AGRICULTURE, TRADE AND BIODIVERSITY: A POLICY ASSESSMENT MANUAL

Volume II: Reference Manual

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The United Nations Environment Programme

The United Nations Environment Programme (UNEP) is the overall coordinating environmental organization of the United Nations system. Its mission is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing and enabling nations and people to improve their quality of life without compromising that of future generations.

In accordance with its mandate, UNEP works to observe, monitor and assess the state of the global environment, improve the scientific understanding of how environmental change occurs, and in turn, how such change can be managed by action-oriented national policies and international agreements. UNEP’s capacity-building work thus centers on helping countries strengthen environmental management in diverse areas that include freshwater and land resource management, the conservation and sustainable use of biodiversity, marine and coastal ecosystem management, and cleaner industrial production and eco-efficiency, among many others.

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In parallel, UNEP administers several multilateral environmental agreements (MEAs) including the Vienna Convention’s Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (SBC), the Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention, PIC) and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity as well as the Stockholm Convention on Persistent Organic Pollutants (POPs).

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The Economics and Trade Branch (ETB) is one of the five branches of DTIE. ETB seeks to support a transition to a green economy by enhancing the capacity of governments, businesses and civil society to integrate environmental considerations in economic, trade, and financial policies and practices. In so doing, ETB focuses its activities on:

- Stimulating investment in green economic sectors;
- Promoting integrated policy assessment and design;
- Strengthening environmental management through subsidy reform;
- Promoting mutually supportive trade and environment policies; and
- Enhancing the role of the financial sector in sustainable development.

Over the last decade, ETB has been a leader in the area of economic and trade policy assessment through its projects and activities focused on building national capacities to undertake integrated assessments – a process for analysing the economic, environmental and social effects of current and future policies, examining the linkages between these effects, and formulating policy response packages and measures aimed at promoting sustainable development.

This work has provided countries with the necessary information and analysis to limit and mitigate negative consequences from economic and trade policies and to enhance positive effects. The assessment techniques and tools developed over the years are now being applied to assist countries in transitioning towards a green economy.

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Agriculture is the most important economic activity in many of the world’s poorest countries and most vulnerable regions. It is an important employer providing a cash income to millions of farmers and workers, supporting large rural populations, and making a vital contribution to food security. In some regions, commercial agricultural plantations are expanding and are major contributors to both GDP and export earnings.

Many of the countries whose economies are dominated by the agricultural sector are also custodians of much of the world’s biological diversity, boasting a wide variety of species and habitat diversity and very high levels of endemism. Biodiversity is an integral part of a healthy ecosystem including agricultural systems, which comprise cultivated biodiversity (such as crops and livestock) and use biodiversity to provide a range of ecosystem services. Productive farming and long term food security depend on sustaining biodiversity as the basis for provision of essential ecosystem services.

At the same time, agricultural expansion - both in area farmed and intensity of management - is one of the major drivers for loss of biodiversity worldwide. The most important threat to biodiversity is loss of natural habitat, which comes about through changes in land use and in particular the conversion of land for agriculture. Certain agricultural practices can lead to the deterioration in soil, water and air quality and loss of biodiversity, through agrochemicals, intensification and monoculture.

Many of these changes in land use and agricultural practices are driven or influenced by trade and trade-related policies. Trade measures – ranging from import tariffs and quotas, export taxes and subsidies to a variety of non-tariff barriers – influence the cost structures and potential revenues that farmers and farming companies use as a basis for their production decisions, which affects the use of land, soil, labour, and other inputs, such as fertilisers and pesticides. This, in turn, can have significant impacts on various aspects of biodiversity, such as food crop diversity, biodiversity in adjacent ecosystems (for example, through run off and agrochemicals), and biodiversity located on land previously under alternative use (‘the cut down forest’).

With trade in agricultural products increasing and the world’s biodiversity already being lost at an alarming rate, it is vital for long-term sustainability that biodiversity considerations are included in trade discussions and policies and that agricultural expansion is accompanied by proactive measures that promote the sustainable use and conservation of biodiversity.

The policy assessment approach presented in this manual provides a framework for comprehensive analysis of the complex issues linking trade liberalisation, agricultural production, and biodiversity. In the hands of governments and other practitioners, it should lead to the design of trade policies and trade-related policies that promote development and contribute to achieving the Millennium Development Goals, through the conservation and sustainable use of biodiversity.
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<th>Description</th>
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<tbody>
<tr>
<td>AC</td>
<td>Avoided cost</td>
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<td>ACP</td>
<td>African, Caribbean and Pacific</td>
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<td>BT</td>
<td>Benefit-Transfer</td>
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<td>BTTFP</td>
<td>BioTrade Facilitation Programme</td>
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<td>CAC</td>
<td>Citizen Advisory Committee</td>
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<td>CAP</td>
<td>Common Agricultural Policy</td>
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<td>CBA</td>
<td>Cost-Benefit Analysis</td>
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<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<td>CCA</td>
<td>Casual Chain Analysis</td>
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<td>CE</td>
<td>Choice experiments</td>
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<td>CGE</td>
<td>Computable General Equilibrium</td>
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<td>CIM</td>
<td>Cross Impact Matrix</td>
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<td>CV</td>
<td>Contingent valuation</td>
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<td>DIP</td>
<td>Deliberative and inclusionary approach</td>
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<td>EP</td>
<td>Expert Panel</td>
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<td>EU</td>
<td>European Union</td>
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<td>FAO</td>
<td>Food and Agriculture Organisation of the United Nations</td>
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<td>GDP</td>
<td>Gross domestic product</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<td>GEO</td>
<td>Global Environment Outlook</td>
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<td>GM</td>
<td>Genetically modified</td>
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<td>Genetically Modified Organism</td>
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<td>GMZ</td>
<td>Gene Management Zones</td>
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<td>Government of Canada</td>
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<td>H</td>
<td>Hedonic pricing</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<td>HA</td>
<td>Health Analysis</td>
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<td>Integrated environmental assessment</td>
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<td>MCA</td>
<td>Multi-Criteria Analysis</td>
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<td>MDG</td>
<td>Millennium Development Goal</td>
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<td>MERCOSUR</td>
<td>Southern Common Market</td>
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<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<td>Non-timber forestry product</td>
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<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>P</td>
<td>Production approach</td>
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<td>Partial equilibrium</td>
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<td>Participatory Multi-Criteria Analysis</td>
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<td>Sustainable Livelihood Approach</td>
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<td>Strengths, Weaknesses, Opportunities and Threats</td>
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<td>United Nations Environment Programme</td>
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<td>World Trade Organisation</td>
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1. Introduction

Integrated Assessment is a tool that can assist countries in recognising the potential economic, social, and environmental impacts of trade policy. UNEP has produced this manual (hereafter referred to as “the Manual”) which explains how integrated assessment can be used, in conjunction with trade policy making, to help ensure that trade policies support development which is compatible with the conservation and sustainable use of biodiversity.

Trade and trade policy are a major force driving changes in agricultural practice and it is therefore important to ensure that proposed changes are compatible with a sustainable, productive environment and with global goals for biodiversity, such as the 2010 biodiversity targets. To ensure that impacts on biodiversity are addressed at the source, the consideration of agricultural impacts on biodiversity has to start at a policy and strategic level. In this process, it is important to be aware of the impacts of trade liberalisation but also of other influences on the agriculture sector, including changes in product demand not related to trade, production methods and transportation-related costs.

The Manual aims to support the implementation of the Convention on Biological Diversity (CBD) and was developed as a direct response to the CBD Conference of the Parties Decision VI/5, which requested the Executive Secretary to further study the impacts of trade liberalization on agricultural biodiversity. It provides a framework and process for Integrated Assessment that national institutions and governments can employ to assess, design and implement trade-related policies in the agriculture sector, recognising the need to sustain biodiversity as the basis for essential ecosystem services.

The Manual also builds on earlier work on Integrated Assessment by UNEP and others. Through its specific focus on biodiversity and agricultural trade policies, it contributes to the general body of work developed under UNEP’s Global Environmental Assessment initiative and the Millennium Ecosystem Assessment (MA). It also supports capacity building in environmental assessment within the framework of the Bali Strategic Plan on Technology Transfer and Capacity Building.

The Manual is divided into two volumes. Volume I is a practical step-by-step approach to Integrated Assessment of trade policy in the agricultural sector, explaining how biodiversity considerations can be incorporated. Volume II, this volume, is a Reference Manual which accompanies the practical guide. It explains why biodiversity and ecosystem services are important and explores the complex linkages that exist between trade in the agriculture sector and biodiversity. It also contains supporting information on both procedures and substance to support the use of Volume I.

Chapter 2 of this Volume addresses the relationship between agriculture and biodiversity. This relationship merits particular attention because of the global significance of agricultural impacts on biodiversity, the relationship between biodiversity and agricultural ecosystems, the strong inter-dependence of biodiversity with food security and poverty alleviation, and the significant impact that trade can have by driving changes in land use and agricultural practices.

Chapter 3 discusses trade measures and the trade policy-making process. Agricultural trade policies are a major influence on land use patterns and a driving force behind agricultural practices and ultimately on biodiversity. It is likely that there will be important changes to global agricultural trade as a result of the negotiation and implementation of the World Trade Organisation's (WTO) Doha Development Agenda or regional and bilateral trade agreements, and that these changes will have an impact on biodiversity.

Chapter 4 examines issues related to stakeholder participation and consultation. Effective participation is a vital component of Integrated Assessments. It is desirable to establish a process that is as inclusive as possible and ensures that all views are heard at key stages in the assessment process.

Chapter 5 presents a conceptual framework for analysis, adapted from the Millennium Ecosystem Assessment (MA) approach. The MA was carried out between 2001 and 2005 to assess the consequences of ecosystem change for human well-being and to analyze options available to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being. Responding to requests for information (including through the CBD), it was carried out by 1,395 experts from 95 countries, and has been extensively peer reviewed by governments and experts. Chapter 5 also includes examples of indicators that can be used to help measure the impacts of key issues that are included in the conceptual framework. The identification of indicators is an essential activity associated with the development of a conceptual framework along with the identification of objectives. Indicators can be used to determine whether an impact will be significant and/or acceptable and if proposed policy changes will achieve the desired outcomes or objectives.

Chapter 6 provides approaches to valuation. Biodiversity (including biodiversity resources and functions) is intuitively valuable. Few would contest the fact that the decline of biodiversity would be costly to humankind, in particular with regard to those functions that cannot be replicated. But this does not shed light on how to identify, describe and measure the specific values that are held in respect of biodiversity and biological resources and functions. Chapter 6 explores approaches that take into account economic and non-economic values of biodiversity in order to contribute to sound decision making and policy making.

There is no single method to employ in undertaking an Integrated Assessment. Therefore, Chapter 7 presents a wide range of tools and techniques that might be employed to assess the impacts of agricultural trade on biodiversity. The methods presented include a range of qualitative and quantitative techniques that can be used alone or together in an assessment.

Chapter 8 includes guidance on developing and selecting appropriate policy responses in response to the findings of the Integrated Assessment. These are classified as both trade-related and non-trade related with an emphasis on policies that promote capacity building.

Finally, to assist the users of this Manual, Chapter 9 contains a glossary of terms related to Integrated Assessment, agriculture, trade, and biodiversity.

Chapter 10 includes references and resources where users of the Manual might turn for further information on substance and the process associated with undertaking Integrated Assessments in the agricultural sector, and in particular those with an emphasis on biodiversity.
Introduction

Note

This Manual builds on earlier work produced by UNEP on Integrated Assessment, in particular:

- Handbook on Integrated Assessment of Trade-Related Measures: The Agricultural Sector, UNEP, 2005
- Integrated Assessment: Mainstreaming Sustainability into Policymaking – A guidance manual, UNEP, 2009a

The Manual is also intended to complement the general Integrated Assessment frameworks developed by the CBD, the Food and Agricultural Organization of the United Nations (FAO), GEO, the European Union (EU), the International Association for Impact Assessment, International Union for the Conservation of Nature, the International Institute for Sustainable Development, World Wide Fund for Nature, and others. Specifically, this Manual builds on from the framework and results of the MA.

The Integrated Assessment process (Volume I) and conceptual framework (Chapter 5, Volume II) are intended to be adapted to the unique and varied situations found in different countries. National institutions are encouraged to refine the framework and process to meet their specific needs.
2. The Relationship between Agriculture and Biodiversity

**Key points**

- Agricultural ecosystems form the basis for global food security and therefore play an essential role in the maintenance of human well-being.
- Biodiversity is an integral component of agro-ecosystems and underpins the services required to support sustainable agriculture.
- Biodiversity and associated ecosystem services (including food production) can benefit from or be adversely affected by agricultural practices, depending on how these are managed. Both agricultural extensification and intensification can have negative impacts.
- There are opportunities for the conservation and sustainable use of biodiversity and agricultural biodiversity within agricultural ecosystems, for example through the use of practices such as agro-forestry.
- The management and policy challenge is to achieve a balance that optimises both biodiversity and production in the long term, as millions of lives and livelihoods depend directly on agricultural biodiversity.

2.1 Biodiversity

Biodiversity is the diversity of life at all levels, including landscapes, ecosystems, communities, populations and genes. For the purpose of this Manual, biodiversity includes agro-biodiversity (further described in Box 2.1) as well as biodiversity with no recognisable role in food production (which may nevertheless be affected by changes in agricultural land use and production). It provides the genetic resources directly needed for food production and underpins a range of other ecosystem services which play a key role in global food security.

Biodiversity is an essential and integral part of healthy environments. If too much biodiversity is lost, many essential ecosystem services will be undermined or lost as well, including those required to support productive farming. This relationship between biodiversity and agricultural ecosystems explains why biodiversity also plays a vital role for poverty reduction, global food security and other aspects of human-well-being.
Box 2.1 Agricultural biodiversity or ‘Agro-biodiversity’

Agricultural biodiversity is the basis of global food security and millions of lives and livelihoods depend directly on it. The CBD defines agricultural biodiversity as:

“A broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agro-ecosystem: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes” (CBD Decision V/5, appendix).

Agricultural biodiversity can be discussed in terms of:

- **Cultivated or ‘planned’ biodiversity**: largely domesticated biodiversity such as crops, livestock, and freshwater aquaculture fisheries. Planned production may be supplemented by wild food sources e.g. honey from forests or fish harvested from wetlands. This diversity, including crop wild relatives comprises the genetic resources directly needed for food production.

- **Associated biodiversity**: the biodiversity that supports agricultural production through nutrient cycling, pest control, and pollination. Associated biodiversity includes soil microbes, natural enemies of pests, and pollinators. Biodiversity that provides broader ecological services, such as watershed protection, and alternative forage plants for pollinators, as well as, biodiversity in the agricultural landscape are included in this dimension.

- **Additional biodiversity**: other biodiversity that occurs within the agricultural ecosystem but does not directly provide support, such as fish and amphibian populations in rice paddies. This is known as wild biodiversity that depends on niches provided by the agricultural landscape. There are examples where the wild species have co-evolved with agricultural practices (e.g., fire-managed ecosystems in semi-arid areas have promoted large herbivore populations and their predators).

- **Wild biodiversity outside agricultural ecosystems**: is biodiversity that occurs beyond that which is used or is directly supporting the production system. However, this group of biodiversity does contribute to other indirectly relevant ecosystem services such as watershed protection, and cultural and amenity services.


2.2 The role of biodiversity in agricultural ecosystems

Agricultural systems rely on biodiversity and associated ecosystem services for their productivity including, *inter alia*, pollination, nutrient cycling and soil formation. Some examples are given in Box 2.2. While it is possible to substitute artificially for some of the services provided by biodiversity, this often carries additional costs, e.g. in terms of energy-use.

Ecosystem services are - as defined by the Millennium Ecosystem Assessment - the benefits that people obtain from ecosystems. There are many benefits that people obtain from agricultural ecosystems and from the ecosystem services that are either supplied or influenced by them, as summarised in Table 2.1.
Box 2.2 Examples of biodiversity supporting ecosystem services for agriculture

**Pollination.** Three-quarters of the world’s major crops rely on pollination by animals. Of these, 73% (including cashews, mangos, and cocoa) are pollinated by species of bee. However, domestic bees pollinate only 15% of the hundred crops which contribute to most of the world’s food supply. Wild bees and other wildlife, including flies, bats, wasps, beetle, birds, butterflies and moths, pollinate 80% of crops. Estimates of the value of pollination services supplied by wild pollinators are thought to be US $4.1 billion a year to US agriculture alone. In Costa Rica, forest-based pollinators have been shown to increase the value of coffee production at a single farm by US $60,000 per year through an increase in yields and improved crop quality. Farms around the world are now paying for pollinator services, with farmers importing and raising pollinators. There is a growing concern that many pollinator species are at risk of extinction and ultimately placing important ecosystem services in jeopardy. Pollinator numbers are declining due to habitat fragmentation, agricultural and industrial chemicals and associated pollution, parasites and disease and the introduction of exotic species.

**Pest Management.** Natural enemies to crop pests include insects, spiders and other arthropods. These are promoted by high temporal and spatial heterogeneity in the landscape. For example, the patchwork of rice fields in Central Java, has retained natural vegetation and a greater abundance of natural predators. The natural vegetation supplies alternative food sources when populations of crop pests drop in number, thus keeping natural predator populations high or constant.


