Chapter 3

Global environmental challenges to the integrity of Indigenous Peoples' food systems

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> "In less than 100 years since the colonization of Hokkaido, our land was changed to farmland and resort land, the mountains are ruined, rivers are covered with concrete and their flows were changed by dams."
>
> Koichi Kaizawa, Ainu community leader

Abstract

The integrity of Indigenous Peoples' food systems is intimately connected to the overall health of the environment. Recent declines in many aspects of environmental quality, from loss of biodiversity to environmental contamination, have combined with social, economic, political and cultural factors to threaten the health and well-being of Indigenous Peoples, and ultimately of people everywhere. This has affected the quality of indigenous food, restricted its availability or curtailed access to it.

All of the global case studies of Indigenous Peoples in the Indigenous Peoples' Food Systems for Health Program indicate concerns over environmental degradation as a major aspect of Indigenous Peoples' declining use of their indigenous food. Interconnected concerns include biodiversity loss of wild species and of cultivated species and varieties; hydroelectric dams and their impacts on fish and other foods; contamination of water and food from a host of chemical, radioactive and biological pollutants; and climate change, with its accompanying uncertainties and instabilities regarding food systems.

Reconnecting Indigenous Peoples with their traditional territories, and reversing some of the restrictive regulations against Indigenous Peoples' historical hunting and plant harvesting practices may help to restore and maintain traditional resources. More cooperative arrangements for co-management of habitats and resources should be instated. Collaborative research is recommended, such as that reflected in this volume in which environmental and other relationships among Indigenous Peoples' cultures, lands and resource stewardship are complemented with supporting work by academic partners. Ultimately, this will help to maintain and strengthen the resilience of ecosystems and cultural systems, including diverse and healthy food systems.

Introduction

Humans are completely dependent on healthy environments for their health and well-being. Global human food systems have been created and supported by a combination of the earth's multitudes of life forms and ecosystems and by human ingenuity, developed and shared over many thousands of years. Today, however, both the cultural diversity and the global biodiversity that gave rise to human food systems are threatened in many places, and Indigenous Peoples' food systems are particularly vulnerable (Davis, 2001; Carlson and Maffi, 2004; Wilson, 1992). To maintain the integrity of human food systems around the world, the environmental problems affecting biodiversity and biological productivity must be addressed, as the survival of the life forms that provide food, directly and indirectly, is fundamental to the well-being of human cultures and populations.

Almost daily, reports of environmental problems with impacts on human nutrition dominate the media. All of these influence human nutrition through:

- overexploitation of major fish stocks (Jackson *et al.*, 2001; Myers and Worm, 2003; Pauly *et al.*, 2000; Roach, 2006; Schindler *et al.*, 2002), forests (FAO and IPGRI, 2002) and terrestrial wildlife (Bennett and Robinson, 2000);

Table 3.1 Environmental impacts identified as affecting indigenous food systems of case study communities

Source/type of environmental impact	*Examples/food system impact*	*References*
Erosion of biodiversity (wild species)	Threats to caribou calving grounds from natural gas pipeline and oil drilling in Arctic regions; widespread loss of tropical forests; decreased yield and availability of certain foods (e.g., ooligan for Nuxalk; wild fish and shellfish species, and wild game in many places)	Egeland *et al.*, 2009 (Inuit, Nunavut); Kuhnlein *et al.*, 2009 (Gwich'in, northern Canada); Chapter 8 in this volume (Ingano, Colombia); Turner *et al.*, 2009; Chapter 11 in this volume (Nuxalk, western Canada)
Erosion of biodiversity (cultivated species)	Decreased use and loss of cultivated varieties (cultivars or landraces) (e.g., traditional cereals, banana varieties, taro, breadfruit); threats from large-scale monocultures and genetically modified food crops	Brookfield and Padoch, 1994; Chotiboriboon *et al.*, 2009; Chapter 10 in this volume (Karen, Thailand); Creed-Kanashiro *et al.*, 2009; Chapter 5 in this volume (Awajún, Peru); Englberger *et al.*, 2009; Chapter 12 in this volume (Pohnpei, Federated States of Micronesia); Salomeyesudas and Satheesh, 2009; Chapter 6 in this volume (Dalit, India); Turner *et al.*, 2009; Chapter 11 in this volume (Nuxalk, western Canada)
Deforestation and overexploitation of forest resources	Destruction of forests through logging and illicit crop cultivation; overharvesting of rubber; deforestation through charcoal making and fuelwood harvesting	Chotiboriboon *et al.*, 2009; Chapter 10 in this volume (Karen, Thailand); Correal *et al.*, 2009 (Ingano, Colombia); Creed-Kanashiro *et al.*, 2009; Chapter 5 in this volume (Awajún, Peru); Oiye *et al.*, 2009 (Maasai, Kenya)
Water shortages	Drought, desertification; acute shortages of water for livestock and household use	Correal *et al.*, 2009 (Ingano, Colombia); Oiye *et al.*, 2009 (Maasai, Kenya); Salomeyesudas and Satheesh, 2009 (Dalit, India)
Hydroelectric dam construction	Loss of salmon and other indigenous food; changes in environment; loss of access to indigenous food; loss of water quality	Iwasaki-Goodman, Ishii and Kaizawa, 2009 (Ainu, Japan)
Water pollution from domestic and livestock waste	Solid waste disposal problems; inadequate sanitation; faecal contamination of water and bacterial disease from poor waste disposal	Correal *et al.*, 2009 (Ingano, Colombia); Creed-Kanashiro *et al.*, 2009; Chapter 5 in this volume (Awajún, Peru); Englberger *et al.*, 2009; Chapter 12 in this volume (Pohnpei, Federated States of Micronesia); Oiye *et al.*, 2009 (Maasai, Kenya)
Contamination of food web, and threat of contamination, from industrial development, mining, herbicide spraying, nuclear power facilities	Pollution and chemical contamination from mining, oil drilling and petrochemical development; toxic residues in food	Correal *et al.*, 2009 (Ingano, Colombia); Creed-Kanashiro *et al.*, 2009; Chapter 5 in this volume (Awajún, Peru); Egeland *et al.*, 2009 (Inuit, Nunavut); Kuhnlein *et al.*, 2009 (Gwich'in, northern Canada)
Soil erosion and deterioration	Decline in soil fertility; soil loss; overgrazing and reduced carrying capacity for livestock; deterioration of pastures	Correal *et al.*, 2009 (Ingano, Colombia); Oiye *et al.*, 2009 (Maasai, Kenya); Okeke *et al.*, 2009 (Igbo, Nigeria)
Global climate change	Melting glacial ice and sea ice (in the north); changes in rainfall patterns; weather extremes, floods; raised sea levels	Correal *et al.*, 2009 (Ingano, Colombia); Creed-Kanashiro *et al.*, 2009; Chapter 5 in this volume (Awajún, Peru); Egeland *et al.*, 2009 (Inuit, Nunavut); Englberger *et al.*, 2009; Chapter 12 in this volume (Pohnpei, Federated States of Micronesia); Kuhnlein *et al.*, 2009 (Gwich'in, northern Canada); Oiye *et al.*, 2009 (Maasai, Kenya)

