200 million people are chronically undernourished – maize is the staple food for an estimated 50% of the population, yet the region has the lowest maize productivity yields in the world, largely due to invasive species. For example, invasive witchweed (*Striga hermonthica*) from West Africa is responsible for annual maize losses in excess of US\$ 7 billion, and impacts on the lives of more than 300 million Africans<sup>27</sup>. Likewise, the cassava mealybug (*Phenacoccus manihoti*) resulted in cassava yield losses of up to 80%, before it was brought under biological control. The larger grain borer (*Prostephanus truncates*), native to South America, also attacks cassava, maize, and a range of other staple food. In Tanzania it causes some US\$ 91 million in maize losses per annum, and in West Africa is responsible for cassava losses of approximately US\$ 800 million per annum<sup>28</sup>. These and other invasive species have been estimated to cause losses in yield of eight of Africa's principal crops amounting to approximately US\$ 12.8 billion per annum<sup>29</sup>.



Despite their good intentions, international assistance programmes are known to be a pathway for the introduction of invasive species. For example, parthenium – an aggressive invader also known as congress weed – is thought to have been introduced to Ethiopia during the 1980s, when drought-induced famine triggered a massive multi-national relief effort. The weed was first seen growing near food-aid distribution centres, so it is likely that imported wheat grain was contaminated with its seeds. The weed spread rapidly, and soon came to dominate pastures and crop fields because it has allelopathic properties, releasing chemicals that suppress the growth and germination of neighbouring plants. Its invasion of Ethiopia has not only had a devastating effect on crop production, but also results in grazing shortages, since the weed is unpalatable to livestock.

## Invasive Species and the Millennium Development Goals

The United Nations Millennium Development Goals<sup>30</sup>, summarized in the table below, were adopted by governments in 2000 to address the needs of the world's poorest people by 2015.

Invasive species are clearly compromising our ability to meet these goals, both directly by imposing constraints on various economic activities at commercial and subsistence levels, and indirectly in as much as the costs being incurred by national governments to prevent, control and counteract the impacts of invasive species are reducing the funding available to meet these goals.

The need for a better understanding of the economics of these issues should, therefore, not delay the development and implementation of strategies to deal with them. Invasive species must be recognised as a development issue, and addressed as a matter of urgency.

GOAL	CONSTRAINTS IMPOSED BY INVASIVE SPECIES
<ol style="list-style-type: none"> <li>1. Eradicate extreme poverty and hunger</li> <li>2. Achieve universal primary education</li> <li>3. Promote gender equality and empower women</li> <li>4. Reduce child mortality</li> <li>5. Improve maternal health</li> <li>6. Combat HIV/AIDS, malaria and other diseases</li> <li>7. Ensure environmental sustainability</li> <li>8. Develop a global partnership for development</li> </ol>	<ul style="list-style-type: none"> <li>• Reduce yields of agriculture, forestry and fisheries</li> <li>• Diminish the availability of natural resources for subsistence purposes</li> <li>• Cause land degradation and damage to housing</li> <li>• Detract from tourism potential</li> <li>• Lower the quantity and quality of water supplies, but may promote flooding</li> <li>• Increase transport costs</li> <li>• Compromise the viability of irrigation canals and hydroelectric schemes</li> <li>• Limit access to export markets due to diseased animal and plant products</li> <li>• Cause a variety of human health problems</li> </ul>



Almost 3 billion people, or half the world's population, live below the poverty line, surviving on less than \$2 per day. In sub-Saharan Africa alone, 16 million children are underweight.

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## Useful websites

Millenium Ecosystem Assessment: [www.maweb.org/en/index.aspx](http://www.maweb.org/en/index.aspx)

Living Planet Index: [www.panda.org/livingplanet](http://www.panda.org/livingplanet)

Poverty-Environment Partnership: [www.povertyenvironment.net](http://www.povertyenvironment.net)

UNDP/UNEP Poverty and Environment Initiative: [www.undp.org/pei/peppapers.html](http://www.undp.org/pei/peppapers.html)

Convention on Biological Diversity: [www.biodiv.org](http://www.biodiv.org)

## Photo credits

We are grateful to all those who have made their photographs available, including Silvia Ziller (p. 5, pines); David Mudge (p.5, rat); Bob Jones (p. 7, water hyacinth); Pierre Hebert (p. 7, nutria) and R. Coutin/OPIE (p. 7, wasp).

# The Global Invasive Species Programme – a Partnership in Action

The goals of the Global Invasive Species Programme are to:

**1. Prevent the spread of invasive species through:**

- Promotion of international cooperation for pathways/vector management;
- Development and dissemination of risk assessment tools;
- Training of relevant authorities;
- Provision of technical support to the drafting of invasive species prevention strategies;

**2. Reduce the impact of established invasive species on natural ecosystems and human livelihoods across the globe to a minimum, through the:**

- Dissemination of knowledge on best management practice;
- Provision of technical support to the drafting of invasive species management plans;
- Development of institutional, legal and technical capacity in countries and regions;
- Mainstreaming of invasive species issues into relevant sectors;

**3. Create a supportive environment for improved management of invasive species, through:**

- Awareness and capacity building initiatives;
- Exchange of information;
- Networks of invasive species specialists and managers.



Global Invasive Species Programme  
South African National Biodiversity Institute  
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