<table>
<thead>
<tr>
<th>Table 2.1 Ecosystem Services Provided by Agricultural Ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Provisioning services</strong></td>
</tr>
<tr>
<td>• Food (including wild plants)</td>
</tr>
<tr>
<td>• Genetic resources</td>
</tr>
<tr>
<td>• Biochemical, natural medicines and pharmaceuticals</td>
</tr>
<tr>
<td>• Fresh water</td>
</tr>
<tr>
<td>• Fuel</td>
</tr>
<tr>
<td>• Fibre</td>
</tr>
<tr>
<td>• Shelter (such as forests)</td>
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<tr>
<td><strong>Cultural services</strong></td>
</tr>
<tr>
<td>• Cultural diversity</td>
</tr>
<tr>
<td>• Spiritual and religious values</td>
</tr>
<tr>
<td>• Knowledge systems</td>
</tr>
<tr>
<td>• Educational values</td>
</tr>
<tr>
<td>• Inspiration</td>
</tr>
<tr>
<td>• Aesthetic values (scenic qualities)</td>
</tr>
<tr>
<td>• Social relations</td>
</tr>
<tr>
<td>• Sense of place</td>
</tr>
<tr>
<td>• Cultural heritage values</td>
</tr>
<tr>
<td>• Recreation and tourism</td>
</tr>
<tr>
<td><strong>Regulating services</strong></td>
</tr>
<tr>
<td>• Pollination</td>
</tr>
<tr>
<td>• Air quality regulation</td>
</tr>
<tr>
<td>• Climate regulation</td>
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<tr>
<td>• Water regulation</td>
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<td>• Water purification</td>
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<tr>
<td>• Erosion regulation</td>
</tr>
<tr>
<td>• Disease regulation</td>
</tr>
<tr>
<td>• Pest regulation</td>
</tr>
<tr>
<td>• Natural hazard regulation (such as flood control)</td>
</tr>
<tr>
<td>• Herbivory and predation</td>
</tr>
<tr>
<td>• Seed dispersal</td>
</tr>
<tr>
<td><strong>Supporting services</strong></td>
</tr>
<tr>
<td>• Soil formation</td>
</tr>
<tr>
<td>• Primary production</td>
</tr>
<tr>
<td>• Nutrient cycling</td>
</tr>
</tbody>
</table>

These ecosystem services are important for human well-being and generally have the following features:

- Ecosystem services are built up over a period of time and this rate differs between services. For example, food (such as crop production) can be provided by an ecosystem more quickly than soil formation or natural hazard regulation services.

- Species diversity can be important in maintaining certain ecosystem services. For example, pollination is highly species-specific and agriculture depends on pollination by a wide range of species (Box 2.2).

- In general, natural systems have the highest levels of biodiversity, but unmanaged ecosystems can have lower biodiversity than agricultural ecosystems and may also have reduced capacity to provide provisioning services.

- Using ecosystem services can alter ecosystems but it is possible to use ecosystem services such as pollination, pest regulation and cultural services without necessarily causing depletion and this use can play a part in maintaining a healthy system.

- Ecosystem services can generally recover after use unless over-exploitation occurs, and thresholds are exceeded beyond which a system cannot recover. For example, over-hunting of bushmeat may drive a species to extinction and result in the loss of a source of protein for the local community.

- An investment is needed to extract some goods and services. The cost of this investment may not be very high for the rural poor, and it may be more feasible for them to extract natural resources (such as picking fruit and utilising other NTFP) than make costly investments in farming.

- After use, ecosystems regenerate through natural processes. However, humans can also intervene with restorative investments (such as replanting forests and implementing measures to conserve soil). A minimal level of biodiversity is needed to absorb such investments.

2.3 Biodiversity, Agriculture and Human well-being

(a) The influence of poverty

Agriculture is in many cases closely linked to the poorest and most vulnerable populations. Persistent poverty has prevented hundreds of millions of people from meeting their food needs. The FAO estimated that between 2000 and 2002, 852 million people worldwide did not have enough food to meet their basic needs, with a majority (815 million) living in developing countries (FAO 2002). Over one billion people survive on an income of less than one US dollar per day, the majority of these people living in rural areas where they depend on agriculture for subsistence. These rural areas are characterised by poor health and high levels of infant mortality. Rural populations tend to be affected more directly by ecosystem degradation than urban populations and the most severe and direct impact is on the poor because they tend to depend on natural resources for their livelihoods. The poor are also very vulnerable to ecosystem changes that lead to famine, drought or floods.2

In many developing countries, agriculture is the main economic activity. Agricultural growth, while not sufficient in itself, represents a cornerstone of poverty reduction as it can reduce poverty by raising farm incomes and generating off-farm employment. However, increasing productivity and food production also create pressures on the environment if no adequate attention is paid to land-use management.

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2 (UNEP 2005) Handbook on Integrated Assessment of Trade-related Measures. The Agriculture Sector, p.15
Several studies on the commercialization of non-timber forest products (NTFP), for example, have highlighted the importance of biodiversity’s contribution to the reduction of rural poverty. Policy intervention to help commercialise NTFP must therefore be well-targeted and reduce the risks of any negative impacts on biodiversity, such as overexploitation of the natural resource (Marshall et al. 2006). There are many linkages between biodiversity loss from the agricultural landscape and poverty. Tekelenburg and Kessler (2005), identify some of these as follows:

• There are people in the world who, because of limits on their physical, economic and social situation, do not have access to enough food. Prevalence of hunger is very high among small landholder farmers, herders, traditional fishermen and forest dwellers.

• The rural poor are most dependent on products obtained from their direct surroundings, either through cultivation, collecting, hunting or fishing.

• The rural poor, particularly those in drought-prone areas, depend upon products and services directly obtained from ecosystems. Ecosystems provide a high diversity of food products that help overcome food shortages. This natural resource can be degraded, causing biodiversity loss by over-exploitation.

• Poor nutrition is most frequently found in areas with high soil degradation. Cropland degradation has been identified as having strong links with hunger and ongoing biodiversity loss.

• Poor people can also suffer from a loss of ecosystem services as a consequence of actions by other groups when more powerful individuals exploit ecosystem services at the cost of access by other stakeholders.

Poverty curtails livelihood opportunities and, from the perspective of agricultural production, limits access to inputs (such as credit and new technologies) which can improve farm management. Poverty is also often associated with a lack of security in terms of access to, or title to, land and other natural resources. Lack of land security reduces the incentive and ability of farmers to choose agricultural practices with long-term benefits, resulting in practices that achieve short-term gains and degrade land, with associated damage to biodiversity. Once agricultural land is degraded it is often abandoned, with poor rural communities migrating to areas of marginal production. Agricultural intensification and simplification of agricultural landscapes can also limit the availability of, and access to, wild food. This includes food plants growing as weeds that may be of nutritional importance, particularly to the landless poor and to vulnerable groups within households.

(b) Linkages between health and agriculture

Poor nutrition is not the only health issue linked to agriculture. The clearance and irrigation of land is often responsible for an increase in the incidence of malaria and other waterborne diseases. Better ecosystem management is necessary to respond to this problem (MA 2005). Other health issues, such as breathing difficulties, the build up of toxins within individuals and/or populations and pollution of drinking water, can result from the use (and over use) of fertilisers, herbicides and pesticides. Air pollution is one result of slash-and-burn agricultural practices that were employed in many parts of Asia during the 1990s. To protect human health, responses are required outside the health sector, particularly in agriculture.

The aforementioned poverty and health issues can be magnified through trade policies that favour large landowners and can result in the migration of the rural landless poor to marginal areas which are often less well suited to agriculture, are usually drought prone, and have low levels of soil fertility. These communities then depend on resources from surrounding areas for food, often increasing pressure on wild biodiversity (MA 2005).
Agricultural ecosystems are the basis of global food security, with approximately 24 per cent of the Earth’s terrestrial surface used for cultivation including, inter alia, land used for crop production, shifting cultivation, confined livestock production and freshwater aquaculture (Figure 2.1). Most ecosystems have been modified or cultivated to some extent by human activity for the production of food, income and for livelihood security. Over the past 25 years, agricultural land has expanded by around 130,000 km², predominantly through the conversion of natural forests and grasslands.

Crop production (mostly cereals) is the world’s most important source of food for both direct human consumption and, indirectly, for livestock production. Growth in crop production has slowed as a result of several factors, some of which are related to environmental degradation and some of which are related to changes in demand (for example, the use of cereals for animal feeds in the EU declined until the early 1990s) (MA 2005).

Recent studies by FAO suggest that there will be very little land available for further extensification of agriculture in future and that increases in yield will result largely from intensification (producing greater yields per unit of time and area) and increased efficiency of production on existing land. Increased demand for food over the past 50 years has resulted in a major shift away from agricultural expansion globally to intensification though regional variations occur, with land still being converted for agricultural use in developing countries (particularly in sub-Saharan Africa). The management and policy challenge is to achieve a balance that optimises both biodiversity and production in the long term, as millions of lives and livelihoods depend directly on agricultural biodiversity.

Climate change introduces new challenges and has significant implications for agro-ecosystems and associated biodiversity. Land use change is a major part of humans’ impact on the world’s climate. Greenhouse gas emissions from deforestation, agriculture and other land use conversion activities are responsible for 30% of total human emissions.

Figure 2.1 Image Land-cover for the Year 2000

2.4 Impacts of agricultural production on biodiversity and ecosystem services

Agricultural development can have a variety of negative impacts on biodiversity (Table 2.2) and these may be associated with land conversion, intensification of production or land degradation associated with over-use of marginal land in low input systems.

Table 2.2 Impacts of agricultural production on biodiversity and ecosystem services

<table>
<thead>
<tr>
<th>Activity</th>
<th>Examples of negative biodiversity impacts</th>
<th>Examples of negative impacts on ecosystem services</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct (directly attributable to agriculture)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest clearance, cultivation of grassland</td>
<td>Loss of important habitat and associated species.</td>
<td>Loss of products provided by habitat, such as timber and non-timber forest products (e.g., food, medicines); forest loss reduces water storage / flood attenuation capacity, soil erosion in grasslands.</td>
<td>Increased area of land for cultivation. Rural landless poor migrate to marginal areas and poverty pressures alter the environment. Loss of ecotourism potential.</td>
</tr>
<tr>
<td>Cultivation and mechanical farming operations in grasslands and wetlands</td>
<td>Destruction of ground nesting birds.</td>
<td>Soil erosion, CO₂ emission from oxidized carbon in soil organic matter.</td>
<td>Short-term gain in increased agricultural production yields leading to increased food security and human health.</td>
</tr>
<tr>
<td>Irrigation of drylands</td>
<td>Loss of dryland species.</td>
<td>Long-term salinisation and soil damage.</td>
<td>Increased agricultural production yields but also an increased occurrence of waterborne disease such as malaria.</td>
</tr>
<tr>
<td>Drainage of wetlands</td>
<td>Loss of wetland species.</td>
<td>Loss of non-crop species of food, medicinal or other value. CO₂ emission from oxidized carbon.</td>
<td>Increased area of fertile land for cultivation. Rural landless poor migrate to marginal areas and poverty pressures alter the environment. Loss of ecotourism potential.</td>
</tr>
<tr>
<td>Use of artificial fertilisers</td>
<td>Decline in plant (and associated species) diversity due to dominance of weed species favoured by high nutrient conditions.</td>
<td>Loss of non-crop species of food, medicinal or other value.</td>
<td>Increased agricultural production yields, but continual use of fertilisers required to maintain crop yields. Increased food security and human health due to reduced risk of crop failure.</td>
</tr>
<tr>
<td>Activity</td>
<td>Examples of negative biodiversity impacts</td>
<td>Examples of negative impacts on ecosystem services</td>
<td>Trade-offs</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Use of pesticides / insecticides</td>
<td>Declines in directly impacted species and reductions in food chain supplies for others. Increases in pests and disease, when resistance to chemicals evolves.</td>
<td>Contamination of non-crop foods; loss or population declines in natural predators. Loss of natural pest management systems.</td>
<td>Increased agricultural production yields, but continual use of pesticides and insecticides required to maintain crop yields. Increased food security and human health due to reduced risk of crop failure.</td>
</tr>
<tr>
<td>Use of modern commercial crop varieties</td>
<td>Fast growing dense crops out-compete native species.</td>
<td>Loss of genetic diversity and potential future crop varieties.</td>
<td>Reduced use of fertilisers, pesticides and insecticides, increased nutritional value of crops. Increased food security and human health due to reduced risk of crop failure. Increased income as less capital input required (e.g., pesticides) however, seed cannot be sourced from the crop and must be bought regularly.</td>
</tr>
<tr>
<td>High stocking density</td>
<td>Losses of grazing sensitive species.</td>
<td>Competition with wild herbivores used for food and loss of ecotourism.</td>
<td>Increased agricultural production yield leading to increased food security and human health in the short-term. Increased income in the short term as surplus food can be sold in markets.</td>
</tr>
<tr>
<td>Use of veterinary drugs</td>
<td>Secondary poisoning risk (e.g., vultures in India).</td>
<td>Loss of scavenging species that assist with carcass disposal.</td>
<td>Healthy livestock, leading to increased income and human health. Increased capital input in the purchasing of veterinary drugs.</td>
</tr>
<tr>
<td>Hunting of wildlife that damage crops and livestock</td>
<td>Loss or declines in species (e.g., tigers).</td>
<td>Loss of potential food species and species of ecotourism importance.</td>
<td>Livestock and crop protected, leading to increased agricultural production yields. Food security is increased, as is human health.</td>
</tr>
</tbody>
</table>
The Relationship between Agriculture and Biodiversity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Examples of negative biodiversity impacts</th>
<th>Examples of negative impacts on ecosystem services</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect (indirectly attributable to agriculture)</td>
<td>Eutrophication of water bodies (from nutrient rich runoff and soil erosion)</td>
<td>Degradation of wetland habitats, river systems and marine and coastal areas.</td>
<td>Reduced drinkable water supplies and fish stocks.</td>
</tr>
<tr>
<td>Poultry and livestock rearing and rice production</td>
<td>Terrestrial eutrophication and loss of nutrient sensitive species.</td>
<td>Atmospheric nitrogen pollution (greenhouse gas emissions) contributing to climate change.</td>
<td>Benefits from increased agricultural production but loss of other ecosystem services.</td>
</tr>
<tr>
<td>Secondary impacts (resulting from actions that are not an intrinsic part of the agriculture)</td>
<td>Increased road and infrastructure development to supply agricultural areas</td>
<td>Further habitat loss from footprint and sourcing of building materials, disturbance, habitat fragmentation.</td>
<td>Hydrological disruption and pollution of water bodies, loss of arable land.</td>
</tr>
<tr>
<td>Migration and displacement of people</td>
<td>Loss or declines in wild food species (e.g., bush meat) in marginal areas.</td>
<td>Loss in food resources if accessed unsustainably. Pressures on urban environments, if migration is to urban centres.</td>
<td>Rural landless poor migrate to marginal areas and poverty pressures alter the environment. Potential work force migrates to urban centres searching for work.</td>
</tr>
<tr>
<td>Increased incomes from farming</td>
<td>Loss of biodiversity and degradation of habitat.</td>
<td>Hydrological disruption and pollution of water bodies, loss of arable land, loss of food species and drinkable water.</td>
<td>Reduction of poverty in some communities and capital input available to contribute to increasing production rates. Rural landless poor migrate to marginal areas and poverty pressures alter the environment.</td>
</tr>
</tbody>
</table>

(a) Land conversion

Land conversion has played an important role in reducing biodiversity. Between 1961 and 1999 the area of global cropland increased by 12 per cent while permanent pasture increased by 10 per cent. A 2005 study (Pagiola et al) compared agricultural systems with forest systems in Borneo and found substantially lower numbers of species in most groups in farmland than in forest. Farmland also supported relatively more
common species, whereas forests supported a higher proportion of endemic and indigenous species. The study also found that traditional agro-forestry systems in Sumatra contained only half the diversity found in neighbouring primary forests. Large areas of grassland savannah in Africa are threatened by continued conversion from natural grazing ecosystems to row-crop agriculture and cattle and wild-game ranching. Land use data from the FAO indicate that there has been a substantial increase in the area under arable and permanent agriculture over the last decade, with particularly significant increases in Africa (including, inter alia, Benin, Burkina Faso, Ghana, Guinea-Bissau and Malawi), parts of Asia (including, inter alia, South-east Asia, Bangladesh, Indus Valley, and Central Asia), the Middle East, and the Amazon Basin. In recent years, there have been several cases where rapid and large-scale agricultural developments have led to major and ongoing impacts on biodiversity (Box 2.3).

Box 2.3 Cattle production and tropical deforestation

Cattle production in tropical forest areas has caused extensive damage to biodiversity through deforestation. Growth in beef production encourages habitat destruction in two ways. First, expansion of grazing lands to accommodate larger herds often requires the conversion of natural habitat to pasture, and is a direct driver of deforestation and environmental degradation. Second, intensification of production requires an increasing supply of feed grains, which leads to conversion of natural habitat for maize, wheat, barley, and soybean monoculture.

Today there are over 1.3 billion head of cattle worldwide (32% more than in 1965) and this number is growing. Much of this growth has been in Asia, Latin America and Africa. About one-quarter of the world’s cattle are in Latin America. Most countries have historically produced most of the meat that they consume, with trade in beef accounting for less than 4% of all trade. Brazil, where beef exports are very important, is an exception. Growth in domestic demand led to pasture expansion and deforestation from the 1970s to the mid-1990s. However, the extensive deforestation in the Amazon in recent years has been linked with a five-fold increase in beef exports between 1997 and 2003.