Chapters in this volume:
5 – Creed-Kanashiro *et al.*, 2013;
6 – Salomeyesudas *et al.*, 2013;
8 – Caidedo and Chaparro, 2013;
10 – Sirisai *et al.*, 2013;
11 – Turner *et al.*, 2013;
12 – Englberger *et al.*, 2013.

- habitat loss from urbanization and the industrialization of landscapes (Millennium Ecosystem Assessment, 2005; CBD, 1992);
- invasive species (Crosby, 1986; Wilson, 1992);
- pollution and degradation of lands, waterways and the foods they produce (WWF, 2004; Ross and Birnbaum, 2003; Kuhnlein and Chan, 2000);
- global climate change (Ashford and Castleden, 2001; IPCC, 2007; Salick and Ross, 2009; Thomas *et al.*, 2004).

Invariably, environmental impacts on food systems are cumulative and interconnected, and they interact at multiple scales of time and space. To understand and mitigate these impacts more effectively, it is necessary to recognize their pervasiveness, examine the origins of the problems and the processes involved, and address these at multiple levels. Looking at individual case studies of indigenous communities and their direct connections to local environments and food sources provides a solid and tangible starting point.

Widespread environmental deterioration leading to the erosion of biodiversity is not a recent phenomenon. However, because the world's population is increasingly urban and distant from the natural rural environment, the signs and signals that sources of food and clean water are imperilled have received little attention until recently (Ommer and Coasts Under Stress Research Project Team, 2007; Pollen, 2006). For example, most of the medicinal plants traditionally employed in East Africa come from forests that have been nearly eliminated throughout most of their original range (Cunningham, 1997). People living close to their food sources – who include many if not most of the world's Indigenous Peoples living relatively traditional lifestyles – have been firsthand witnesses to much of this environmental loss. For example, the Kogi Indians of the Sierra Nevada de Santa Marta in Colombia have been noting accelerated glacier melting and other associated climatic changes for decades (J. Mayr, personal communication to M. Plotkin, 2006). Far to the north, Canadian Indigenous Peoples of the polar regions, including Inuit, Gwich'in and Dene, have also been observing environmental deterioration: melting of sea ice, thawing of permafrost and siltation of rivers, with a host of effects and impacts on wildlife and Indigenous Peoples' food systems (Berkes *et al.*, 2005; Krupnik and Jolly, 2002; Salick and Ross, 2009). In many cases, it is the observations, experiences, practices and cultural institutions of local Indigenous Peoples that help to determine the rates and causes of environmental loss, and Indigenous Peoples can often have some of the best ideas of possible ways to protect habitats, repair some of the damage and adapt to changing conditions (Turner and Clifton, 2009). This chapter focuses on the environmental aspects of Indigenous Peoples' food security, and discusses how the damage that threatens local and global food resources can be mitigated or possibly reversed.

Indigenous Peoples' food systems and environments

Investigations of the food systems of indigenous communities participating in the CINE Indigenous Peoples' Food Systems for Health Program (Kuhnlein *et al.*, 2006) sought to improve understanding of the environmental context of Indigenous Peoples' foodways. The state of each region's ecosystems and their capacity to support Indigenous Peoples' food systems is of fundamental importance. Indigenous communities participating in the programme identified several major environmental problems that negatively affect their overall food security and food systems (Table 3.1). These include specific concerns, such as declining populations of resource species: caribou in northern Canada, ooligans and salmon on the west coast of Canada, and crop diversity for bananas and other species in Pohnpei, Dalit and Karen communities in the Federated States of Micronesia, India and Thailand, respectively. They also incorporate some impacts that are more indirect but just as significant, such as deforestation, water deterioration, soil erosion and climate change. Each of these conditions and situations affects not only the case study indigenous communities, but also many other Indigenous Peoples and, eventually, all humanity and other species on the globe. As many Indigenous Peoples hold a "kincentric" worldview, in which all species are respected as close relatives, the

notion of harm to species such as polar bears, salmon or orca whales is as alarming and upsetting as direct impacts on human communities themselves (Salmón, 2000; Senos *et al.*, 2006).

In the following sections, four of the overriding environmental problems that affect Indigenous Peoples' food systems are described in more detail to demonstrate the complex web of issues that are involved with each: biodiversity loss, especially of food species; hydroelectric dams and their effects; contamination of water and food; and global climate change.