The future impacts of cattle production on biodiversity will depend on the extent to which growing demand for beef is met by greater intensification or by expansion of grazing into areas currently occupied by important native habitat. Although intensive production systems reduce the pressure on natural ecosystems from deforestation, they pose an indirect threat to their increased demand for feed grain.
One example of these impacts is the expansion of soybean production in Brazil. Currently, in Brazil soybean cultivation is expanding most quickly in the Cerrado region. Since the 1960s, two-thirds of the region has been converted to agriculture. It is known as the ‘development sacrifice zone’ and was created partly in response to international pressure to restrict clearing in the Amazon rainforest. Many natural and un-fragmented areas of the Cerrado contain biodiversity rivalling that of the Amazon. Soybean expansion in Brazil has been driven by market forces, advances in agricultural technology, and government support, which includes subsidies, credit schemes and infrastructure.

(b) Agricultural practices

During the past decade, an increase in global agricultural production has occurred, largely due to increasing intensity of production (intensification). This trend has been most prevalent in developed countries and impacts of agricultural intensification on biodiversity are particularly well-documented in Europe. For example, there is a direct link between agricultural intensification and declining populations of once-common birds. In 2000, the Royal Society for the Protection of Birds reported that over one-third of Europe’s important bird areas were threatened by expansion of intensive farming and that there was some degree of threat from farming to 93 per cent of the 3,619 important bird areas across Europe. A report by Birdlife International reinforced this conclusion showing that European countries with the most intensive farming have experienced the most rapidly declining bird populations. Intensive farming was causing serious population declines in about one-third of Europe’s 515 bird species, including 12 of the 16 most threatened birds in Europe.

In much of the tropics, where most of the world’s biodiversity occurs, rates of intensification have lagged behind countries in the North, such as those in the European Union (EU) (see Box 2.4).

**Box 2.4 Intensification of agriculture in Europe**

Much of lowland western Europe is now characterized by intensive agriculture, driven by agricultural technology (machinery, agro-chemicals and plant breeding) combined with supportive agricultural policies and in particular, the EU’s Common Agricultural Policy (CAP). This policy environment led not only to an expansion in the area cultivated, but also to profound changes in farming practices on existing agricultural land. Intensification resulted in farm and field amalgamation with associated loss of wildlife habitats, which traditionally formed part of the farmed landscape (e.g., hedgerows, woodlands). Farms also tended to specialise and mixed farming declined. There were also marked switches in crop types and a substantial decrease in the area of biodiverse pastures and hay meadows. On the remaining semi-natural grasslands CAP support policies and socio-economic, technological, and structural changes to farming systems have led to increased livestock numbers in many areas of Europe.

Intensification leads to increased levels of use and variety of agrochemicals (particularly inorganic fertilisers, herbicides and pesticides). The biodiversity impacts of these agricultural changes are well documented, and include major population declines in many farmland birds across most of Europe. To overcome some of the environmental degradation from farming practices in Europe, a programme to ‘set aside’ land has been implemented, which involves compensation payments to farmers who do not undertake regular farming practices on set-aside land. However, the land is not left fallow, as farmers are still allowed to grow non-food products such as biofuel raw materials or ingredients for pharmaceuticals on the set-aside land.

Subsidies are also paid to farmers who:

- Reduce the use of fertilisers or introduce organic farming;
- Change to more extensive forms of crops, including forage production;
- Reduce the number of sheep and cattle per forage area;
- Follow environmental friendly farming practices;
• Ensure the upkeep of abandoned farmlands;
• Set aside farmland for at least 20 years to establish biotope reserves and natural parks or to protect hydrological systems; and/or
• Manage land for public access and leisure activities.

Such subsidies are currently under view with the aim to remove all subsidies. For example, sugar beet is one of the crops subsidised by CAP. The EU is the largest sugar beet producer (16-18 million metric tons), and produces a similar amount of sugar to India and Brazil (who produce sugar from sugar cane). The EU is planning to cut the minimum sugar beet price by 39%, which will have an impact on nineteen Africa, Caribbean and Pacific (ACP) countries exporting sugar through changes in the price on the EU market.

There are also many cases of agricultural degradation as a result of inappropriate agricultural management in most regions in the world. One of the most important causes of habitat degradation in arid zones is overgrazing of grasslands and deserts. For example, in Syria, overgrazing is widespread and causes extensive damage to the steppe and desert vegetation. Overstocking is partly a result of water supplies now being provided to livestock, where previously livestock numbers were limited by natural water sources. The required irrigation projects result in further habitat degradation through, inter alia, wetland drainage. In the Sahel area of Western and Central Africa, increased desertification has occurred in many areas as a result of extensive habitat degradation through intense logging (for firewood and timber), overgrazing and frequent burning, which is considered to have had major impacts on migratory birds.

(c) The influence of genetically modified organisms

In addition, practices such as the increasing use of genetically modified organisms (GMOs) are causing controversy in terms of their contribution to sound agricultural management (Box 2.5). Only a limited number of GMOs have been approved in some countries (such as cotton, maize, canola, papaya, potato, rice, soybean, squash, sugar beet, tomato, and wheat). Very few products (such as herbicide and insect-resistant maize, soybean and rape seed) are actually available on the international market as several countries have concerns about GMOs. Despite this, the area of genetically modified (GM) crops is expanding and some developing countries are opting for GM varieties for cultivation to contribute to food security. GMOs have met with consumer resistance that could disrupt trade and international negotiations.

The ongoing intensification of agricultural land is further in evidence by a global seven-fold increase in nitrogen fertilization, a four-fold increase in phosphorus fertilization, a two-fold increase in the amount of irrigated cropland, and the increase in land in cultivation (FAO 2005). Agriculture is the major user of industrially fixed nitrogen and only a fraction of this fertilizer is used and retained in food products. Poor control of run-off of the excess nitrogen leads to biodiversity loss in inland water, coastal, and marine systems through eutrophication. Nitrogen loads in rivers eventually find their way to the coastal zone, where they also cause eutrophication.

While it is possible that agricultural land use is compatible with high biodiversity, in many cases it results in degradation and loss. Biodiversity is declining globally and there are clear links between agricultural change and this decline across a wide range of agricultural systems. Agricultural expansion has historically been a major contributor to loss of global biodiversity. There is also increasing evidence that intensification of agricultural production (using agrochemicals and fossil fuels) is altering ecosystems to the point where they may not be viable in the long term and there are increasing risks to productive agriculture from environmental damage. Historically, the expansion and intensification of agricultural systems has been seen to have had a small overall impact on biodiversity compared to other activities such as urban development, hunting, mining, construction, invasive alien species, industrial pollution, land degradation and energy development. However, the current scale and technology of agricultural land use have made agricultural production a leading threat.
Box 2.5 Genetically Modified Organisms in Agriculture: Potential Benefits and Risks

<table>
<thead>
<tr>
<th>Potential benefits from the use of GMOs</th>
<th>Risks and concerns about the use of GMOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased productivity leading to increased incomes.</td>
<td>Products are tailored largely to the needs of large scale farmers and therefore resource poor farmers fail to benefit; market control of the seed industry reduces farmer choice.</td>
</tr>
<tr>
<td>New crop varieties for marginal areas increasing the sustainability of agriculture in poor farming communities.</td>
<td>Patenting of genes originating in the developing countries without compensation.</td>
</tr>
<tr>
<td>Decrease in dependence of chemical inputs.</td>
<td>Technologies that prevent farmers re-using seed.</td>
</tr>
<tr>
<td>Enhanced food security through reduced fluctuations in yields.</td>
<td>Food safety and the environmental risks of GMOs escaping and out-competing natural populations or recombinant DNA transferring to wild or weedy species.</td>
</tr>
<tr>
<td>Higher nutritional values through higher protein and nutrient quality.</td>
<td></td>
</tr>
<tr>
<td>Production of valuable chemical and pharmaceuticals at a lower cost.</td>
<td></td>
</tr>
</tbody>
</table>


(d) Conservation of biodiversity and agricultural biodiversity within the agricultural ecosystem

The incidents of conflict between agricultural and biodiversity interests are expected to rise in the future, particularly in the most important protected areas, the ‘wider’ farmed landscape, and in areas not actively farmed where induced changes may occur. The scale of potential conflict is considerable. It is being driven by a global expansion in the area of land used for crops, pasture and plantations, and is associated with increasing levels of use of energy, water, and agrochemicals and by environmental damage, which places the capacity of ecosystems to sustain food production at risk. The constant growth in the world’s population drives much of this change.

Agricultural biodiversity itself is also under threat, with the diversity of animal breeds, plant and crop varieties, and the genetic resources they contain, generally declining. During the past century, over 90 per cent of crop varieties have been lost. Livestock breeds are disappearing at a rate of five per cent per year. Greater priority is now being placed on conserving wild relatives of crops and vegetables. Many countries also have their own national conservation programmes, such as the former Soviet Union’s national list of wild relatives of crops in 1981, Turkey’s 22 Genetic Management Zones, Mexico’s special biosphere reserve to protect the wild relatives of maize, India’s citrus reserve, and the United States’ policies to protect the wild relatives of grapes, onions, and potatoes.

In Armenia, for example, its plateau is recognised as an important centre of origin for cultivated plants. This is based upon both the number of wild relatives of crop plants and the number of varieties of different species
occurring in the country. Archaeological and ethno-botanical studies also indicate long-term cultivation of grains (wheat, barley, rye, millet, oats), pulses (peas, lentils, chick peas, broad beans), fruit (water-melon, grapes, apricot, quince, plum, cherry, pomegranate, peach, apple), and nuts and wild grasses on the Armenian plateau. This extent of cultivation and variety of crops indicates that Armenia is an important site of origin for crop cultivars and the government has carried out extensive work to map and locate important wild relatives of crops to contribute to the development and implementation of a national strategy and related legislation to conserve wild crop relatives.

The management of agricultural land is particularly important because it covers so much of the world’s land surface. In western and central Europe, for example, farming occupies roughly 50 per cent of the land surface compared with protected areas, which cover only 10 per cent to 12 per cent. Agricultural policy in Europe has moved towards increased agri-environmental support as a means of sustaining agricultural biodiversity. Some of these programs have been successful in reversing declines in wildlife populations on farmland.

Agro-forestry is another way to manage agricultural and wild biodiversity. It involves the integration of trees into farming systems to create a biodiverse system. Agro-forestry systems have brought many benefits to farmers in developing countries. For example, in the Philippines, the primary agro-forestry practice is contour hedgerows, where food crops are planted between hedges of woody perennials established along the contours of upland sloping farm plots. Pruned clippings from the hedgerows trees or shrubs are placed at the up-slope base of the hedges to trap eroding soil so that, over time, natural terraces are formed. Such hedgerows can improve soil conservation by 15 per cent to 20 per cent for a typical small farmer. In addition to erosion control, biophysical effects of contour hedgerows on soil include the maintenance or increase of organic matter and diversity, nitrogen fixation, enhancement of physical properties such as soil structure, porosity and moisture retention and the enhancement of the efficiency of nutrient use (MA 2005). Agro-forestry systems have also been shown to increase farmers’ incomes in sloped areas of Nepal, Cameroon, Thailand and Indonesia. They provide more niches for ‘wild’ biodiversity to coexist with crops and livestock and more opportunities for people to harvest a variety of biodiversity-based products (such as medicinal plants or building materials) alongside, or in conjunction with, their main crops. Sustainably managed agricultural systems can contribute to the maintenance of healthy ecosystems and support high levels of biodiversity.

### 2.5 Predicted future challenges

The MA predicted that over the next 50 years (likely to be the final period of rapid agricultural expansion) demand for food by a wealthier and 50 per cent larger global population will be a major driver of global environmental change. The anticipated doubling of food production will result in an approximately three-fold increase in rates of nitrogen and phosphorus fertilization, a doubling of the irrigated land area, and an 18 per cent increase in cropland. It has been calculated that across the developing countries the area under 23 key crops will need to increase by 23 per cent by 2050.

Such projected changes would have a dramatic impact on the diversity, composition, and functioning of the world’s remaining natural ecosystems, and on their ability to provide essential ecosystem services. It is predicted that the largest impacts will be on freshwater and marine ecosystems, which will become severely eutrophied by high rates of nitrogen and phosphorus from agricultural run-off. This would in turn lead to loss of biodiversity, outbreaks of pest species and impairment of fisheries. Furthermore, due to aerial redistribution of various forms of nitrogen, agricultural intensification would also eutrophy many natural terrestrial ecosystems, which would contribute to the atmospheric accumulation of greenhouse gases (MA 2005) (Box 2.6).
The Relationship between Agriculture and Biodiversity

Box 2.6 Future challenges of climate change, agricultural production, and food security

Climate change is an emerging challenge to agricultural production and food security. Agricultural production could benefit from the rise in global temperatures through an increase in area suitable for cropping, an increase in the length of growing periods, a reduction in costs for over-wintering livestock, improvement of crop yields, and forests that may grow more quickly. However, these gains are offset by the losses such as a reduction of fertile land to flooding along coastal plains.

Those groups who will disproportionately feel the greatest adverse impacts of climate change are the poor, such as the small-scale farmers and low-income groups in developing countries prone to drought, flooding, fire, saltwater intrusion and sea surges. It is in these countries, where food production is already insufficient, and agricultural yield varies and a further decline will result in further malnutrition and famine. Hence, climate change will affect the availability and distribution of food production and people’s access to food.

Agricultural production is not only a victim of climate change, but also part of the cause. The agriculture sector is a major source of greenhouse gas emissions, releasing large quantities of carbon dioxide and half of all methane emissions. Livestock production and irrigated rice farming are the two highest contributors of methane gas.

However, agriculture can play an important role in mitigating the impacts of climate change. Crop farming can be a carbon sink, although agricultural soils (like other biological sinks such as vegetation) have an inherent upper limit for storage. The total amount of carbon stored is dependant on the crop and location. Moreover, the rate of sequestration declines after a few years of crop growth. Other measures could include cultivation patterns, reduction of fertiliser use, improvement of livestock diet, improved manure management, alternatives to slash and burn land expansion, and more efficient uses of water.


It has been observed that with trade liberalisation, there is a trend towards the intensification of agriculture. In many places intensification is being achieved in an unsustainable way, through the excess use of chemical inputs and energy. It would be preferable to move towards programmes and policies which support sustainable intensification. Intensification generally means increasing non-land inputs to generate an increase in agricultural yield. While increasing agricultural output can come about by increasing chemical input, it is also possible to increase levels of production through the use of knowledge to improve management.

The FAO (2002) has identified a need to move toward the further use of sustainable agriculture in the future, and has identified possible sustainable agricultural practices which merit further consideration including:

- **No-till/conservation agriculture.** This involves minimum disturbance of the soil, maintenance of a permanent cover of live or dead plant material, and crop rotation.

- **Integrated pest management.** This aims to minimise the amount of pesticides applied by using other control methods more effectively, such as pest-resistant varieties, bio-insecticides and traps, and the management of crop rotations, fertiliser use, and irrigation, in ways that minimise pests.

- **Integrated plant nutrient systems.** These use a range of practices that include recycling vegetable and animal wastes, and the use of legumes, to fix atmospheric nitrogen. Limited fertiliser is applied.

- **Sustainable intensification.** This uses technologies such as nutrient recovery, water recycling, and hydroponics as a way of meeting rising demand while minimising environmental costs.
3. Trade Measures and the Trade Policy-Making Process

**Key points**

- Agricultural trade policies are a major influence on land use patterns and are a driving force behind agricultural practices.
- Changes in land use influence biodiversity, whether this is within or outside agro-ecosystems.
- Integrated Assessment can assist countries in recognising not only the social, economic and broader environmental impacts a trade policy may have, but also in considering its impacts on biodiversity and ecosystem services. Using such a tool can assist countries (including developing countries) in using trade to maximise development opportunities while minimising impacts on biodiversity.

People and countries have traded with each other for thousands of years, originally to exchange local goods for imported goods, specialities, and luxuries that were not available domestically. For some goods, such as diamonds, various minerals, coffee and oil, this still remains the principal reason for international trade, as many countries do not have, or cannot produce, these items. With most trade, however, in particular merchandise (which comprises about 80 per cent of world trade), factors such as market demand, economies of scale, marginal price differences, efficiency gains, perceived value and quality, fashion, and styling are increasingly important. In addition, many companies now have re-organised their research, development and manufacturing sites and their marketing, shipping and distribution networks across many borders, so their location and investment decisions also drive significant growth in cross-border shipping and trade.

In order to pay for imports a country needs to export. Those with specialities of their own can export them, but others must export more readily available agricultural produce, manufactured goods, or services, which other countries might be able to produce, but less efficiently or with a higher opportunity cost.

Governments regulate the flows of trade with trade policies. These policies cover many areas, including import tariffs and quotas, export taxes, subsidies and a variety of non-tariff barriers to trade in goods or services. Other policies that influence international trade include product standards, intellectual property rights, and health, safety and phytosanitary standards. Many countries use trade policy to secure a competitive advantage in either domestic or foreign markets, or to protect locally-important firms or sectors. Trade policy may also be used as a means to provide the regulatory and legal context needed to reduce barriers to liberalised trade and competition.
Many developing countries try to reduce their dependency on commodity exports and low-cost labour, and build the technology and skill levels needed to compete with higher added value goods and services. Greater participation in international trade can facilitate inward investment and technology transfer and help countries acquire these capabilities, while satisfying consumer demand for imports. Some governments feel that uncompetitive domestic industries need protection to survive for long enough to acquire the skills and technologies needed for their long-term development. In practice, relatively closed markets, a reliance on preferential terms of trade, an emphasis on import substitution and the use of tariff barriers have protected particular industries and favoured domestic companies. However, in some cases this comes at the cost of insulating them from normal competitive pressure and removing incentives to change, innovate and develop. As a result, some of these industries and companies have fallen further behind global standards and become even less competitive. This is further exacerbated where governments have resisted modernisation in industries that are major employers.

As a result of this plethora of trade-offs, trade policies and agreements are usually the result of protracted and complex negotiations. Concessions in one area are used to secure reciprocal concessions in other areas as countries try to maintain preferences or preserve their competitive advantages. This process has become increasingly fluid, as the process of global economic development and growth has widened dramatically in recent decades, bringing both additional competition and a range of new business opportunities onto the market and thereby transforming the global economy.

### 3.1 Types of trade measures and agreements

The WTO (with some 150 members) is the principal forum for negotiating international trade agreements. In addition to this multilateral forum, regional and bilateral trade agreements enable countries to make greater commitments to each other than those required by the WTO (although they must be consistent with WTO rules). Such agreements may also include non-WTO members. They may be characterised as:

- **Bilateral free trade agreements.** Special tariff arrangements and agreements to reduce or eliminate other trade barriers (for example, the United States-Singapore Free Trade Agreement).

- **Bilateral association agreements.** Providing for a greater degree of integration, such as for standards and investment provisions (for example, such as those that exist between the EU and neighbouring countries).

- **Plurilateral free trade agreements.** Agreements between three or more partners (such as the North American Free Trade Agreement).

- **Customs unions.** Common external tariffs for most products (such as MERCOSUR).

- **Common markets or economic unions.** Further integration to include free movement of labour and capital, common standards and regulations, and supranational economic management (such as the EU).

At the end of 2008, over 400 bilateral and regional trade agreements had been notified to the WTO. Some of the principal regional agreements are listed in Table 3.1.
Table 3.1 **Regional trading blocs**

<table>
<thead>
<tr>
<th>Trade agreements</th>
<th>% world exports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major blocs</strong></td>
<td></td>
</tr>
<tr>
<td>Asia-Pacific Economic Cooperation forum</td>
<td>45.3</td>
</tr>
<tr>
<td>European Union</td>
<td>35.5</td>
</tr>
<tr>
<td>North American Free Trade Agreement</td>
<td>18.4</td>
</tr>
<tr>
<td>ACP (Cotonou Agreement, including the EU)</td>
<td>&gt;30.0</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td></td>
</tr>
<tr>
<td>Association of South-East Asian Nations</td>
<td>6.1</td>
</tr>
<tr>
<td>Bangkok Agreement</td>
<td>4.8</td>
</tr>
<tr>
<td>Economic Cooperation Organisation</td>
<td>1.1</td>
</tr>
<tr>
<td>South Asian Association for Regional Co-operation</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Middle East and North Africa</strong></td>
<td></td>
</tr>
<tr>
<td>Gulf Cooperation Council</td>
<td>1.7</td>
</tr>
<tr>
<td>Arab Maghreb Union</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Latin America and the Caribbean</strong></td>
<td></td>
</tr>
<tr>
<td>Latin American Integration Association</td>
<td>4.7</td>
</tr>
<tr>
<td>MERCOSUR</td>
<td>1.5</td>
</tr>
<tr>
<td>Andean Group</td>
<td>0.8</td>
</tr>
<tr>
<td>Central American Common Market</td>
<td>0.3</td>
</tr>
<tr>
<td>Caribbean Community</td>
<td>0.1</td>
</tr>
<tr>
<td>Organisation of Eastern Caribbean States</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
</tr>
<tr>
<td>Southern African Development Community</td>
<td>0.8</td>
</tr>
<tr>
<td>Common Market for Eastern and Southern Africa</td>
<td>0.4</td>
</tr>
<tr>
<td>Economic Community of West African States</td>
<td>0.4</td>
</tr>
<tr>
<td>Economic Community of Central African States</td>
<td>0.2</td>
</tr>
<tr>
<td>Economic and Monetary Community of Central Africa/ Customs and Economic Union of Central Africa</td>
<td>0.1</td>
</tr>
<tr>
<td>West African Economic and Monetary Union</td>
<td>0.1</td>
</tr>
<tr>
<td>Economic Community of the Great Lakes Countries</td>
<td>0.0</td>
</tr>
<tr>
<td>Mano River Union</td>
<td>0.0</td>
</tr>
<tr>
<td>East African Community</td>
<td>-</td>
</tr>
</tbody>
</table>

UNEP’s *Handbook on Integrated Assessment of Trade-related Measures - the Agricultural Sector* (2005) discusses some trade measures that are relevant for biodiversity. These include market access for agricultural products, export subsidies, domestic support, standards and conformity assessment, investment, and intellectual property rights (Box 3.1). For example, developing countries increasingly engaged in international trade in agricultural products must be able to adapt to standard-setting initiatives in such agreements as the WTO’s Agreements on Technical Barriers to Trade or Sanitary and Phytosanitary Issues. Given the fact that many developing countries have limited technical, financial and legal capacities, they may encounter difficulties in fully participating in defining these standards, and generally find it hard to adopt, enforce, and promote them.

**Box 3.1 TRIPS Agreement, the CBD and biodiversity**

The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is based on a recognition that increasingly, the value of goods and services entering into international trade resides in the know-how. The agreement holds WTO members to minimum standards of protection over intellectual property through instruments such as copyright for books and patents for industrial design. By protecting the innovator’s right to sell their innovation, TRIPS encourages innovation, including the development of new technologies and processes that will benefit sustainable development. On the other hand, such innovation might be slower to make a contribution if new, more environmentally benign technologies or pharmaceuticals become so expensive as to be inaccessible by the countries and people most in need.

It is believed that TRIPS and the CBD have different and non-conflicting objectives and purposes and deal with different subjects. In fact, some believe that TRIPS supports the implementation of the obligations of the CBD more effectively, for example, patents can be instruments in the sharing of benefits and the conservation of biodiversity based on voluntary contracts. However, there is evidence that conflicts between the two instruments exist, especially in relation to traditional knowledge of indigenous peoples and local communities (Article 8j of the CBD). TRIPS allows for patents to be granted in respect to genetic materials. This is inconsistent with the CBD as this limits access to such genetic material and conflict with the sovereign rights of countries in particular indigenous groups, over their genetic resources (WTO, 2006). However, the actual impact TRIPS has on biodiversity conservation has yet to be quantified.

While these are the principal measures that have a direct influence on biodiversity, all other measures in a trade negotiation agenda can have a significant indirect influence. The WTO agenda is the most comprehensive, but a regional or bilateral trade agreement may include the equivalents of any or all of its measures. Other measures which might arise include the following: market access for non-agricultural products; trade in services; trade facilitation; government procurement; competition policy; rules of origin; subsidies, countervailing measures and anti-dumping; preferences for developing and least developed countries; and dispute settlement mechanisms.

Non-agricultural products in the WTO classification include forest products. Integrated assessments need to consider how impacts on biodiversity and ecosystems associated with agriculture trade policies and agreements might influence production of such non-agricultural products. They also need to consider how trade policies for these products might have consequences for biodiversity.

Trade in services has become increasingly important. Services generally represent 60 per cent of global output and, in many countries, an even larger share of employment. However, developing countries have not become fully engaged in the export of services, which is dominated by countries belonging to the Organisation for Economic Cooperation and Development (OECD). With a minority of developing countries having made commitments under the WTO’s General Agreement on Trade in Services, there is room for potentially larger
Trade Measures and the Trade Policy-Making Process

gains from trade in services for these countries than from trade in goods. This may come with significant impacts on biodiversity. For example, the liberalisation of distribution services has major effects on sources of supply of food products, and hence on agricultural production levels and techniques.

Trade facilitation has an impact on market access for all products, both agricultural and non-agricultural. It refers to ways in which the administrative and regulatory burden on companies seeking to import or export can be relieved through measures such as transparency and access to information (of other countries’ importing and exporting regulations), and the administrative issues associated with customs procedures and other formalities. It is the simplification and harmonisation of international trade procedures, where trade procedures are activities, practices and formalities involved in collecting, presenting, communicating and processing data required for the movement of goods in international trade. This relates to a wide range of activities such as import and export procedures (such as customs); transportation formalities; and payments, insurance, and other financial requirements.

The other rules governing trade may also have significant indirect effects on biodiversity, and the details of proposals need to be examined carefully to identify potential impacts. For example, rules of origin and the criteria used to determine the national origin of a product, can be designed so as to encourage, or discourage local processing of agricultural commodities, thereby having an impact on production, land-use and biodiversity.

Each component of the trade-related agenda presents its own challenges. While the potential for tariff reduction is significant in some countries, much of the emphasis has now moved on to trade in services, trade facilitation, and investment, as discussed above. The effects of changes in these areas tend to be understood even less fully than for tariff changes. The economic analysis used in forming trade policy tends to be fairly simple, and may for example go no deeper than the assumption that the attraction of foreign investment will accelerate growth and generate employment. The analysis may take no account of the nature of the development, its long-term potential, and its social and environmental effects.

In general, it is particularly important to ensure that public institutions are strong and effective before introducing a major structural change to an economy. Many of the problems at this stage are associated with inadequate government regulation and weak supervision. In the financial sector, this can result in various problems ranging from money laundering to unmanageable financial volatility. It can also result in negative impacts on the environment, such as illegal construction and unauthorised trade in hazardous waste.

3.2 Trade policy in the agriculture sector and biodiversity

In around 25 per cent of countries, the share of agricultural exports exceeds two-thirds of total exports, while in a further 20 per cent the share exceeds one-third. Many low-income countries are net agricultural importers, while many others rely on one or a few agricultural exports for the bulk of their foreign exchange earnings. The general global trend has been away from traditional, family-based and small-scale production with an emphasis on self-sufficiency, towards larger-scale production with a focus on production for markets and export.

Since 1994, developing countries (whose share of world industrial exports has been steadily increasing) have not increased their share of agricultural exports. Many developing country exports still face tariffs, subsidies and other barriers in developed country markets and, in particular, attempts to develop processing industries for export are sometimes hampered by tariff escalation, the erosion of tariff preferences, and reciprocal reductions in tariffs which means that domestic industries are subject to increasing competition from products that can
be produced more cheaply elsewhere. This is particularly problematic for the least developed countries where agriculture often constitutes the single most important sector in the economy and where exports are typically not diversified but based on one or two primary products for which global demand or international prices are often declining. Partly because of subsidies in high income countries many developing countries are net importers of major agricultural commodities. For example, wheat is the most important cereal traded on international markets, and developing countries generally account for nearly 80 per cent of all wheat imports.

Trade and trade-related policies have a major influence on patterns of land and resource use. Agricultural trade policy drives changes in agricultural production and distribution by altering markets for products and through levels of subsidy. Farmers make production decisions in the light of the changes in revenue and cost structures. These decisions in turn change land use and ultimately affect the compatibility of land and farming practices with the conservation and sustainable use of biodiversity. Changes in agricultural production patterns as a result of changes in trade policy vary depending on the initial conditions in a country in terms of production, trade and consumption of agricultural commodities (for example, whether there have been high or low levels of protective subsidy, or whether the country is a net importer or exporter of food) (Table 3.2).

Trade and trade policy are a major force driving changes in agricultural practice and it is therefore important to ensure that proposed changes are compatible with a sustainable, productive environment and with global goals for biodiversity. Avoidance of agricultural impacts on biodiversity has to be incorporated at a policy and strategic level to avoid impacts at source. One of the main challenges is to distinguish between the impacts of trade liberalisation and other influences on the agriculture sector, including changes in product demand, production methods and transportation-related costs.

Table 3.2 Possible trade-related issues and impacts on biodiversity

<table>
<thead>
<tr>
<th>Issue</th>
<th>Direction of change</th>
<th>Possible trade-related issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cerrado in Brazil has relatively low levels of protection for biodiversity. Soybean cultivation is a significant cause of direct habitat loss in biodiversity-rich areas. Increased soybean cultivation also displaces cattle production, sometimes causing further land conversion.</td>
<td>Negative</td>
<td>Further liberalisation of trade may increase rates of conversion of pastureland to soy cultivation and catalyse further forest conversion to pasture for displaced cattle production.</td>
</tr>
<tr>
<td>Sugarcane has known adverse effects on important biodiversity, including some global biodiversity hotspots.</td>
<td>Positive</td>
<td>The removal of tariffs may reduce production in inappropriate environments or locations.</td>
</tr>
</tbody>
</table>

3.3 Formulating trade policy

Trade policy in all countries is primarily a component of economic policy, influenced by technology policy and development policy, where these exist separately. Wider social and environmental considerations may also be taken into account when domestic concerns are high enough to influence top-level government decisions, such as in the EU and in the United States. In most other areas, trade policy typically aims to maximise short-term or long-term economic performance, and leaves social and environmental issues to be dealt with separately in domestic policy-making.
A country’s negotiating position in multilateral, regional or bilateral agreements has to take into account the interests of all economic sectors, which may complement or conflict with each other. Extensive consultation therefore normally takes place with the main economic interest groups, but the transparency of consultation is usually fairly limited.

The main stages of developing policy and formulating a negotiating position include:

- consultation with main economic interest groups;
- commissioning economic studies;
- consultation with other influential groups;
- review of other countries’ proposals;
- inter-departmental meetings to develop a negotiating position;
- negotiations;
- external consultation (possible);
- environmental assessment where identified as necessary or legislated (e.g., Canada);
- further consultation and ongoing negotiation; and
- inter-departmental meetings to accept/reject final proposals.

In most countries, the mechanisms through which civil society influences trade policy directly are relatively weak or non-existent. In the EU, a clear distinction is drawn between two parallel impact assessment processes. A Sustainability Impact Assessment (SIA) is conducted publicly, and considers social, environmental and economic impacts of prospective trade liberalisation negotiations in the EU and in its trading partner(s). The SIAs involve extensive public consultation and full public access to assessment reports. A parallel Impact Assessment is conducted under other EU procedures, which apply to all major policy proposals, as part of the development of a negotiating position. For trade policy however, these Impact Assessments are conducted internally and access to the reports is restricted. If the development of a negotiating position were done publicly, it would reveal the hand of the negotiators and weaken their position. Therefore, although the publicly conducted SIA process is intended to inform negotiating positions, it does not define them. It does however make trade negotiators more fully aware of public concerns, and also facilitates a greater degree of dialogue between trade officials and other government departments in the formulation of trade policy.

The United States and Canada adopt a different approach, in which strategic impact assessments of trade policy are directed primarily towards environmental impacts, and concentrate on impacts in the country itself and not in trading partners. The impact assessment can therefore play a more direct role in the formulation of a negotiating position, alongside the contributions of separate economic and social analyses. In these cases, the impact assessment does not itself integrate the three spheres of sustainable development. Canada has recently published a *Handbook for Conducting Environmental Assessments of Trade Agreements* for those interested in learning more about this approach (GoC 2008).

For a developing country, Integrated Assessment offers considerable potential for strengthening the decision-making process. Civil society is generally weaker than in high-income countries, which adds to the difficulties of enhancing its voice, but at the same time, trade ministries themselves lack the capacity to fully understand the effects of alternative policies on their own economic objectives. Neither the North American approach nor the European approach is directly applicable, but elements of either may be incorporated into an assessment process that is designed to meet the country’s needs and be compatible with its own decision-making structures. Even more than in high-income countries, decisions tend to be influenced most strongly by a fairly small group of key economic actors. The prime need is therefore to understand fully the economic effects, and the effects that social and environmental impacts can have on them.
Typically, a reduction in tariffs (in exchange for reduced protection by other countries) has two immediate effects: domestic firms are exposed to greater competition, and government revenues fall. In some countries, both of these effects are small, but in others, particularly low income ones, they can be highly significant. Domestic production and employment will both decline, and some firms will become unprofitable and close. In those economic sectors where new export opportunities arise, production will expand, but usually with a time lag, associated with the need for investment, land acquisition and training the necessary workforce. Carefully designed domestic policies will be needed in parallel with the trade reforms, in order to avoid potentially serious adverse impacts while the economy adjusts, and to fully capitalise on the longer-term opportunities. The impacts and opportunities for some economic actors are obvious, and they will therefore play a strong role in influencing the negotiating position and parallel domestic policies. For others, the impacts are less clear. Potentially influential actors will lack both the ability and the motivation to influence policy unless they have a deeper understanding of the interacting social, environmental and economic effects.

Non-economic actors can also have a significant influence on policy. However, except when non-economic objectives over-ride economic ones, their greatest influence tends to come from demonstrating that social or environmental impacts can have a significant economic effect, while also elucidating what the economic effects are likely to be. Integrated Assessment can play a key role in this. Trade policy tends to be based on fairly simple economic analyses, which give a reasonable indication of the likely changes in imports, exports and production levels in different sectors, once an economy has adjusted to the change in tariffs or trade rules. However, information is often lacking on the economic effects that will occur during the period of adjustment, on the likely magnitude of the loss in government revenues, on the influence of the changes on exchange rates, and on the mechanisms through which the changes might accelerate or decelerate pressures on land and water availability, rural-urban migration, technology transfer and long-term economic growth.

Additionally, information is often lacking on the economic costs of social and environmental effects. In sectors where production rises, domestic policy measures will need to be introduced or strengthened in order to contain unacceptably adverse environmental impacts, and these will have associated costs. The magnitude of these costs is rarely known at the time the decision is made. Similarly, as production moves between sectors, unemployment will rise, unless action is taken to smooth the transition. In either case, there will be economic costs, associated with the social costs of rising unemployment, or the action taken to prevent it. Again these costs are rarely known when the decisions are made and can often only be predicted in broad terms.

As well as being among the most important of the economic effects, all of these can have a major influence on social and environmental issues. The ability of an Integrated Assessment to provide fuller information of this type may be particularly influential in helping to formulate trade policy more effectively.