Biodiversity loss

On every continent, Indigenous Peoples, other local peoples and biologists have noted alarming declines in the populations of many of the world's species (Wilson, 1992; Millennium Ecosystem Assessment, 2005). In recent times, many species have become extinct, for diverse reasons, most of which are directly or indirectly attributable to human activity. There are compelling examples of past human-caused extinctions or severe depletions of important food species, including the passenger pigeon in the Americas and the American bison (Davis, 1998). Today, with burgeoning human populations, globalization and increasing commodification of wild resources that were, and still are, major components of Indigenous Peoples' food systems, erosion of biodiversity is an ever-growing concern, and needs increased attention. For both wild species and crop varieties important to Indigenous Peoples, the largely negative role of large-scale commercialization and globalization of the marketplace cannot be ignored.

Many Indigenous Peoples have traditionally had strong protocols and culturally mediated prohibitions against overharvesting and towards the sustainable use and enhancement of food resources (Anderson *et al.*, 2005; Berkes, 2008; Deur and Turner, 2005; Johannes, 2002; Turner and Berkes, 2006). Today, however, species that were once carefully stewarded by local people – such as sea urchins, herring eggs and abalone for British Columbia coastal peoples in Canada – have become commodified, with global demands for immense quantities. Without proper and careful constraints on the use of these species, this situation characteristically leads to overexploitation, to the ultimate detriment of the local peoples who rely on them (Berkes *et al.*, 2006). Similarly, the health and livelihoods of local and Indigenous Peoples in many countries are threatened by escalating unsustainable use of wild meat or "bushmeat" (Bennett and Robinson, 2000; Anderson *et al.*, 2005), and by industrial and government-sanctioned deforestation to meet a great world demand for timber and dominant agricultural crops (Mackenzie, 1993; Balée, 1994; Turner and Turner, 2006; 2008; Graham, 2008). Habitat loss, the impacts of introduced species and the loss of pollinators are a few of the many threats to Indigenous Peoples' food systems, beyond direct overharvesting (Porcupine Caribou Management Board, 2007; Kuhnlein, 1992; Nabhan, 1986). The story is repeated again and again, from flying foxes and tropical forests in Samoa to Pacific salmon and coastal temperate rain forests on the northwest coast of North America (Cox, 1997; Nabhan, 2006).

Salmon farming or marine net-pen aquaculture can cause many direct and indirect negative impacts on marine environments. Depletion of fish stocks used as fish feed, destruction of coastal ecosystems such as eelgrass beds that are important nursery grounds for marine species, potential invasion of introduced Atlantic salmon, eutrophication caused by nutrients from fish and excess food and faeces, use of antibiotics, and sea lice infestations are some of the challenges facing Indigenous Peoples on the northwest coast of North America, who rely on the annual runs of wild Pacific salmon for their nutrition and cultural integrity (Volpe, 2007). Globally, all marine systems are now showing deleterious effects of human-caused change (Pauly *et al.*, 2000).

Alongside the decline and extinction of native or wild species around the globe, crop varieties and special landraces (adaptations of domesticated species) of plants and animals have also been declining dramatically (Fowler and Mooney, 1990; Nabhan and Rood, 2004). Again, the reasons are complex, but political and industrial agendas are clearly implicated (Shiva, 2000), along with valid efforts to provide sufficient food for a burgeoning world population through a

movement known as the green revolution. Increasing use of fertilizers, pesticides and herbicides, high fossil fuel inputs for ploughing, seeding and harvesting, and monoculture crop production are outcomes of the green revolution. The escalating production of genetically engineered crops has caused growing concern for Indigenous Peoples wishing to retain control over their own landraces and food systems (La Duke and Carlson, 2003; Pasternak, Mazgul and Turner, 2009; Kurunganti, 2006). Plantations of sugar cane, coffee, maize and other megacrops for export markets often give employment to Indigenous Peoples, but have widely replaced their diverse subsistence crops. Large-scale production of cattle and other livestock, with the accompanying pollution and degradation of pasturelands and deforestation, has also had severe negative consequences for Indigenous Peoples. Drought and desertification – often resulting from poor management practices, overcrowding and overgrazing – are also widely recognized as threats to Indigenous Peoples' food security.

One of the growing threats to subsistence food production is the biofuel industry. Biofuels are becoming a popular alternative and supplementary fuel for motor vehicles and heating. Although they tend to burn cleaner than fossil fuels and are theoretically a renewable resource, the market forces at play often result in the sequestering of lands formerly used for food production, to generate biofuels – often at the expense of Indigenous Peoples' well-being. Food security may decrease with cash cropping (Dewey, 1979; 1981): in Brazil, sugar cane, soybeans, castor beans and maize are being grown in increasing quantities to produce ethanol, reducing the nutrition opportunities for smallholder farmers (Conservation International, 2007; FIAN International, 2008; Graham, 2008).

Hydroelectric dams

Industrial-scale hydro projects provide power, but have proven destructive to Indigenous Peoples' ways of life and food systems; however, more dams are being planned and constructed. For example, the James Bay project of Hydro-Quebec in Canada put thousands of square kilometres of traditional Cree territory under water in 1983, not only cutting off access to Cree food resources, but also placing the Cree's health at risk from mercury contamination of the fish they consumed. The decomposing trees and other plants covered by the dam floodwaters produced methane, which converted natural mercury in the soil into a toxic form that entered the food chain, poisoning both the fish and those who eat them (Richardson, 1991; Kuhnlein and Chan, 2000). Another example is dam construction in Mato Grosso State of Brazil, which will severely restrict aquatic protein for 14 tribes whose main source of protein is fish (M. Plotkin, personal observation, 2009).