### 3.4 Linkages between agricultural trade and biodiversity

The current global trend is towards trade liberalisation within the agriculture sector. This is characterised, *inter alia*, by a planned/projected reduction of import tariffs and subsidies. In theory, if all subsidies were removed, there would be a reduction in over production, an increase in world market prices, and a fall in total production. The biodiversity impacts of agriculture would likely be reduced in the subsidising countries (such as the USA and the EU). Full liberalisation, the removal of all subsidies and import tariffs, would result in decreased production in highly protected countries and increased production in those whose agriculture is more competitive (such as Brazil and Argentina). The key issues affecting the relationship between agriculture and various aspects of biodiversity are the relative intensity of various factors of agricultural production
Trade Measures and the Trade Policy-Making Process

(such as land and other forms of natural capital including climate, soil quality and water resources), labour, human knowledge and management, and external capital inputs (such as fertilisers and pesticides). It can be expected that these issues will be affected, with varying degrees of intensity, by liberalisation of trade in agriculture. Table 3.3 indicates some questions and explanations that can help begin to develop the linkages between sustainability, agricultural trade policies, and biodiversity.

Table 3.3 Understanding the relationship between sustainability, agricultural trade policies and biodiversity

<table>
<thead>
<tr>
<th>Sustainability Goals</th>
<th>Key Questions</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>To maintain productive and sustainable food production</td>
<td>Does the policy recognize the fundamental role of biodiversity in supporting productive and sustainable food production?</td>
<td>Biodiversity provides a range of services to agriculture. Loss of biodiversity undermines the capacity of ecosystems to support agriculture and a sustained stream of income.</td>
</tr>
<tr>
<td>To ensure food security</td>
<td>Does the policy recognize the need for biodiversity and sustainable ecosystem management as the basis for food security?</td>
<td>Food security requires genetic diversity as the means of adaptation to new environments. Agro-biodiversity also buffers production (e.g., against drought).</td>
</tr>
<tr>
<td>To support livelihoods, including environmental income</td>
<td>Does the policy make provision for maintaining biodiversity-based ‘environmental income’ and food security? Does the policy recognize the importance of ecosystems (and biodiversity) as a key source of additional environmental income, allowing the poor to increase their income security?</td>
<td>Many of the rural poor rely on ‘other’ biodiversity (outside the agro-ecosystem) for food (especially in scarce times) and to meet other needs. People relying on biodiversity, as a source of environmental income may not benefit from new opportunities associated with commercial agriculture.</td>
</tr>
<tr>
<td>To support delivery of the Millennium Development Goals (MDGs)</td>
<td>Is the policy compatible with MDG7 targets, including area protected for biodiversity? E.g., ‘Maintain at least 60% of the country under forest cover in perpetuity (Bhutan); increase areas protected for biological diversity from 8% in 1990 to 12% in 2015 (Senegal).</td>
<td>Biodiversity is fundamental to delivery of most, if not all, of the MDGs.</td>
</tr>
<tr>
<td>To contribute to the achievement of the 2010 targets</td>
<td>Will the policy result in increased agricultural production? Will this result in an increased area under production and in increases in either area under production or intensity of production? Are there implications for: • Status and trends of biodiversity? • Sustainable use of biodiversity? • Levels of threat to biodiversity? • Ecosystem integrity and the provision of ecosystem services? • Access and benefit sharing?</td>
<td>Agriculture is a major cause of biodiversity loss worldwide and there is steadily increasing demand for food. Any changes in the area under production, the intensity and methods of production or rates of land conversion associated with trade policies or agreements could have implications for the achievement of all the 2010 targets.</td>
</tr>
</tbody>
</table>
In addition, some recently developed scenarios (Brink et al. 2006) indicate that trade liberalisation could lead to an acceleration in the rate of biodiversity loss in some regions and countries in the short term, for example as agriculture production shifts from the United States, Japan and the EU to Latin America and Southern Africa. In Latin America, it is predicted that biodiversity will decline from 66 per cent in 2000 to 59 per cent in 2050 (GLOBIO consortium’s model). The strong loss that has been documented prior to 2000 has been due to infrastructure development, land use change, fragmentation and effects of climate change (Figure 3.1).

It is predicted that trade liberalisation has by far the strongest effect in Latin America, further reducing biodiversity by 5.4 per cent. Liberalisation will induce ‘south-south-trade’ in agricultural products, driven by low production costs and an ample supply of productive land. This model predicts a 40 per cent expansion in the area used for food crops, grass and fodder by 2050.
Figure 3.1  **Spatial distribution and change in the mean abundance of the original species present (2000, 2050 baseline and trade liberalisation)**

Note: the dark green areas indicate a high level of the original species occur in that area. These areas are usually less fragmented.

**Liberalisation option**
4. Stakeholder Participation and Consultation

Key points

• Relevant stakeholders should be identified at the outset of an Integrated Assessment.

• Stakeholders can fall into different categories, depending on whether they will be affected by the plan or policy, whether they are intermediaries, or whether they have an influence on the planning process.

• It is important to identify the most relevant stakeholders to involve, ensuring a representative group for the purpose of the assessment.

• It is vital to understand the positions, perceptions, and interests of the identified stakeholders to be aware which stakeholders may be hostile to the process, which are vital for the success of the project, and how to generate and maintain interest in the assessment with respect to a core group of stakeholders.

• The assessment should consider the most effective and efficient methods for consultation, taking into account the characteristics of the main stakeholders, the availability of technology, the budget of the project, and other factors that will help determine whether face-to-face meetings, written comments, or internet consultations would be most effective and/or most feasible, and when those consultations should be held.

An open, transparent and participatory approach to the integrated assessment process is generally recommended. Effective participation of all the relevant stakeholders (including vulnerable and minority groups if relevant) is required to make decision-making processes more inclusive. The plurality and often conflicting nature of views and values related to trade policy is a reflection of the particular interests that stakeholders bring to the table, which may be economic, financial, social or environmental. These interests are often unequally represented. It is thus desirable to establish a process that is as inclusive as possible, to ensure that all values and opinions are represented in a balanced way. Few would contest the importance of multi-stakeholder-based processes as this is an important element that can contribute to the strengthening of civil society which in turn may contribute to more sustainable policy solutions. However, there are several challenges to ensuring effective stakeholder participation in an Integrated Assessment. This chapter presents some of these challenges and provides some guidance on ways to start addressing them.
4.1 Identifying stakeholders

At a general level, stakeholders can be defined as people, groups or institutions with specific rights and interests in an issue/policy or sector. These stakeholders may have related powers, knowledge and skills which are of value in an integrated assessment. The first challenge is to identify the stakeholders likely to have an interest in the specific issue under investigation. It may be useful to categorise stakeholders as follows:

- **Primary stakeholders** are those likely to be directly affected, positively or negatively, by the issue/policy or plan. Here it may be important and relevant to pay special attention to the poor and marginalized, and those communities whose voice and opinion have traditionally been muted (such as landless farmers).

- **Secondary stakeholders** are intermediaries in the planning process and its implementation. They generally have a critical interest, knowledge and expertise (such as an important landowner).

- **Key stakeholders** are those who can significantly influence the planning, policy or decision-making process, and generally have power and influence (such as a government trade negotiator involved in WTO agricultural trade negotiations).

In considering these categories, one can further distinguish between:

- Stakeholders involved in the Integrated Assessment project (such as members of the project implementation team) and stakeholders likely to be affected by the project or policy under consideration;

- Stakeholders with primary (direct) and secondary (indirect) dependence on, and interest in, a certain sector or sub-sector. For example, in the context of an Integrated Assessment in the agricultural sector, farmers would have a direct interest in the outcome of the project while a researcher from an agricultural institute may have a more secondary or indirect interest; and

- Stakeholders coming from different societal organisations such as government, non-governmental organisations (NGOs), industry/private sector and other representatives of civil society (such as labour groups, parliamentarians, indigenous communities and academics).

**Box 4.1 Checklist for identifying stakeholders**

- Have all primary and secondary stakeholders been listed?
- Have all potential supporters of opponents of the assessment project and/or the trade policy under consideration been listed?
- Have the interests of vulnerable/marginalised groups been identified?
- Has gender analysis been used to identify different types of female stakeholders?


To identify the range of potential stakeholders, it may be useful to conduct a stakeholder analysis. This can be done by developing a ‘stakeholder table’ comprised of: (i) a comprehensive list of possible stakeholders, and, based on that list (ii) a list of stakeholders classified by primary, secondary and key stakeholder categories. Each stakeholder can be allocated a score (rank) using the following criteria: their position, their interests, their level of power, their role in the planning process and the potential negative and positive impacts. This can be done through brainstorming, semi-structured interviews, use of existing data and information, or analysis of
past events or policies. The shortlist can be established by clustering and highlighting critical values for the above criteria. Table 4.1 presents an example, adapted from an Integrated Assessment process in Uganda.

**Table 4.1 Stakeholder table adapted from a proposed project on Integrated Assessment of trade in the horticulture sector in Uganda**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Interests</th>
<th>Potential impact of export-led horticulture policy</th>
<th>Relative priorities of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary stakeholders</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horticulture producers</td>
<td>Successful implementation of new policy, increased revenues</td>
<td>(+)</td>
<td>1</td>
</tr>
<tr>
<td>Traders</td>
<td>New export opportunities, profits</td>
<td>(+)</td>
<td>2</td>
</tr>
<tr>
<td>Cash crop farmers</td>
<td>Loss of resources because of horticulture expansion, loss of income, new work opportunities</td>
<td>(-) (?)</td>
<td>1</td>
</tr>
<tr>
<td>Biodiversity community</td>
<td>Water and soil problems, biodiversity loss, increased revenue for research</td>
<td>(-)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Secondary stakeholders</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade negotiators</td>
<td>New export markets, new trading partners</td>
<td>(+)</td>
<td>2</td>
</tr>
<tr>
<td>Treasury department</td>
<td>Increased budget revenue, taxes</td>
<td>(+)</td>
<td>3</td>
</tr>
<tr>
<td>Service providers</td>
<td>New business opportunities, more employment, foreign competition</td>
<td>(+/-)</td>
<td>3</td>
</tr>
</tbody>
</table>

*Explanatory Note:* The table identifies the relative priorities to be given to each stakeholder according to the project’s objectives. This example assumes that high priority is given to biodiversity conservation and livelihood opportunities for small farmers.

Participation and consultations can be costly and time-consuming, so it is important to determine which stakeholders are the most critical to involve. This may include stakeholders to be:

- in the national steering committee;
- consulted in view of their expertise and interests;
- involved as partners or co-researchers;
- directly involved and kept well-informed in view of their major power/influence; and
- considered as potentially affected (both positively and negatively) by the new plan or policy.
Relevant stakeholders will vary with the issue being discussed and the interest and capacity of different potential groups. In addition, the scope (geographic and sectoral), budget and timing of the project must be considered when deciding who to involve, how, and when.

A middle ground should be sought between a very narrow set of stakeholders, which might imply that a restricted number of views and opinions will be taken into consideration (such as those of one or two ministries) and a broad, open list of stakeholders reflecting a wide (and potentially un-manageable) range of perspectives. An Integrated Assessment should attempt to strike a balance between the different categories of stakeholders described above and between the different stakeholders from societal organisations (UNEP, 2005).

### 4.2 Understanding the perceptions, positions and interests of stakeholders

The next step in the stakeholder analysis consists of clarifying and defining the positions, perceptions and interests of identified stakeholders so that these can be reflected in the integrated assessment. Possible approaches are considered in the next section.

#### 4.2.1 Determine stakeholders with influence and importance for project success

Analysing stakeholders who may have an influence on a policy or plan (organisations such as unions, business associations or NGOs) is critical to understanding the likely support or opposition of various groups to the policy. Boxes 4.2 and 4.3 indicate some of the variables that might be taken into account when considering their relative power and influence.

| Box 4.2 Variables affecting the relative power and influence of stakeholders |
|----------------------------------|----------------------------------|
| **Within and between formal organisations** | **For informal interest groups and primary stakeholders** |
| • Legal hierarchy (command and control, budget holders) | • Social, economic and political status |
| • Authority of leadership (formal and informal, charisma, political, familial or cadre connections) | • Degree of organisation, consensus and leadership in group |
| • Control of strategic resources for the project | • Degree of control of strategic resources |
| • Possession of specialist knowledge (agro-economist) | • Informal influence through links with other stakeholders |
| • Negotiating position (strength in relation to other stakeholders involved in Integrated Assessment) | • Degree of dependence on other stakeholders |

In considering how to involve stakeholders in an integrated assessment, it is necessary to recognise that there may be important stakeholders who have weak capacity to participate and limited power to influence decisions (resource-poor farmers or women, for example), but whose involvement is nevertheless crucial.
4.2.2 Identify information needs

The interest of stakeholders in the assessment project will depend on the concrete benefits that such participation may bring. This in turn is largely determined by the level and relevance of information provided to stakeholders. In identifying information needs, the accessibility and complexity of information, language and resource issues, as well as other practical considerations related to the characteristics of specific stakeholders need to be taken into account. This includes attention to different types of knowledge and information. It may comprise the following forms of knowledge: scientific or traditional; objectively verifiable or subjective; qualitative or quantitative; implicit or explicit. For example, consulting women’s groups operating in a distant district may require a contribution from a village intermediary who speaks their language. Similarly, ensuring that a key trade negotiator is engaged may involve holding face-to-face meetings every two or three months.

4.2.3 Analyse the relationship between stakeholders and power relations

Understanding the relationships between critical stakeholders is important, to understand how they influence each other, and thus provide insight into potential coalitions or conflicting interests. It might also be useful to analyse in greater detail the power relations in order to know who is in charge and how best the planning/decision-making process can be influenced. Various types of power exist including, inter alia, managerial power, executive power, bargaining power and positional power. Next, an overview may be made that indicates for each stakeholder: their numbers, their potential to influence the planning process in a positive manner, and their power to influence the planning process in a negative manner.

4.3 Methods and tools for consulting stakeholders

There are a number of possible mechanisms for consultation and which one is used depends largely whether the aim is active participation or more passive consultation.

Whatever the method chosen, the process must clearly establish the following:

- **Objectives:** Reasons for consultation/involvement and expected outcomes
- **Topic:** The nature and scope of the issue
- **Participants:** Who is affected, interested or can positively contribute
- **Time:** Amount of time available and the frequency of consultation
- **Budget:** Availability of resources
It is also useful to draw a distinction between:

(i) analytical techniques, which seek stakeholder participation for the analysis of the problem or issue at hand; and
(ii) facilitation techniques, which aim to facilitate the interaction of stakeholders/groups during the assessment process in order to gather their views and opinions.

Possible consultation methods (which are discussed in UNEP, 2001) include the following:

*Face-to-face meetings.* This approach has the advantage of providing direct access for stakeholders to those undertaking the assessment, but meetings are costly and only allow for limited participation.

*Written comments.* This approach provides a broad range of inputs over a longer period of time but is less direct. Moreover, resource limitations may dictate the extent to which documentation can be made available.

*Internet consultations.* This approach has been growing in popularity in recent years, where policy documents have been posted on the internet. This method enhances access to information and requires minimal resources. However, it assumes widespread access to computers and technology, which is not available in many countries.

In the context of an Integrated Assessment in the agriculture sector, rural populations often have limited access to education and technology, making the solicitation of input in written form (using the internet, for example) of limited value. Face-to-face meetings should be organised to take into account the fact that many of the stakeholders directly concerned with agricultural production are located in remote rural areas. Therefore, a number of small meetings in remote locations might be more useful than large meetings in urban centres.

Timing is also an important issue. Decisions need to be taken regarding the best time for consultation during the assessment process and the frequency of consultations. In addition, a participatory process is not likely to have a strong impact upon policy-making if conducted just after negotiations or when legislation has been passed. Identifying opportunities to enhance the influence and impact of consultations must be kept in mind when planning such consultations.

Regardless of which method is chosen, consultation must set up a clear process to follow-up on the different contributions and provide feedback to participants.
5. A Conceptual Framework and Indicators for the Assessment

Key points

- Conceptual frameworks can help develop a common understanding between different stakeholders with respect to key issues and drivers of change. Volume I of this Manual suggests that a conceptual framework should be developed as part of Stage B to help focus the integrated assessment on key issues and linkages.

- A generic conceptual framework is presented to illustrate the links which can be expected between trade policies, agriculture, biodiversity and ecosystems, and human well-being. The framework is adapted from the conceptual framework of the MA and focuses on the potential impacts on biodiversity, ecosystem services and human well-being of changes in agriculture that may result from changes in trade agreements.

- Countries are encouraged to adapt this generic conceptual framework to their own domestic situations. Some examples are given to show how the framework might be populated with relevant information.

- As part of this process, suitable indicators can be chosen to provide a basis for objective comparison between different assessments or scenarios included in the assessment. Indicators make it easier to understand directions, amounts and desirability of change relative to the baseline. They can be used to help determine whether proposed policy changes will achieve desired outcomes or objectives.

5.1 Use of conceptual frameworks and indicators in an Integrated Assessment

Integrated Assessments must, by definition, deal with a range of considerations in a consistent manner. Many of the impacts of trade policy in agriculture are complex and difficult to predict, but linkages between agriculture and biodiversity have to be understood before the impacts of any changes in trade policy can be predicted. Developing a conceptual framework as part of an integrated assessment can help clarify key inter-relationships and linkages and ensure that limited resources are invested in gathering relevant data. Using a common framework also makes it possible to combine analyses of specialist topics conducted by different players or stakeholders in a logical and consistent manner and this was one of the motivations for the MA conceptual framework:
A well-designed conceptual framework for either assessment or action provides a logical structure for evaluating the system, ensures that the essential components of the system are addressed as well as the relationships among those components, gives appropriate weight to the different components of the system, and highlights important assumptions and gaps in understanding (MA 2005).