Iwasaki-Goodman, Ishii and Kaizawa (2009) have documented a wide range of impacts resulting from the construction of an immense hydroelectric dam on the Saru River, site of the Ainu homeland for at least 1 000 years. The Ainu resided along the riverbanks and obtained much of their sustenance from the river by fishing, while farming and hunting on the adjacent lands. Traditionally, the river also provided high-quality drinking-water. More than 100 years ago, non-Ainu Japanese began colonizing the area, and the Hokkaido Government started establishing regulations aimed at assimilating the Ainu and restricting their cultural traditions, including hunting and fishing. In 1997, the Nibutani Dam was completed in the heart of Ainu territory, against the wishes of the Ainu. A court challenge of the legality of this dam by two Ainu landowners eventually resulted in a judgment that the government had failed to assess the effect that the dam's construction would have on the local Ainu culture, thereby ignoring values that required serious consideration. This led to increased recognition of the importance of cultural impact assessments in any future developments, establishing an important precedent. In the same year that the dam was completed, the Law Concerning Promotion of Ainu Culture and Dissemination and Enlightenment of Knowledge about Ainu Traditions was enacted. This law has reinforced an ongoing movement to revitalize Ainu culture, and interviews about the impacts of the Nibutani dam have been part of the impact assessment programme required before any subsequent dams are constructed.

Respondents in these interviews identified many changes resulting from the dam construction:

- cooler weather and more fog and mist;
- increased siltation and significant shallowing of the river;
- undesirable flooding of the rice fields following a typhoon in 2003;
- loss of access to the other side of the river for food gathering;
- restrictions on children's play areas, fishing places and picnicking areas;
- loss of shallow ponds and riverbanks that were sources of fish and other cultural resources;
- loss of spawning areas for smelts (fish);
- disappearance of kelp, shellfish, flounders and octopus;
- muddying of the river and loss of clear drinking-water.

In short, the Nibutani Dam "killed the natural environment" for the Ainu (Iwasaki-Goodman, Ishii and Kaizawa, 2009).

Contamination of water and food

Consumption of and exposure to contaminated water is an ongoing and growing concern, especially for people living in rural areas. Worldwide, many indigenous communities have been adversely affected by contaminated water. For example, the Wayanas of southern Suriname have up to 17 times the recommended level of mercury in their hair samples, resulting from mercury pollution (C. Healy, personal communication to M. Plotkin, 2006; Nuttall, 2006).

Sewage pollution is another ongoing and related issue. Many small communities – and some large cities – discharge large amounts of raw or minimally treated sewage into rivers, lakes and coastal waters, which affects the foods in these systems. The city of Victoria, Canada, which used to have some of the best clam digging beaches on the coast, now has chronically contaminated beaches; for many decades, the local Straits Salish First Nations have not been able to harvest their seafood near the populated areas of the Saanich Peninsula and Victoria coastline.

Among the case study communities, the Awajún of Peru and their neighbouring communities face major problems relating to water quality and pollution from human waste: all homes in the region have precarious access to basic water and sewage services, most have no running water, and rubbish is thrown into the river. Human faeces are commonly seen in public areas, and a system of latrines installed by a government organization in the early 1990s – when there were concerns about cholera in the region – is generally considered a failure because of poor design, bad location and lack of training in maintenance. Many people, both children and adults, suffer from diarrhoea, parasites and other illnesses related to contamination, and there is concern about typhoid fever (I. Tuesta, M. Carrasco and H. Creed-Kanashiro, personal communication, 2008).

Environmental contaminants that biomagnify and concentrate in food webs are also a threat, and have been well studied in some places (Kuhnlein *et al.*, 1982; 2005; Kuhnlein and Chan, 2000; Chan *et al.*, 1996; Chan, Kuhnlein and Receveur, 2001; Thompson, 2005; Ross, 2000; 2006; Ross and Birnbaum, 2003; Ross *et al.*, 2004). As already mentioned, mercury contamination has been particularly insidious, causing health concerns such as nervous system disorders from eating local fish from affected rivers (Lebel *et al.*, 1997; Shkilnyk, 1985; Khaniki *et al.*, 2005), in addition to the more widely publicized phenomenon of mercury contamination of coastal ecosystems and large oceanic species such as tuna.

As well as mercury and other metals, a range of organic industrial compounds, classed generally as persistent organic pollutants (POPs), are also of concern. These are semi-volatile fat-soluble toxic compounds, including polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioins (PCDDs, also known as dioxins), polychlorinated dibenzofurans (PCDFs, also known as furans), polybrominated diphenyl ethers (PBDEs) polybrominated biphenyls (PBBs) and polychlorinated naphthalenes (PCNs) (Iwasaki-Goodman, Ishii and Kaizawa, 2009; Rayne *et al.*, 2004; Ross, 2006; Ross and Birnbaum, 2003; Ross *et al.*, 2004). The origins of these compounds are mainly industrial, and range from local sites such as pulp mills

and discarded machinery, to diffuse, distant sources from which the contaminants are transported through the atmosphere, ocean currents, soil and waterways, including by migratory species such as whales and salmon that have been contaminated (Johannessen and Ross, 2002; Krümmel *et al.*, 2003; Lichota, McAdie and Ross, 2004). Arctic regions are particularly vulnerable to contamination from POPs whose sources are known to be very distant; many of the contaminants in northern Canadian, for example, come from industrial centres in northern Asia and Europe (Knotsch and Lamouche, 2010).

Because predator species such as tuna, salmon and seals are at the upper trophic levels of food webs, these "sentinel" species are particularly vulnerable to contaminants, which accumulate in their fatty tissues (Ross, 2000). Humans who use these species as food in any quantity are placed at risk: ingesting contaminated food is the principal means by which humans are exposed to these highly toxic environmental pollutants (Parrish *et al.*, 2007). This situation is of particular concern in the food systems of Indigenous Peoples who consume large amounts of seal, salmon or other predator species (Johannessen and Ross, 2002; Mos *et al.*, 2004; Ross and Birnbaum, 2003). For example, POPs can interfere with the immune function of animals and – potentially – humans, making them more vulnerable to infectious diseases (Ross, 2002; Ross, Vos and Osterhaus, 2003). They can also disrupt endocrine function, reproduction and vitamin A production in the human body (Ross, 2000; Simms *et al.*, 2000). Recently, researchers have been observing possible associations between diabetes and levels of POPs (Jones, Maguire and Griffin, 2008; Rignell-Hydbom, Rylander and Hagmar, 2007).