Volume I of this Manual explains how the development of a conceptual framework can be built into the assessment process, seeing it as part of the scoping stage (setting the stage, designing and focusing the assessment, deciding which issues will be addressed). One of the benefits of developing a conceptual framework to use in an integrated assessment is that it can be used to simplify assessments of likely outcomes compared with the baseline situation. An essential associated activity is the identification of objectives (desired outcomes) and associated indicators which can be used to test alternatives and decide if an impact will be significant and/or acceptable. It is recommended that the objectives and indicators be considered at an early stage of the assessment (see Action B3), if possible, because they have a key impact on the scope of the assessment, as well as on the methods, the tools and resources needed.

Indicators have to be chosen on a case-by-case basis and should be in line with the identified priorities and objectives. The selection of indicators should be guided, in the first instance, by a conceptual understanding of the proposal being assessed, taking into account how well the indicator will reflect likely changes. Indicators should therefore reflect the conceptual framework and convey relevant information about the impacts of a particular policy on the different components and linkages identified in it.

For example, an important biodiversity objective might be to maintain the integrity of national parks in a country and one indicator of this might be the maintenance of forest cover. One of the benefits of using indicators is that they lend themselves to use of significance criteria, thresholds or targets. Drawing on the same example, the performance of different policy options could be compared either against the baseline level of forest cover or in terms of their likely outcome relative to a target level of forest cover. Such comparisons, using a common framework, make it easier to test the performance of different policy options relative to the baseline or to each other in terms of achieving desired sustainability outcomes or objectives. Internal policy conflicts can also be identified in this way (achieving one objective may have a detrimental effect on the achievement of others).

Indicators can help to simplify the assessment process by focusing it (or its’ reporting) on selected “pointers” which give a reliable reflection of underlying change relative to the baseline situation. Indicators may be used to reflect a direction of change (for example increases or decreases in levels of production) or an amount of change (for example a 10% increase in production relative to the base year) and should give a meaningful reflection of the types of change which can be expected as a result of the proposed policy. Indicators should therefore reflect any critical environmental, social and economic sustainability issues within the country, region or sector and the rationale for selecting indicators should always be explained clearly. While indicators should be selected to meet a specific purpose, the choice of indicators can also be guided by reference to indicators used in other assessments or by considering their likely suitability for assessments in other localities or at different scales of analysis.

As well as being relevant, indicators should be straightforward and cost effective to measure. Availability of suitable data is often a limiting factor in assessments so ultimately, the selection of indicators may depend on the ability to measure change using best professional knowledge, scientific modelling, expert judgements or review by public panels. Provided that changes can be reliably measured or predicted, proposed options or activities can be evaluated against indicators, and possible impacts can be assessed by comparing impacts against stated baseline or target values.
5.2 A generic conceptual framework

A generic conceptual framework is presented which could be adapted to suit different country contexts and used as a starting point to identify links between trade policies, agriculture, biodiversity and ecosystems, and human well-being. There is no universal conceptual framework for conducting an Integrated Assessment, and many different ones have been developed. The MA framework (Figure 5.1) was selected as the basis for this generic framework because it specifically addresses the drivers of change that affect biodiversity, whether directly or indirectly, and the possible consequences of change in biodiversity for human well-being. The MA conceptual framework is based on the widely used ‘causal chain analysis’ framework of ‘Driving Force-Pressure-State-Impact-Response’, shown at a very general level in Figure 5.2 (response measures are not included because they are likely to be highly context-specific).

**Figure 5.1** MA conceptual framework of interactions among biodiversity, ecosystem services, human well-being, and drivers of change

**Figure 5.2** Simple analytical framework for linking change in trade policies to change in agriculture, biodiversity and ecosystem services, and human well-being

<table>
<thead>
<tr>
<th>Driving Force</th>
<th>Pressures</th>
<th>State</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Agreements</td>
<td>Agricultural Activities</td>
<td>Agricultural Biodiversity</td>
<td>Farmers’ income &amp; food security</td>
</tr>
<tr>
<td>Other influences on</td>
<td>Intensity of land use</td>
<td>Ecosystem Services</td>
<td>Other aspects of human well-being</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The framework is a static representation of key issues and linkages, rather than a dynamic model, but it could be used as the basis for a more sophisticated ‘systems dynamics modelling approach’ in the future if the necessary data were available. This might allow for greater precision in sensitivity analysis of options.

Figure 5.3 demonstrates the main types of issues which should be considered when assessing the impact of agricultural trade policies on biodiversity and ecosystem services at a very broad level of conceptualisation. The Integrated Assessment process requires the understanding of how these issues and the main drivers of change which can be expected to operate relate to each other.

**Figure 5.3 General conceptual framework for the assessment of linkages between trade policies, agriculture, biodiversity and ecosystem services, and human well-being**

It may be necessary to identify drivers of change in agriculture at three scales: one is at the farm level, where the types of farms (such as large, small, owner, or tenant) and their objectives of production (such as cash income, subsistence needs, cultural values) directly determine the type of farming. Second, the types of farms and their choices of farming are greatly influenced by the regional and national socio-economic context, including national development objectives and agriculture and trade policies. Thirdly, as well as being the focus of an assessment, international trade policy may also be a driver of change in national development objectives and policies. It is also important to remember that some important impacts on biodiversity may take some time to become apparent: many significant impacts on ecosystems are cumulative and long term.

The process of conducting an assessment includes determining the strength and the direction of the main causal links in a particular context. For example, a change in an agricultural trade agreement resulting in reduced tariffs may actually have little influence on the price that farmers receive for their produce compared to many other factors influencing prices. Similarly, any changes in product prices are only one factor influencing a farmer’s decision on intensification or extensification of production.
As more information becomes available, the conceptual model can be developed to assist in understanding the likely impacts of a proposed change in an agricultural trade agreement or policy (an iterative process is likely to be required). A more detailed representation of the conceptual framework is given in Figure 5.4, which further specifies key components and dependencies, such as the influence of a trade agreement on agricultural prices and the associated change in farmers’ choices of products and intensity of inputs (the arrows represent the influence of one factor on another). It is apparent from the many issues and linkages in the conceptual framework that determining the outcome for biodiversity and ecosystem services of a change in an agricultural trade agreement is very context specific. In some cases, data deficiencies and other constraints may not allow for precise determination of linkages and impacts. However, the development of a conceptual framework can still improve the understanding of the complex interrelationships between policy changes and outcomes on the ground.

Figure 5.4  Detailed conceptual framework showing the possible linkages between trade policies, agriculture, biodiversity and ecosystem services, and human well-being

5.3 Agriculture trade agreements as a driver of change

The following sections take the conceptual framework described in Figure 5.4 and show how it could be used as a basis to further explore relevant issues, identify the main drivers of impact and select suitable indicators for use in an integrated assessment.

5.3.1 Prices and markets for agricultural products

New international trade agreements are likely to result directly in changes in tariffs, quotas and subsidies at the national level which may then result in changes in product prices at the national level. Trade agreements and associated changes in prices act as an indirect driver for biodiversity change by affecting farmer choices about land use and production methods. The FAO (2003) report *Trade Reforms and Food Security - Conceptualizing*
the Linkages provides a conceptual framework and methodological guidelines for assessing the impact of changes in trade policies on agricultural prices and production. Price changes may occur at national borders and at the point of purchase from producers and prices may also vary between regions in a country, as well as between border points and local markets. Agricultural and statistical government agencies and commercial trading and marketing bodies may compile statistics on the price of agricultural products.

In addition to price, agriculture trade agreements can give rise to many other types of change, including:

- Conditions for foreign direct investment in a country, resulting in, inter alia, changes to the national market standards for products and how they are produced.
- Market access for agricultural products.
- Levels of export subsidy, domestic support.
- Availability of credit for export crop production.
- Intellectual Property Rights (IPR).
- Standards for export products (e.g., levels of pesticides, labelling).
- The market for agricultural products may change due to altered quotas by importers, or as a consequence of price changes stimulating or reducing demand.

As identified in Chapter 3 and discussed in UNEP’s Handbook on Integrated Assessment of Trade-related Measures - the Agricultural Sector (2005), impacts of trade agreements and policies in the agricultural sector need to be considered within the context of other influences on agriculture to determine their relative significance.

5.3.2 Other factors influencing agriculture

There are many other factors that influence directly the prices of, and markets for, agricultural products. Some of these factors have a clear economic influence (such as the prices of agricultural inputs) while others are part of a wider context for determining prices and agricultural activities (such as transportation infrastructure). These other influences also affect the choice of agricultural products and the intensity of inputs. These “other” influences form an important part of the baseline situation and it is important to understand the part that they play in order to assess the relative significance of changes in agriculture trade policy. The appropriate level of detail required to identify and analyse them will have to be determined during the initial phase of the Integrated Assessment.

Below, some sample indicators are presented to measure a selection of other potential issues that, in addition to trade policy, can be expected to influence the price of, and markets for, agricultural products.

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Agricultural development policies and support</td>
<td>• Subsidies for production (e.g., subsidised fertiliser price)</td>
</tr>
<tr>
<td></td>
<td>• Government technical support (e.g., extension service availability)</td>
</tr>
<tr>
<td></td>
<td>• Tax regime for agricultural enterprises</td>
</tr>
<tr>
<td>• Taxes on farm products and income</td>
<td>• Taxable values</td>
</tr>
<tr>
<td></td>
<td>• Thresholds</td>
</tr>
<tr>
<td>• Access to farming technology and technical support</td>
<td>• Size of commercial farm machinery and input suppliers</td>
</tr>
<tr>
<td></td>
<td>• Size of government agricultural extension service</td>
</tr>
</tbody>
</table>
### Key factor Possible indicator

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport infrastructure for farm products and inputs</td>
<td>Average average travel time from farm to first point of sale, or nearest surfaced road</td>
</tr>
<tr>
<td>Security of land tenure</td>
<td>Percentage of farm land with undisputed legal registration documents</td>
</tr>
<tr>
<td>Governance and legal framework</td>
<td>Restrictions on sale or use of land (e.g., federal or communal property)</td>
</tr>
<tr>
<td>Corruption index</td>
<td>People living per km$^2$ in rural and urban areas</td>
</tr>
</tbody>
</table>

### 5.3.3 Policies and national development objectives

It is also important to consider the role of relevant national development objectives and policies, which might include those relating to:

- agriculture (including, *inter alia*, subsidies for production and export, technical support for production);
- land use (including, *inter alia*, different categories of protected areas for biodiversity protection, land ownership);
- economic and sustainable development (such as the tax regime); and
- planning and infrastructure development (including, *inter alia*, transport, communications, health and education, and which is closely linked to land use policy).

The extent of farming and the spatial integrity of natural areas can also be affected by the existence of protected areas and policies and institutions for the conservation and sustainable use of biodiversity. Protected areas for biodiversity conservation can have a variety of management and protection objectives, ranging from strict protection to the regulated use of natural resources. Many protected areas include farming activities within them, as part of activities to maintain their biodiversity, livelihood and cultural values. However, changes in the extent and intensity of farming within and outside of protected areas can result in illegal encroachment and degradation. Land-use zoning and restrictions on use that include biodiversity conservation objectives can affect options for agricultural expansion.

**Possible indicators to assess impacts of protected areas and other policies aimed at the conservation or sustainable use of biodiversity.**

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Possible indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected areas negatively affected by changes in farming</td>
<td>Area of protected area encroached or degraded by agriculture (ha)</td>
</tr>
<tr>
<td>Coverage of protected areas of ecosystems and vegetation types</td>
<td>Area of protected area per ecosystem and by IUCN PA Management Categories I to VI (ha)</td>
</tr>
<tr>
<td>Enforcement of protected area legislation</td>
<td>Number of punitive measures taken by the Government if encroachment of protective areas</td>
</tr>
</tbody>
</table>
5.4 Direct drivers of change associated with agricultural land use

The factors discussed in the previous section (5.2) can be considered indirect drivers of change in terms of impacts on biodiversity, ecosystem services and human well-being. Choices by individual farmers about what to produce and what methods to use (the farm level choices presented in Figure 5.5) are key drivers for the modification of land and water resources with very direct consequences for biodiversity, ecosystem services and human well-being.

Figure 5.5 Factors to consider when analysing changes in agricultural practise and land use

5.4.1 Choice of agricultural products and intensity of inputs

The choice of agricultural products and intensity of inputs is influenced by many social, economic and environmental factors. The sale price of products is a key factor, but also the costs of inputs and the availability of resources such as labour, land and financial capital. Socio-cultural values are also significant in making production choices, with tradition and exchange of goods and services with the local community often being important. Perceptions of risk and profitability influence farmers’ decisions about whether to focus their production on meeting household (subsistence) needs, or on production for trade; whether to diversify their systems or use monocultures. These decisions are also influenced by farm size, with larger farms tending to be commercial and having greater access to additional land and financial credit resources if they wish to expand. Farm ownership can also be a factor influencing the choice of crops, with tenant farmers less likely to cultivate perennial crops (such as coffee) which require several years to produce a harvest.

Some of the factors likely to affect farm level choices about production that may be influenced by agriculture trade agreements are summarised below, together with examples of indicators that might apply:
### Key factors affecting farm level choices and possible indicators

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Possible indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size</td>
<td>• Percentage of farms per main size classes (e.g., up to 50 ha, 50 – 300 ha, 300 – 5,000 ha, above 5,000 ha)</td>
</tr>
<tr>
<td>Farm ownership</td>
<td>• Percentage of farms as tenants, owner-occupier, absent landlord, corporate, communal</td>
</tr>
<tr>
<td>Crops and livestock produced and traded</td>
<td>• Per crop – total area used in production (ha), total production (tonnes), value traded ($)</td>
</tr>
<tr>
<td></td>
<td>• Per livestock class – total production (tonnes or head), value traded ($)</td>
</tr>
<tr>
<td>Agricultural productivity</td>
<td>• Crop harvest (tonnes/ha/yr)</td>
</tr>
<tr>
<td></td>
<td>• Livestock sales (kg/farm/yr)</td>
</tr>
<tr>
<td>Intensity of technology inputs</td>
<td>• Area cultivated with machinery (ha)</td>
</tr>
<tr>
<td></td>
<td>• Area with drainage system (ha)</td>
</tr>
<tr>
<td></td>
<td>• Area under irrigation (ha)</td>
</tr>
<tr>
<td></td>
<td>• Inorganic fertiliser intensity (kg/ha/yr)</td>
</tr>
<tr>
<td></td>
<td>• Pesticide intensity (kg/ha/yr)</td>
</tr>
<tr>
<td></td>
<td>• Herbicide intensity (kg/ha/yr)</td>
</tr>
<tr>
<td>Crop and livestock diversity</td>
<td>• Average number of crops and varieties per farm</td>
</tr>
<tr>
<td></td>
<td>• Average number of livestock types and breeds per farm</td>
</tr>
<tr>
<td>Farming land use intensity</td>
<td>• Percentage of farm land not cultivated per year (such as fallow and field boundaries)</td>
</tr>
<tr>
<td>Harvesting of natural products</td>
<td>• Yield of non-cultivated wild products (kg/ha) (such as mushrooms, nuts, medicinal plants and game meat)</td>
</tr>
</tbody>
</table>

#### 5.4.2 Extent of agriculture

The area of land farmed (the extent of agriculture) and the intensity of land-use has a major influence on biodiversity worldwide. Changes in the area of land under cultivation or used for livestock grazing may occur as a direct consequence of farm-level choices, as outlined above, or as a consequence of people being displaced and forced to colonise new areas. A key determinant of increases in the extent of agriculture is the availability of land and capital for expansion. This availability may arise from conversion of land in a natural state (such as primary forest) or the re-use of land formerly used in agriculture which has been left to rest or abandoned. The availability of land for expansion by farmers will depend on the physical existence of suitable land, the land tenure system, land prices and farmers’ access to financial and political resources to secure use of the land. Similarly, the availability of financial capital for investment in agriculture is often a key factor affecting agricultural opportunities and the extent of intensification or extensification. This may be affected by trade negotiations where, for example, they result in increased investment by foreign companies or the liberalisation of financial services, influencing loan interest rates.

#### 5.4.3 Extent of modification of land for agriculture

The relative intensity of agricultural production is generally reflected in the extent to which land is modified from its natural state. The degree of modification is a continuum but for the purposes of assessment some categories need to be assigned. A first level of categorisation could be whether the natural state of the land has been slightly or highly modified by farming. Following slight modification, some of the features of relatively undisturbed ecosystems might remain, for example areas of selectively logged forest or semi-natural grassland. A highly modified area, on the other hand, will have undergone transformation to the extent that
the majority of its habitat and species are all deliberately introduced as part of an artificial agro-ecosystem, for example a monoculture of wheat.

Natural water bodies, such as lakes, rivers and marshes, can also be categorised as being in a natural state or being slightly or highly modified. For example, a lake could be used for fishing and aquaculture or it could be drained.

Highly modified land can be further categorised as agriculture with low or high external inputs. The amount of external inputs results in significant differences in the impacts of agriculture on biodiversity and ecosystem services, as well as the sustainability of the production system.

**Low external input agriculture.** In a low external input system the agricultural production largely relies on human and animal labour, and is likely to use traditional crop and livestock breeds adapted to the local agro-ecosystem. The livelihoods depend directly on the functioning of the supporting ecosystem services of primary production by plants, soil formation and nutrient cycling, and water cycling and its availability in the soil for plants and decomposition. These supporting ecosystem services sustain not only the agricultural production (provisioning ecosystem services), but also the delivery of regulating ecosystem services such as water supply, pollination and erosion control.

The agricultural biodiversity in low external input agriculture is likely to be simplified and reduced in comparison with the biodiversity of the natural state of the land. However, many species have adapted to agricultural landscapes (especially if some elements of original habitats remain) and the greater diversity of habitats can increase some measures of biodiversity, such as species richness.

**High external input agriculture.** Under high external input agriculture the functioning of the supporting ecosystem services is supplemented and altered to a significant extent by inputs external to the agro-ecosystem. These external inputs can include chemical fertilisers, herbicides, pesticides, and machinery using external energy sources (usually non-renewable). Cultivation and land management practices are also likely to include investment in maintaining regulating ecosystem services that have been altered by the intensity of agriculture, such as control of soil erosion and flooding and pest control. High external input agriculture is likely to have increased the productivity of a few products, with a greater proportion of the supporting ecosystem services producing these products. The simplification of the agro-ecosystem is likely to result in less associated and other biodiversity in the agro-ecosystem, which will mean less primary productivity and other supporting ecosystem services and a consequent reduction in regulating and cultural ecosystem services.

The agricultural biodiversity in a high external input agricultural system tends to be considerably simplified due to:

- reductions in solar energy captured in the non-agricultural food chain, due to reduced primary productivity by smaller populations of non-cultivated plants;
- high nutrient inputs from inorganic fertilisers favouring the growth of a few plant species;
- simplification of food chains, including fewer predators due to poisoning, loss of habitat and prey; and
- greater fluctuations in species populations, due to variability in nutrient flows, changes in herbivore and predator populations, and conditions favouring species adapted to colonising disturbed environments.

Different cropping and livestock production systems could be classified as causing slight or high modification to the natural state of the land. The extent of these cropping and livestock production areas could then be used as an indicator of the degree of modification of the land. Sample indicators are presented below to help assess changes in the intensity of modifications to the natural landscape.
### A Conceptual Framework and Indicators for the Assessment

#### Extent of agriculture

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Possible indicators</th>
</tr>
</thead>
</table>
| Change in intensity of modification of natural land state | • Area of land and water bodies in natural state, slightly modified, highly modified and low input, highly modified and high input (ha, % total land, change/year)  
• Mapped presentation of states or use of land  
• Area of land and water bodies of high value for regulating and cultural ecosystem services |

#### 5.4.4 Landscape configuration of “natural” and modified land

Biodiversity and levels of provision of ecosystem services (see 5.5) are greatly influenced by the configuration of the landscape and the relationship between agricultural and other land uses. For example, the degree of fragmentation of ecosystems affects their carrying capacity and their ability to support viable populations of species. For example, fragmentation of habitat (such as forest) can affect biodiversity in the following ways:

- **Area effects.** These occur when large patches of natural land are divided and not all species are included in the remaining smaller patches. Rare species and those requiring large areas of habitat are especially vulnerable. Research from isolated islands suggests that reducing the size of a patch of habitat by 90 per cent will result in 50 per cent of its species vanishing, with predator species especially vulnerable. The species that disappear first are the ones that require interior habitats (such as forests).

- **Edge effects.** These occur when fragmentation of natural areas creates greater edges adjacent to other land cover types, such as farmland. The edges generate environmental gradients that affect vegetation, animal populations, ecological processes and species composition along the edges.

- **Isolation effects.** These occur when fragmentation creates gaps between blocks of natural land that reduce the movement of species, increase the chances of local extinctions and may reduce the genetic diversity within populations.

Geographic Information Systems can be used to derive measures of patch size, shape and isolation which can be used to produce indicators of, for example, spatial integrity. Such indicators can be presented in both mapped and statistical formats by identifying the land belonging to different classes and reporting the total area in each class. Their usefulness is dependent on the resolution and accuracy of the source data and on having a good understanding of ecological relationships. The appropriate scale of the analysis also needs to be determined. The scale of effects of fragmentation on a large mammal will be very different to a sedentary species of beetle, for example. Indicators relating to the area and configuration of natural land should generally be expressed as absolute areas, rather than as percentages or proportions, which can give a misleading impression. Sample indicators are presented below to help measure changes in the fragmentation of natural land.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
</table>
| • Fragmentation of natural land   | • Patch size (km²)  
• Isolation of fragments – distance to nearest natural patch (km)  
• Length of edge of natural patch fragments (km)  
• Spatial integrity index |
5.5 Assessing changes in biodiversity ecosystem services

Biodiversity forms the foundation and the medium for the vast array of ecosystem services that contribute to human well-being. The conceptual framework in this Manual is adapted from the framework of MA, which described four types of ecosystem services: supporting, provisioning, regulating and cultural. They are presented in this sub-section along with agricultural biodiversity and biodiversity outside agricultural areas.

Figure 5.6 Factors to consider when analysing changes in biodiversity and ecosystem services

5.5.1 Agricultural biodiversity

Agricultural biodiversity (as described in Box 2.1) is often divided into planned/cultivated biodiversity, associated biodiversity, additional biodiversity, and wild biodiversity outside agricultural ecosystems (biodiversity that occurs beyond that which is used or is directly supporting the production system). Sample indicators are presented below to help assess changes in issues related to agricultural biodiversity.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Example indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned / cultivated agro-biodiversity</td>
<td>Extent and quantity of cultivation of domesticated biodiversity - crops, livestock, and freshwater aquaculture fisheries (ha, kg)</td>
</tr>
<tr>
<td>Associated agro-biodiversity (supports agricultural production through, inter alia, nutrient cycling, pest control, pollination)</td>
<td>Populations of crop pollinators (insects, birds, mammals) Abundance and diversity of soil fauna (or proxies such as soil organic matter levels)</td>
</tr>
</tbody>
</table>
5.5.2 Biodiversity outside agricultural areas

Since biodiversity includes the diversity within species, between species and of ecosystems, there are many potential measures of biodiversity. The number of species in a given area (species richness) is a common measure, but this does not take into account the contribution of species to ecosystem properties. Species composition and abundance matters as much, or more than, species richness in terms of ecosystem services. Ecosystem functioning, and hence ecosystem services, is strongly influenced by the ecological characteristics of the most abundant species, not by the number of species.

The extinction of local species or the depletion of populations to a level where they can no longer contribute significantly to ecosystem functioning can have dramatic impacts on ecosystem services. Changes in the biotic interactions between species (such as levels of predators, herbivores or parasites) can lead to large alterations of ecosystem processes. The integrity of the food chain (plants, herbivores, predators and decomposers) and the amounts of biomass at each level is also a key aspect of the functioning of ecosystem processes and the supporting ecosystem services. The loss of multiple components of biodiversity will lead to lowered ecosystem stability and resilience to stresses and disturbance (such as changes in rainfall, fire or harvesting of species). Components of biodiversity could include whole functional groups (such as predators) or even the loss of whole ecosystem types from a landscape.

The distinction between biodiversity and the four types of ecosystem services is not a clear or simple one, but some useful measures of biodiversity and the properties of ecosystems can be identified as indicators. Some indicators are relevant to the functioning of more than one ecosystem service. Sample indicators are presented below to help measure changes in issues related to biodiversity outside agricultural areas.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
</table>
| • Maintenance of original species composition, to meet biodiversity conservation objectives and maintenance of ecosystem services | • Number of locally and nationally threatened and extinct species  
• Number of species with rapid population declines  
• (these indicators could be for separate types of species, such as mammals, birds, trees) |
| • Conservation of valued species (such as exploited, listed as threatened, cultural value) | • Total counts or sample census of populations, or indicators of abundance such as harvest levels per unit of effort |
| • Productivity and integrity of the food chain                                  | • Annual peak biomass of plant and woody matter (kg/ha)  
• Annual peak biomass of mammal and bird herbivores and omnivores (kg/ha)  
• Annual peak biomass of mammal and bird carnivores (kg/ha)  
• Population levels of major wild vertebrate carnivores and herbivore species within viable limits |
| • Genetic and biomass reserve for future use                                   | • Area of land in a natural state |

5.5.3 Supporting ecosystem services

The functioning and productivity of supporting ecosystem services determines the functioning and productivity of provisioning, regulating and cultural ecosystem services. For agriculture, the management of supporting ecosystem services is crucial to obtain the other ecosystem services, of which the provision of food, fibre and fuel are the most tangible.
Primary production by plants through photosynthesis provides the molecules and energy on which all other biodiversity and ecosystem processes and services depend. The amount of primary production determines the amount of biomass an ecosystem can sustain, through the food chain of herbivores, predators and decomposers. Agriculture uses cultivated/planned biodiversity to capture primary production for products of value to people. This capture of primary production is either directly in the form of useful plants, or indirectly through livestock.

Plants and their ability to photosynthesize depend on the availability of nutrients and water, which are principally determined by the properties of soils and the soil biodiversity. The living processes of decomposition and cycling of nutrients form soils and organic molecules by soil biodiversity, including bacteria, fungi, protozoa, nematodes and earthworms. This soil biodiversity also influences the structure of the soil to provide the air spaces and porous structure for the infiltration of rainwater and its retention in the soil, providing the conditions for healthy plant root growth and nutrient cycling. Sample indicators are presented below to help measure changes in issues related to supporting ecosystem services.

### Key issue/factor

<table>
<thead>
<tr>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Biomass of cultivated plants (kg/ha)</td>
</tr>
<tr>
<td>• Growth rate of cultivated plants (kg/ha/yr)</td>
</tr>
<tr>
<td>• Biomass of non-cultivated plants (kg/ha)</td>
</tr>
<tr>
<td>• Soil moisture content</td>
</tr>
<tr>
<td>• Soil evaporation rates</td>
</tr>
<tr>
<td>• Crop and pasture growth limited by lack of soil moisture (days/yr)</td>
</tr>
<tr>
<td>• Percentage of bare soil and percentage of soil surface covered by vegetation</td>
</tr>
<tr>
<td>• River flow volumes and maxima and minima</td>
</tr>
<tr>
<td>• Water table depth (m)</td>
</tr>
<tr>
<td>• Frequency of floods</td>
</tr>
<tr>
<td>• Soil organic matter content in croplands (average percentage of organic matter [dry weight] in the upper soil profile [4–6 inches]/ farm/yr)</td>
</tr>
<tr>
<td>• Soil erosion or formation rates (tons/ha/yr)</td>
</tr>
<tr>
<td>• Percentage of bare soil and percentage of soil surface covered by vegetation (greatly reduced nutrient cycling under bare soils)</td>
</tr>
<tr>
<td>• Percentage of land covered with trees, for cycling of nutrients from deep soil layers</td>
</tr>
</tbody>
</table>

#### 5.5.4 Provisioning ecosystem services

Provisioning ecosystem services are probably the most straightforward of the aspects of biodiversity and ecosystem services amenable to measurement. Tangible products for human use are the focus of agriculture ecosystems. Sample indicators are presented below to help measure changes in issues related to provisioning ecosystem services.
A Conceptual Framework and Indicators for the Assessment

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Crops</td>
<td>• Production per ha per year</td>
</tr>
<tr>
<td>• Livestock</td>
<td>• Production per ha per year</td>
</tr>
<tr>
<td>• Wild plant and animal products</td>
<td>• Harvest per sq km per year</td>
</tr>
<tr>
<td>• Timber</td>
<td>• Harvest per sq km per year from natural forests and plantations</td>
</tr>
<tr>
<td>• Fresh water</td>
<td>• River flow volumes and maxima and minima</td>
</tr>
<tr>
<td>• Construction materials and fuel source</td>
<td>• Percentage of household fuel needs met from fuel wood</td>
</tr>
<tr>
<td>• Diet and income from non-cultivated biodiversity</td>
<td>• Percentage of household and farm material needs met from local timber and fibre</td>
</tr>
<tr>
<td>• Presence of key wild species for construction materials (such as fibre, fuel, food, commerce and tourism)</td>
<td>• Population levels and/or harvest levels of key species within viable limits</td>
</tr>
<tr>
<td></td>
<td>• Extent and connectivity of habitat features for key species</td>
</tr>
</tbody>
</table>

5.5.5 Regulating ecosystem services

The scale at which regulating ecosystem services are functioning may often be larger than an individual farm and may include, for example, landscape and regional processes of water and climate regulation. Populations of crop pollinators or predators of crop pests may extend over areas larger than a single farm for at least part of their lifecycle. In this way, biodiversity outside agricultural areas is part of, and influencing, the biodiversity and ecosystem services in agricultural landscapes. Sample indicators are presented below to help measure changes in issues related to regulating ecosystem services.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Regional and local climate</td>
<td>• 5 year moving average of length of climate conditions unsuitable for crop growth (days/yr)</td>
</tr>
<tr>
<td>• Water regulation</td>
<td>• Change in the timing and magnitude of river flows, flooding and aquifer recharge</td>
</tr>
<tr>
<td>• Soil erosion regulation</td>
<td>• Soil organic matter content in croplands (average percentage of organic matter [dry weight] in the upper soil profile [4–6 inches]/farm/yr)</td>
</tr>
<tr>
<td></td>
<td>• Soil erosion or formation rates (tons/ha/yr)</td>
</tr>
<tr>
<td>• Water purification and waste treatment</td>
<td>• Nitrate and phosphate concentration in rivers and wetlands</td>
</tr>
<tr>
<td>• Pest regulation</td>
<td>• Crop losses due to insect pests (kg/ha/yr) or percentage of expected harvest</td>
</tr>
<tr>
<td></td>
<td>• Crop losses due to vertebrate pests (kg/ha/yr) or percentage of expected harvest</td>
</tr>
</tbody>
</table>
5.5.6 Cultural ecosystem services

Cultural ecosystem services are culture specific and must be classified and assessed on a location- or country-specific basis. Issues of non-economic valuation are relevant to the assessment of cultural ecosystem services (see Chapter 6). Sample indicators are presented below to help measure changes in issues related to cultural ecosystem services.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Conservation of valued species</td>
<td>• Total counts or sample census of populations, or indicators of abundance such as harvest levels per unit of effort</td>
</tr>
<tr>
<td>• Spiritual and religious values from biodiversity and landscape</td>
<td>• Number of sacred sites</td>
</tr>
<tr>
<td>• Recreation and ecotourism values</td>
<td>• Number of visitors per year</td>
</tr>
<tr>
<td></td>
<td>• Percentage of farm or regional income from expenditure by tourists</td>
</tr>
</tbody>
</table>

5.6 Human well-being and poverty

There are several dimensions to human well-being. The conceptual framework in the MA identified broad categories of basic material for a good life, health, good social relations, security, freedom of choice and action. For an assessment focusing on the links among trade, agriculture and biodiversity the most relevant aspects of socio-economic well-being need to be selected, taking into account the priorities of the country involved and the availability of existing indicators and data. A farmer’s income and food security are two measures of human well-being that are directly linked to agricultural production (provisioning ecosystem services).

The UNDP Human Development Reports provide further information and data on indicators of human development (hdr.undp.org/hd/). Sample indicators are presented below to help measure changes in issues related to human well-being and poverty.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td></td>
</tr>
<tr>
<td>• Farm income and profit</td>
<td>• Total income/farm and locality or district</td>
</tr>
<tr>
<td></td>
<td>• Proportion of subsistence farmers compared to market farmers</td>
</tr>
<tr>
<td>• Employment</td>
<td>• Rural jobs/ha</td>
</tr>
<tr>
<td></td>
<td>• Farm wages ($/day)</td>
</tr>
<tr>
<td></td>
<td>• Estimate of unemployed (per age class, each sex, and total)</td>
</tr>
<tr>
<td></td>
<td>• Rural unemployment levels (structural versus seasonal)</td>
</tr>
<tr>
<td></td>
<td>• Ratio of subsistence farmers to waged agricultural labourers</td>
</tr>
<tr>
<td>Key issues/factor</td>
<td>Sample indicators</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
</tr>
<tr>
<td>- Life expectancy</td>
<td>• Average life expectancy for rural areas, urban areas and country</td>
</tr>
<tr>
<td>- Income equality</td>
<td>• GINI index</td>
</tr>
<tr>
<td>- Poverty</td>
<td>• Population living below national poverty line (%)</td>
</tr>
<tr>
<td>- Access to water</td>
<td>• Percentage of population with access to safe drinking water</td>
</tr>
<tr>
<td></td>
<td>• Percentage of population with access to water for agricultural activities</td>
</tr>
<tr>
<td>- Health</td>
<td>• Proportion of population with sustainable access to an improved water source</td>
</tr>
<tr>
<td></td>
<td>• Proportion of population with access to affordable essential drugs on a regular basis</td>
</tr>
<tr>
<td></td>
<td>• Percentage of rural population with access to health services</td>
</tr>
<tr>
<td></td>
<td>• Infant mortality rate</td>
</tr>
<tr>
<td></td>
<td>• Under 5 mortality rate</td>
</tr>
<tr>
<td></td>
<td>• Average daily per capita calorie supply, 1999 (kilocalories)</td>
</tr>
<tr>
<td></td>
<td>• Average daily per capita calories from animal products, 1999 (kilocalories)</td>
</tr>
<tr>
<td></td>
<td>• Underweight children under age 5 (%)</td>
</tr>
<tr>
<td></td>
<td>• Prevalence of malnutrition among children under age 5</td>
</tr>
<tr>
<td></td>
<td>• Undernourished people (as a % of total population)</td>
</tr>
<tr>
<td></td>
<td>• Proportion of population below minimum level of dietary energy consumption</td>
</tr>
<tr>
<td></td>
<td>• Percentage of illness and injuries associated with agricultural activities</td>
</tr>
<tr>
<td>- Food security</td>
<td>• Food aid levels</td>
</tr>
<tr>
<td>- Gender</td>
<td>• Gender Development Index (GDI)</td>
</tr>
<tr>
<td></td>
<td>• Ratio of female to male farm household heads</td>
</tr>
<tr>
<td></td>
<td>• Ratio of male to female time inputs to farming</td>
</tr>
<tr>
<td></td>
<td>• Ratio of estimated male to female earned income</td>
</tr>
<tr>
<td></td>
<td>• Female economic activity rate (% for age 15+)</td>
</tr>
<tr>
<td></td>
<td>• Female economic activity rate (as % of male rate)</td>
</tr>
<tr>
<td></td>
<td>• Female employment in agriculture (% of female labour force)</td>
</tr>
<tr>
<td></td>
<td>• Share of women in waged employment in the non-agricultural sector</td>
</tr>
<tr>
<td>- Human development (index)</td>
<td>• The Human Development Index (HDI) is an index composed of longevity, education and standard of living</td>
</tr>
<tr>
<td>- Conflicts over land and water</td>
<td>• Number/yr</td>
</tr>
<tr>
<td></td>
<td>• Proportion of households with access to secure tenure</td>
</tr>
<tr>
<td>- Autonomy of indigenous peoples</td>
<td>• Land titles for indigenous communities</td>
</tr>
<tr>
<td>- Demographics</td>
<td>• Total population, and per district</td>
</tr>
<tr>
<td></td>
<td>• Annual population growth rate (%)</td>
</tr>
<tr>
<td></td>
<td>• Immigration/emigration rate</td>
</tr>
</tbody>
</table>

A significant influence on farmers’ decision-making with respect to their choice of agricultural products and their degree of investment in agriculture is the availability of alternative sources of income and employment. This is influenced by the productivity and profitability in the agricultural sector and the extent to which it
supports a wider economy. Non-agricultural income options are likely to be important aspects of the social and economic analysis in an Integrated Assessment. Below, sample indicators are presented to assist in assessing these issues.