Many indigenous communities have expressed concerns about contamination of their food (and their medicines and basketry materials) from agricultural chemicals and pesticides and from the herbicides used in industrial forestry, factory farming and powerline rights-of-way (Wong, 2003; Pollen, 2006). Mining and its associated smelters and refineries also present contamination concerns. Centres of industrial activity, such as at Kitimat in British Columbia, Canada have affected the habitats and food systems of indigenous and other local people. In Kitimat, pollutants from an aluminium smelter and other industrial plants have contaminated many Haisla foods, such as oulachens (ooligans, a favourite fish of the north coast) (Chan *et al.*, 1996; Turner *et al.*, 2009; Chapter 11 in this volume – Turner *et al.*, 2013), shrimp, clams and other species in the vicinity of the smelter. The Haisla elders used to refer to this area along the Kitimat River as their "grocery store", because it was such an important source of food, but they can no longer harvest their indigenous foods there (G. Amos, personal communication, 2007).

Gold, uranium, diamond and other mines are common in regions such as northern Canada, where many of the miners and local residents are Indigenous Peoples (e.g., Deline Mine in Canada's Northwest Territories). These people are directly affected by contaminants from the mines, while the caribou, fish and other animals on which they depend for food are affected by mining pollution and the impacts of the roads, settlements and infrastructure built to support prospecting and mining (B. Erasmus, personal communication, 2008). Mining in Amazonia is notoriously destructive to Indigenous Peoples and their food systems (Roulet *et al.*, 1999). The Awajún in Peru are concerned about possible mercury pollution of their rivers from gold mines upriver in the mountains and from mines in neighbouring Ecuador, but tests have not yet been carried out to determine the extent of the threat (I. Tuesta, M. Carrasco and H. Creed-Kanashiro, personal communication, 2008).

Oil and gas exploration and extraction, together with the construction of pipelines and their corridors, present a range of environmental problems and concerns regarding Indigenous Peoples' food systems and health (Wernham, 2007). In northern Alberta, Canada, the tar sands development, in which oil and gas are extracted from heavy crude oil that is mined from the surface and treated with large quantities of heated water, has resulted in environmental devastation and large deforested areas, described as "a moonscape" (Griffiths, Taylor and Woynillowicz, 2006). Impacts on wildlife are of great concern, with reports of entire flocks of ducks being destroyed in the expansive oil sands tailing

ponds contaminated with bitumen residues (Torys LLP, 2010; B. Erasmus, personal communication, 2008). Not only is such destruction harmful to people's food resources, but it is also emotionally and culturally devastating to witness. In the Amazon region of Peru, the Awajún are concerned about the development of large-scale hydrocarbon extraction south of their lands; such development can cause deforestation and environmental devastation, as the Awajún are already observing in neighbouring Brazil.

Airborne radioactive contamination of food is a concern for Indigenous Peoples in the Arctic, where lichens absorb airborne contaminants before being eaten by caribou and reindeer, which are then eaten by humans. Concerns about poisoning from radioactive compounds have diminished since the cessation of aerial testing of nuclear bombs, but the threat of contamination from accidents in nuclear power plants continues. A catastrophic nuclear power plant accident at Chernobyl in the Ukraine region of the former Soviet Union in 1986 resulted in a massive atmospheric plume of radioactive contaminants that drifted across the Russian Federation, eastern, western and northern Europe and into North America, affecting the Sami of Scandinavia and the Inuit and other northern peoples of Canada (Berti *et al.*, 1997; Strand *et al.*, 1998; Kuhnlein and Chan, 2000).

Political decisions from governments and other agencies outside indigenous communities often have unrecognized or unacknowledged impacts on Indigenous Peoples' environments, cultures and food systems (Turner *et al.*, 2008b). In Colombia, for example, government-sponsored large-scale aerial spraying of herbicides to destroy illegal coca crops has had impacts on the Ingano's crops. The herbicides fall on to grazing lands and farms, killing food crops such as manioc and banana. If the crops are mature when this happens, people consume them immediately, risking their own health to utilize crops that would otherwise soon die. The Ingano also suffer when the waste from cocaine production, referred to as cocasa, contaminates the rivers and streams they use for drinking-water and household purposes (Correal *et al.*, 2009).

Global climate change

Global climate change is cited as a major concern in the Inuit and Gwich'in case studies (Chapter 7 – Kuhnlein *et al.*, 2013; Chapter 9 – Egeland *et al.*, 2013; Kuhnlein *et al.*, 2004), and is perhaps the most pervasive, overarching threat to the security of Indigenous Peoples' food systems, both regionally and globally (Damman, 2010; Krupnik and Jolly, 2002; Myers *et al.*, 2005; DFO, 2009; Environmental Change Institute, 2007; Dinar *et al.*, 2008; Keskitalo, 2008; Turner and Clifton, 2009). Whether people rely on agriculture, pastoral systems, hunting, fishing, wild plant harvesting or a combination of food production and harvesting practices, climate change is causing, or has the potential to cause, major disruptions to their food systems. Among the host of interrelated problems attributed to climate change are:

- constrained water availability and water quality;
- unseasonably high temperatures, with threats of desertification;
- droughts and fires;
- unpredictable weather events (blizzards, hurricanes, floods, ice storms);
- shifts in seasonal weather patterns;
- changing sea levels, with impacts on coastal ecosystems;
- retreating glaciers and changing species distributions in high mountains;
- soil erosion;
- melting permafrost;
- spread of insect pests and diseases;
- changing wildlife migration routes;
- impacts on pollinators.

All of these affect Indigenous Peoples' food systems. The direct, indirect and cumulative effects of these factors on human food security are only starting to be noted, with locally based Indigenous Peoples sounding alarms (Environmental Change Institute, 2007). One example cited by indigenous people in Pohnpei (Chapter 12 – Englberger *et al.*, 2013) is that rising sea levels are destroying coastal giant taro gardens. Another is the effect of permafrost melt on the safety of hunters and the turbidity of rivers in northern Canada (B.

Erasmus, personal communication, 2008). There is great concern that global climate change, exacerbated by indiscriminate tree cutting in the Amazonian forests will lead to progressive deforestation (WWF, 2008).

Discussion: maintaining food security and environmental sustainability

> Food security exists when "all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life".
>
> *FAO, 1996*

> Food sovereignty is recognized as the "right of Peoples to define their own policies and strategies for sustainable production, distribution, and consumption of food, with respect for their own cultures and their own systems of managing natural resources and rural areas", and is considered to be a precondition for food security.
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> *International Indian Treaty Council, 2002*

The multitude of interrelated impacts of global climate change and other environmental threats described in the previous section illustrate the interactions and cumulative effects of many different factors facing Indigenous Peoples in their efforts to maintain their food security and food sovereignty.

As well as the environmental constraints on food security and food sovereignty, a range of social and economic factors also influence food choices: the impacts of residential schools in preventing intergenerational transference of knowledge and skills relating to food and health; urbanization; lifestyle changes; increased availability of convenience processed, marketed foods; television advertising; and many other pressures that move people away from their healthy original foods (Turner and Turner, 2008; Parrish, Turner and Solberg, 2007; Turner *et al.*, 2008b; Kuhnlein, 1989; 1992; Lambden *et al.*, 2006; Lambden, Receveur and Kuhnlein, 2007; Wernham, 2007).

Addressing such complex, cumulative stresses on Indigenous Peoples' food systems is no simple task. The CINE Indigenous Peoples' Food Systems for Health Program has worked to renew and revitalize indigenous food systems as a way of increasing the health and well-being of Indigenous Peoples. Participants at the 2009 International Congress of Nutrition suggested a number of interventions that would help raise awareness and facilitate and promote local environmental stewardship, good nutrition and the use and relearning of Indigenous Peoples' foodways (Kuhnlein *et al.*, 2006). These included actions under five broad topics:

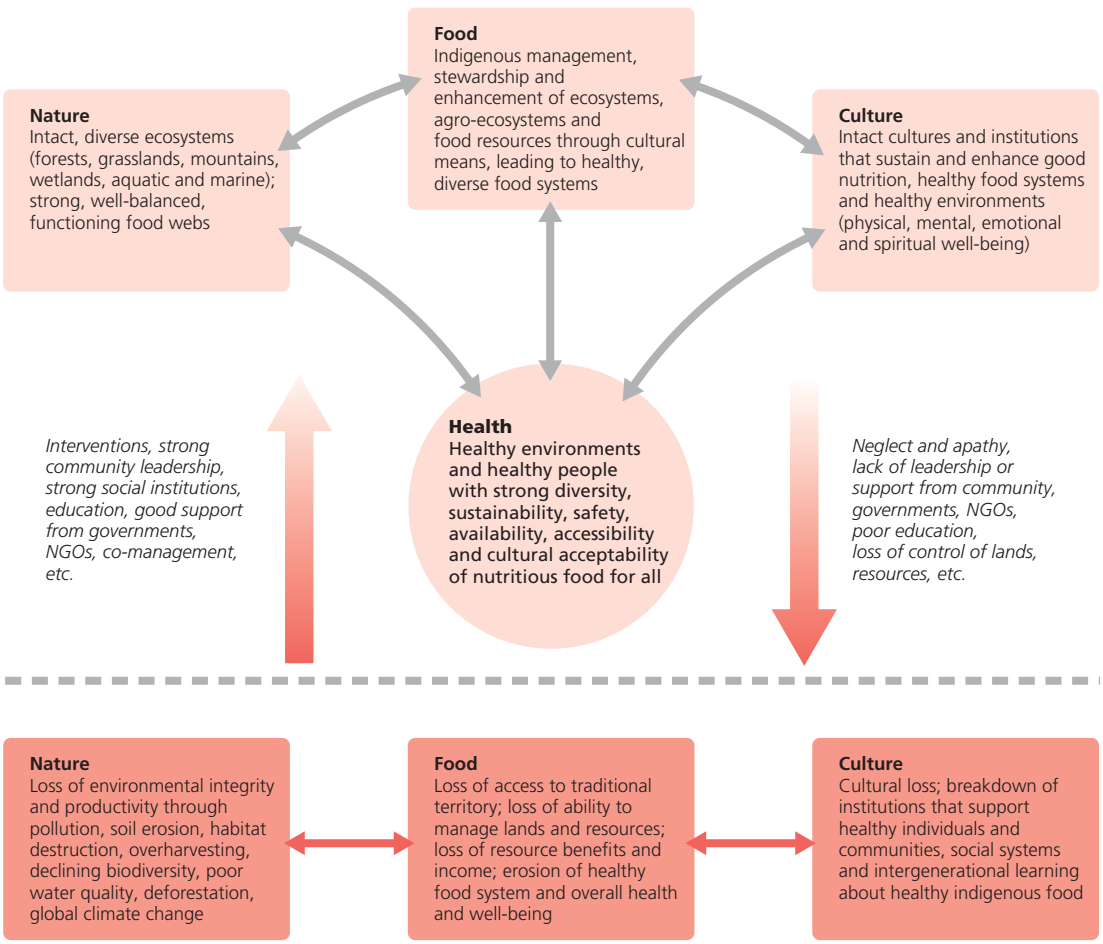
- ***Harvesting wild plant/animal food resources:*** Stimulate more community hunting/gathering/fishing activities, along with conservation training; work to increase access to land and water; teach these activities to youth; share harvests with elders and women; create community-based processing and storage facilities; and work to develop political leverage and agreements to ensure access to harvest areas.
- ***Agricultural activities:*** Stimulate home and community gardens and local food production; plant more trees and other produce; train farmers and others about nutrient-rich crops; develop medicinal plant gardens; form cooperative community groups to undertake agriculture activities; work to enhance access to land; and improve water quality.
- ***Activities in community schools:*** Ensure that school curricula focus on food and nutrition; involve children in teaching their communities about food; develop appropriate teaching materials; hold local food classes; promote healthy indigenous and locally produced snacks; and target unhealthy foods such as high-sugar beverages for elimination from schools.
- ***General community projects:*** Involve elders and cultural committees; encourage participation and cooperative work; train community health workers; prepare educational materials, posters, workshops, etc.; hold community health assessments; and stimulate physical and healthy lifestyle activities, etc.
- ***Links with health care, agriculture, education, government, business and non-governmental***

organizations (NGOs): Engage local steering committees in proactive work; develop prenatal programmes with healthy indigenous and local food; and network with businesses, NGOs, churches and schools to promote local food and health.

Broadly, these suggestions can be characterized as activities for cultural renewal and ethno-ecological restoration, in which Indigenous Peoples' food systems play a pivotal role (Senos *et al.*, 2006). Figure 3.1 illustrates the links and factors affecting Indigenous Peoples' food systems, including the positive effect that various interventions, combined with strong support from community leaders, government and academic institutions and others, can have on the overall health of cultures, environments and food systems. Without such support, the interconnected culture and environmental productivity are lost, resulting in loss of food resources, health and well-being.

Efforts to promote ecosystem enhancement and healthy cultural food systems are under way. Communities are participating in the current case studies and CINE programme, and in other projects with indigenous communities in many different places. Indigenous food harvesting and agricultural activities require government cooperation and collaboration, as

Figure 3.1 Positive and negative links and factors affecting Indigenous Peoples' food systems and health



there is often need to change regulations that prohibit food harvesting or prevent people from practising the management systems they used in the past to sustain their food resources (Posey, 1985; Anderson and Barbour, 2003).

Many environment-based regulations were established during the era of colonial, Euro-centric thinking, without clear understanding of Indigenous Peoples' conservation and management practices. For example, Straits Salish reefnet fishing was banned by the Canadian and United States governments because it was considered a form of "fish trap", and therefore assumed to be bad for conservation. However, this salmon harvesting technology is now recognized as an effective and sustainable management tool that reflects an entire way of life for the Saanich and other Straits Salish peoples (Claxton and Elliott, 1994; Turner and Berkes, 2006), and efforts are under way to reinstate this traditional fishery. Another example, affecting the Indigenous Peoples of western North America, is the banning of traditional landscape burning as being wasteful and destructive (Boyd, 1999; Anderson *et al.*, 2005; Anderson and Barbour, 2003). The positive ecological effects of mid-level human disturbance, including traditional burning practices, are now being revisited, and forestry officials are cooperating in experiments to explore the use of traditional fire regimes to renew huckleberry production and other resources for Indigenous Peoples in the region (Boyd, 1999). In all areas, regulations against Indigenous Peoples' historical hunting and gathering practices should be revisited and either revised or rescinded.

These restrictions could be replaced by more cooperative arrangements for co-management of habitats and resources. There are an increasing number of good co-management models, especially for parks and protected areas, and many have positive implications for Indigenous Peoples' food systems (Anderson and Barbour, 2003; Berkes, 2008; George, Innes and Ross, 2004; Hunn *et al.*, 2003; Nazarea, 1999; Turner, 2005). The United Nations Convention on Biological Diversity (CBD, 1992) and the Declaration on the Rights of Indigenous Peoples, adopted by the United Nations General Assembly in September 2007, contain explicit requirements for governments of Member Nations to respect the rights of Indigenous Peoples, and to consult and collaborate with them in all aspects of resource use affecting their lands and territories.

At the local level, many people are finding small but significant ways to alleviate the environmental problems they face. For example, the Awajún of Peru are starting to raise more chickens and to develop small-scale family fish-raising ponds. Developing these new protein sources has eased the impact on forest wildlife, allowing populations of wild animals to increase to the point where they can be hunted again, on a limited basis (Chapter 5 – Creed-Kanashiro *et al.*, 2013). Other peoples, such as those of the Pohnpei communities, are realizing that their traditional way of serving food on banana and other biodegradable leaves is more environmentally sound than using disposable plastic or other types of dishes (L. Englberger and M. Roche, personal communication, 2008). When practised by an entire community, the use of natural, biodegradable products to harvest, store, cook and serve food, and the recycling and reuse of more durable vessels and containers can have a positive impact on pollution and solid waste outputs (Wilson and Turner, 2004).

As indicated in the intervention ideas from the 2009 International Congress of Nutrition, education is another key factor in efforts to support Indigenous Peoples' healthy traditional food systems. A wide range of education processes should be supported: for indigenous youth and young adults, including the parents of young children, who may not be aware of the cultural or nutritional importance of their indigenous food (Beaton, 2004); for governments and decision-makers outside indigenous communities, and sometimes within them, who may not understand some of the issues regarding indigenous food loss; and for the general public, who could become allies and participants in efforts to restore ecologies and cultures and to renew healthy traditional foods for Indigenous and other local Peoples (Nabhan, 2006).

All Indigenous Peoples have their own educational needs and responses to different strategies for

conveying the information required. Learning-by-doing is a well-tried method for developing knowledge and skills in food harvesting, processing and consumption. Providing children and youth with opportunities for hunting, fishing, berry picking and gardening, with their families or others and through science and cultural camps or school and college field trips, can be very effective in raising their awareness, enhancing their understanding and honing their skills. Participation in the development of demonstration food and medicine gardens and the creation of community and ethnobotanical gardens is also beneficial (Turner and Wilson, 2006). Finding ways for elders' voices to be heard and conveyed, directly in workshops and community meetings or indirectly through films and DVDs, is especially important, as they remember the most about historical food production and preparation. Many communities collaborating with NGOs or government agencies have been able to host cooking events, traditional feasts and other enjoyable, sociable and educational occasions that promote and educate people about the importance of indigenous food, while giving those who have not experienced it a chance to observe and taste such food; examples include Ainu food preparation classes (Chapter 13 – Iwasaki-Goodman, 2013) and community feasts with First Nations around Victoria, involving the Pauquachin, Tsawout, T'souke and Songhees nations (Devereaux and Kittredge, 2008; Pukonen, 2008; Turner *et al.*, 2008a). Programmes that support language and cultural renewal, including potlatches and feasts, dances, stories and ceremonies, are also important, as many indigenous food systems are closely linked to cultural practices and language.

For Indigenous Peoples whose food systems are based on agricultural crops, similar community activities aimed at renewing and reinstating traditional crop landraces and agro-ecology practices can be promoted. Many Indigenous Peoples' resource management systems are sound and sustaining; with cooperation from government and NGOs, these can often be reclaimed and applied to enhance soil fertility, water quality, crop diversity, biodiversity and the overall productivity of traditional food (Colfer, Peluso and Chung, 1997; Englberger *et al.*, 2006; Imhoff, 2003). Indigenous people – particularly women, whose role in conserving crop diversity is often overlooked – are often the best sources of knowledge about traditional landraces for crops such as maize, rice, manioc and many others (Hoyt, 1988; FAO and IPGRI, 2002).

Research undertaken in respectful, effective and collaborative ways is a key element in improving Indigenous Peoples' food systems. Research can help to document and characterize the local foods' contributions to the diet and to nutrient requirements that need special attention. Current dietary conditions can be used as a baseline for understanding dietary change and the environmental and social dimensions of this change. Research can identify the implications of dietary change in terms of threats from chronic disease; focus on issues relating to food safety and availability, including assessing the risk from food contaminants; and document strong cultural traditions and knowledge regarding natural resources, including unique food species held by Indigenous Peoples, as well as the risks of losing this knowledge. Participatory community-based research can build indigenous communities' capacity for improving their own health in the context of their own culture and language. It can identify patterns of land use and local food availability, and help clarify some of the controversies and issues that arise from government policies, such as the establishment of parks and protected areas. It can help to document the tremendous variation in species and varieties of food biota in indigenous areas, which is often unrecognized beyond a particular community, and provide scientific identifications and nutrient analyses of these foods. It can help to guide policy for environmental protection to ensure species habitats, and emphasize the value of cultural expression for retaining traditional knowledge and conserving species (Wyllie-Echeverria and Cox, 2000). It can also assist efforts to frame Indigenous Peoples' perspectives in ways that may be better understood by academics and policy-makers, such as use of the phrase "cultural keystone species" to emphasize the

critically important nature of certain food and other species to particular cultural groups (Garibaldi and Turner, 2004).

Collaborative research on indigenous ecological knowledge systems can also help to create better responses to climate change and other forms of environmental change, through understanding socio-ecological adaptive processes and how these can apply to traditional land and resource management systems (Berkes, 2008; Turner and Berkes, 2006).

Conclusions: sustaining healthy food systems and environments in a changing world

Environmental threats to Indigenous Peoples' food security, food sovereignty and ability to maintain and utilize healthy foods from their own ancestral lands are very real. Although it is widely recognized that the food systems of Indigenous Peoples contain impressive levels of biodiversity (related to plant species, subspecies and varieties/cultivars and to animals and their subspecies), recent environmental impacts range from habitat loss to pollution and from erosion of biodiversity – including crop diversity – to increasingly evident climate change. These effects interact with each other in often unpredictable and insidious ways. The problems must be addressed at the local and global scales, and their complexity must be acknowledged and incorporated into solutions.

Indigenous foods benefit people's physical health, through both the consumption of good food and the physical activity of harvesting and preparing the food. In addition, these foods play a key role in maintaining diverse cultures, languages, heritages and identities – in short, in the mental, emotional, spiritual and physical well-being of Indigenous Peoples.

An important concept in maintaining environmental and cultural integrity – and therefore the integrity of Indigenous Peoples' food systems – is the inextricable linkage between the peoples and their territories. Indigenous Peoples' access to their lands, waters and resources, including genetic resources, is essential for their food security and for sustaining cultural knowledge about traditional food and medicine systems (Laird, 2002; UNPFII, 2009; CBD, 2010). Wisdom and practical knowledge relating to the harvesting, processing, consumption and long-term management of food resources are tied to place and habitat. If these ties to territory are broken, the food system can no longer be maintained. Reconnecting the ties that have been frayed or severed is one of the major ways in which Indigenous Peoples' food security and environments can be enhanced and renewed.

Progress has been made, and Indigenous Peoples now have leading roles in the movement to protect their local food systems; they have participated in national and international controls on contaminant emissions, and initiatives promoting biodiversity in food systems. As is clear from all the case study projects in the CINE programme, the best way forward is to listen to and learn from indigenous elders, study original food systems as a baseline, and address current environmental and social challenges, thereby creating a symbiotic meld of ancient wisdom with modern knowledge and technologies. Such an approach – applied well and patiently – offers hope for not only Indigenous Peoples but also human societies everywhere. Indigenous knowledge can be applied to environmental protection, for example in protecting and conserving genetic resources of nutritious and pest-resistant crop varieties (cultivars or landraces), and in providing practical and effective strategies for sustaining crops, fish, wildlife, forest ecosystems, agroecosystems and other essential habitats. Indigenous worldviews can help other societies by creating a new ethic of respect for other life forms and other cultures.

The viability of Indigenous Peoples' cultures, food systems and ways of life is at stake. If the outside world had listened to the Kogi peoples of Colombia or the Inuit of North America several decades ago, when the impacts of climate change were first noticed, the challenges faced today may have been easier to resolve. Cultivars from indigenous agricultural systems have proved vital to global agriculture by increasing yields and decreasing pests and diseases. Regarding health too, it will be well worth the time and effort to look closely at the changing health circumstances of people

living close to land where there are negative impacts of ecological change. Indigenous Peoples play an immense role, not only in reclaiming the food traditions of individual communities in culturally appropriate ways, but also in maintaining and strengthening the resilience of ecosystems and cultural systems, including the global diversity of healthy food systems

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