<table>
<thead>
<tr>
<th>Key issue/factor</th>
<th>Sample indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment options</td>
<td>• Wages for non-agricultural activities in rural areas and cities ($/day)</td>
</tr>
<tr>
<td></td>
<td>• Availability of remunerative wages in industrial or services sector</td>
</tr>
<tr>
<td>Skills and training options</td>
<td>• Availability of government and NGO programmes for training of former farmer producers</td>
</tr>
</tbody>
</table>
6. Assigning Value to Biodiversity

Key points

- Biodiversity underpins significant ecosystem services. To a large extent, these ecosystem services have not been valued and their use regarded as free. Recognising their value can lead to better, more cost-efficient decisions and avoidance of inappropriate trade-offs. It is an important step towards refocusing economic and financial incentives to achieve sustainability goals.

- Most resource management and investment decisions are strongly influenced by considerations of the monetary costs and benefits of different policy choices. Placing an economic value on biodiversity and ecosystem services can make it easier to factor them into policy and decision making. Assigning economic values to biodiversity and associated ecosystem services is one way to quantify impacts of changes in trade policy.

- Economic valuation should address the relevant components of the Total Economic Value (TEV) of non-marketed ecosystem services to provide information on changes in the value of ecosystem services that result (or could result) from trade policy decisions.

- A variety of tools and techniques can be used, which already exist for this purpose and are being constantly improved. The choice of the valuation tool or tools will be informed by the characteristics of the case, including the scale of the problem, the types of value deemed to be most relevant, and data availability and the availability of human and financial resources.

- In general, tools based on observed behaviour (revealed-preference techniques) are preferred to tools based on hypothetical behaviour (stated-preference techniques) and cost-based approaches are particularly useful when a specific decision-making problem calls for a comparison of the costs of different replacement or restoration options. Benefits transfer can provide reliable estimates under certain conditions with the potential to alleviate challenges posed by poor data and limited funds, which are often encountered in valuation.

6.1 Why assigning value to biodiversity in an Integrated Assessment

As explained in the previous chapters, changes in agriculture trade policies can have significant impacts on biodiversity and techniques for valuing biodiversity can help decision makers to interpret the significance of these impacts. Typically, these techniques focus on the economic values of the ecosystem services generated by biodiversity, rather than on the economic value of biodiversity itself (Pearce and Moran 1994; Pearce 2001).
Many ecosystem services are defined in economic terms as “public goods” and one important characteristic of such goods is that nobody can be excluded from their use. For this reason, markets cannot spontaneously develop public goods and their value is not reflected in market prices. As a result, the prices of many marketed goods and services do not adequately reflect the essential role of ecosystem services in their production. This, in turn, leads to distorted decisions by consumers and producers and public decision-making and its allocation of public funds will also be distorted if the role of biodiversity (and its associated ecosystem services) in supporting economic production is not adequately factored in. Undertaking valuation can help to raise awareness of the hidden benefits of biodiversity in terms of maintaining critical ecosystem services, as well as the potential costs to society of losing such services.

Effective valuation of ecosystem services requires integration of ecology and economics in an interdisciplinary framework in which ecology provides the necessary information on the generation of ecosystem services and the role of biodiversity, while economics brings tools for estimating their value. Valuation usually attempts to measure the value of ecosystem services in monetary terms, in order to provide a common metric in which to express the benefits of the variety of services provided by ecosystems. This does not mean that only monetary sacrifices, or only services that generate monetary benefits, should be taken into consideration. It is also possible to study impacts and tradeoffs in terms of other “metrics” which can later be transformed into a monetary figure. For example, in a subsistence farming system it may make sense initially to quantify tradeoffs in terms of the labour time farmers are willing to provide for achieving some environmentally-friendly outcome. In order to have a common metric, this effort could be transformed into a monetary figure by applying the local or domestic wage rate.3

Some recent efforts have been made to derive the global (as opposed to incremental) value of ecosystems at a given time (Boumans et al. 2002) and to simulate the value of ecosystem services in an integrated Earth system model (MA 2005). The methodologies underlying these efforts, and the figures they produced, however, remain controversial and have limited usefulness for policy because, as the MA notes, it is rare for all ecosystem services to be completely lost. This chapter therefore focuses on the use of valuation techniques to quantify changes in ecosystem services as part of the integrated assessment process. The MA definition of ecosystem services (which includes goods under the umbrella of “provisioning services”) has been used, however, to ensure consistency with the terminology in the MA.

6.2 Using valuation to assess change

To put an economic value on changes to ecosystem services, we first need to understand what those changes are. As a minimum, the valuation process should be based on a qualitative understanding of environmental and social impacts (TEEB, 2009). In the context of the Integrated Assessment approach suggested in this manual, developing a conceptual framework similar to the one set out in the previous chapter would be used to gain such an understanding. If possible, valuation should also address spatial relationships between sources and receptors or beneficiaries of impacts and services.

3 It is suggested that some biodiversity functions are key to the survival of global ecosystems including humans (the so-called life support function) and should therefore be treated as a fundamental constraint and not as an element of the set of possible economic choices. There has been debate on how much biodiversity is necessary to keep the basic services of the planet intact. There is however a consensus that a more diverse ecosystem can provide services more reliably (Peterson et al. 1998). And all economic choices must be made within some ecological constraints otherwise the global system may collapse. The standard toolbox of economic valuation is said to be of limited if any use for the identification of these global constraints. Alternative approaches such as setting a safe minimum standard may be more suitable for those cases, in particular when changes are irreversible (Pagiola et al. 2004).
Valuation is a process involving several steps. First, the services being valued have to be identified. This includes understanding the nature of the services (noting that under the MA services they may also include goods), their scale (local, regional and/or global, on-site or off-site), how they would change if the ecosystem changed, who makes use of the services (in what way and for what purpose), alternatives, and establishing trade-offs that might exist between different kinds of services an ecosystem provides. These are all aspects that should be identified in the conceptual framework. The bulk of the work involved in valuation concerns quantifying the biophysical relationships which underpin the linkages identified in the conceptual framework. In many cases, this requires tracing through and quantifying a chain of causality. Valuation in the narrow sense only enters in the second step in the process, in which the outcome is interpreted, at which point the value of the impacts might be estimated in monetary terms.

In the context of an integrated assessment, it may be necessary to assign a value to comparatively small (incremental or “marginal”) changes in ecosystem services that result (or would result) from management or policy decisions (Costanza et al. 1997). This means that the techniques used to value ecosystem services need to be quite discriminating, but in fact many are notorious for the levels of uncertainty associated with their use. Specialist expertise is therefore generally required to carry out robust assessments of this kind and to apply the techniques which are described in the following section.

### 6.3 Valuation Techniques

A wide range of techniques is used to assign values to biodiversity. In past decades, valuation methods have reached a considerable degree of sophistication and there has been an emerging consensus on the state-of-the-art of the range of available valuation methods. This is reflected by the fact that several recent handbooks and manuals on the topic have given very similar overviews and assessments (IUCN 1998; OECD 2002; Pagiola et al. 2005; de Groot et al. 2006). The recent Scoping the Science report (Balmford et al. 2008) provides an overview of all of the available economic tools associated with biodiversity loss and a further comprehensive overview has been produced by TEEB (2008).

Techniques are therefore not described in detail in this manual. This chapter focuses on the relative strengths and weaknesses of techniques that can be used to quantify changes in biodiversity and associated ecosystem services.

One way for economists to assign values is to observe people’s behaviour when exchanging different goods and services in markets and to measure their willingness to pay (WTP) for them, but WTP techniques have some limitations when used for ecosystem services, because they are not generally traded in markets.

### 6.3.1 Discounting rates

Integrated Assessments suggest and model possible future scenarios. One application of valuation techniques might be to determine the future value or benefit of ecosystem services under alternative future trade scenarios. To measure any future benefit of biodiversity and ecosystem services, economists use discount rates. A higher discount rate means that emphasis is given to current consumption. A lower discount rate, on the
other hand, signifies that preference is given to future consumption. This in turn means that fewer resources are available for investment in economic activities and development. A key challenge is to establish a suitable discount rate as we do not know how future generations will value biodiversity and ecosystem services, but the way we set discount rates today may have a significant influence on future outcomes. Box 6.1 illustrates this problem and shows thereby a limitation of economic valuation in this context.

Box 6.1 Discounting and the optimist’s paradox

There are two main reasons for discounting. The first is called “pure time preference” by economists and refers to the inclination of individuals to prefer 100 units of purchasing power today to 101, or 105, or even 110 next year, not because of price inflation (which is excluded from the reasoning) but because of the risk of becoming ill or dying and not being able to enjoy next year’s income. Whatever the reason for this attitude, it should not apply to a nation or to human society with a time horizon in the thousands of hundreds of thousands of years. Economists have often criticized “pure time preference” for this reason, the most famous being the Cambridge economist Frank Ramsey, in 1928.

In the context of growth theory, economists agree with discounting of the future for other reasons. They might agree with Ramsey that to discount later enjoyments in comparison with earlier ones is “a practice which is ethically indefensible and arises merely from the weakness of the imagination”. But discount they will, as Ramsey himself did, because they assume that today’s investments and technical change will produce economic growth. This means that our descendants will be richer than we are and may have three, four or even more cars per family. Therefore, the marginal utility, or incremental satisfaction they will get from the third, fourth or fifth car, will be lower and lower. In such a scenario, discounting at the rate at which marginal utility decreases could be ethically justified.

Growth is therefore one reason for undervaluing future consumption and future enjoyments, but it can also result in inappropriate undervaluing of the future need for environmental goods and services and does not avert irreversible events. Economic growth might produce virtual Jurassic Theme Parks for children and adults but it will never resurrect the tiger if and when it goes.

Growth theory is economic theory. It does not take out from the accounts the loss of nature, nor does it exclude from the accounts the defensive expenditures by which we try to compensate for nature’s loss (building dykes against sea-level rise induced by climate change, or selling bottled water in polluted areas). If we try to add up the genuine increase of the economy because of positive technical changes and investments (which nobody would deny), and the loss of environmental services caused by economic growth, the balance would be doubtful. In fact, we step on the issue of incommensurability of values.

Discounting gives rise to “the optimist’s paradox”. Modern economists favour discounting not because of “pure time preference” but because of the decreasing marginal utility of consumption as growth takes place. The assumption of growth (measured by GDP) justifies our using more resources and polluting more now than we would otherwise do. Therefore our descendants, who by assumption are supposed to be better off than ourselves, perhaps will be paradoxically worse off from the environmental point of view than we are.


6.3.2 Total Economic Value (TEV)

The framework most commonly used for describing the different types of economic value ascribed to natural resources is the Total Economic Value (TEV) framework. It comprises use values (direct, indirect and option value) and non-use values4 and therefore lends itself relatively well to valuing ecosystem services. A summary of the types of value included in TEV is provided in Table 6.1.

---

4 Option value is sometimes classified as a non-use value.
Table 6.1 Components of total Economic Value

<table>
<thead>
<tr>
<th>Value</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| Direct use value    | • Value derived from direct use or interaction with environmental resources and services, for example, timber, fuel wood, and recreation are direct use values of a forest.  
• Commercial, subsistence, leisure, or other activities associated with a resource.                                                                                                                                                                                                                                                                                                                                                   |
| Indirect use value  | • Indirect support and protection provided to economic activity and property by the ecosystem's natural functions. For example, carbon sequestration is a function of forest ecosystems whose value can be derived from the avoided costs of having to sequester by other means, or from avoiding the actual effects of warming.  
• While these functions have in principle long been recognized, precise field experimentation has often been lacking in order to show more precisely the relationships between ecosystem functions and the services generated.                                                                                                                                                                                                 |
| Option value        | • Relates to future use of the environment or biodiversity resources and functions. Option value arises because individuals may value the option to be able to use the natural resource in the future. For example, there may be an additional premium placed on preserving a forest system if current exploitation or conversion is irreversible.  
• The logic is to maintain a diverse portfolio of resources as a means to reducing the risk of large fluctuations in value. A more diverse ecosystem also tends to be considerably more resilient. This has been researched under the term “insurance value” as well (Baumgaertner 2007).  
• Decisions should always take into account that the results of an interference with an ecosystem can never be fully predicted, making “ignorance a strong motivation for conservation” (Weikard 2002).                                                                                                                                                                                                                         |
| Non-use values      | • Derived neither from current direct or indirect use of the environment. Reasons why utility is derived may be based on religious, spiritual, or ethical motives.  
• Existence value (sometimes called passive value) is, for example, when individuals who do not use the tropical forest but nevertheless wish to see it preserved because they simply derive utility from the ongoing existence of the ecosystem, or because they wish to conserve it for future generations (bequest value).  
• Most complex in terms of quantification and its role in decision-making. Yet, it is a type of economic value that is significant in defining both national and global biodiversity management priorities.                                                                                                                                     |

There is a variety of taxonomies and classifications of the components of TEV. A commonly used approach is the one which first divides them into the two main categories of ‘use’ and ‘non-use’ and then proceeds with their decomposition into sub-categories of value. Figure 6.1 presents an illustration of this classification approach.

When applying different techniques to address different impacts on biodiversity resources and functions, or different types of relevant TEV, care must be taken to avoid the problem of “independent piecewise value” estimation (Randall 2002). Because of the complementarities and multiplier effects associated with different impacts, an estimate of the TEV of a particular biological resource should not be based on a piecewise independent valuation of each impact or TEV type and a simple addition of those individual figures, as this would probably lead to double-counting. For example, if a dose-response approach to the value of agro-biodiversity is estimated and then simply added to the value assigned by farmers’ themselves using a state preference technique, it is very likely that double counting would occur. This is a common problem given the multi-attribute nature of agro-biodiversity and its multifaceted services that it provides both on- and off-farm.
Figure 6.1 Total Economic Value: Values that can be assigned a monetary metric

<table>
<thead>
<tr>
<th>TOTAL ECONOMIC VALUE (TEV)</th>
<th>USE VALUE</th>
<th>NON-USE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct use value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output that is consumed directly</td>
<td>• Fish</td>
<td>• Wood</td>
</tr>
<tr>
<td><strong>Indirect use value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological functions that support and protect economic activity elsewhere</td>
<td>• Watershed protection (flood control, storm protection)</td>
<td>• CO2/O2 stabilisation, etc.</td>
</tr>
<tr>
<td><strong>Option value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertainty over further demand or availability of biodiversity flows; irreversibilities</td>
<td>• Genetic resources</td>
<td>• Potential bio-prospecting values</td>
</tr>
<tr>
<td><strong>Existence value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge of continued existence or that others will enjoy benefits of biodiversity; for future generations</td>
<td>• Charismatic mega-fauna (whales, great apes)</td>
<td></td>
</tr>
<tr>
<td><strong>Bequest value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge of continued existence or that others will enjoy benefits of biodiversity; for future generations</td>
<td>• Charismatic mega-fauna (whales, great apes)</td>
<td></td>
</tr>
</tbody>
</table>

**TEV CATEGORIES**

**COMMONLY USED VALUATION METHODS**

- **Change in productivity, cost-based approaches, stated preference methods**
- **Stated preference methods**
- **Change in productivity, cost-based approaches, travel cost, stated preference methods**
- **Stated preference methods**
- **Ecological functions that support and protect economic activity elsewhere**
- • Watershed protection (flood control, storm protection) • CO2/O2 stabilisation, etc.

**EXAMPLES FOR BIODIVERSITY EARLY**
Assigning Value to Biodiversity

Any one valuation method is unlikely to cover all of the different types of value given in the concept of TEV (Nunes and van den Bergh 2001). Different techniques may also be required for the same biodiversity resource evaluated at different scales. For example, the range of services of a forest, the type of value of those services, and their actual value to a local community living at the fringe of the forest, may differ significantly from the types of value and the value that the national and/or international community may assign to different services of the same forest. The selection of the method or methods should therefore depend on the types of value and levels are deemed the most important (or likely) in a given situation, although many valuation studies use several methods. Table 6.2 gives an overview of the different valuation techniques.

When applying different techniques to address different impacts on biodiversity resources and functions, or different types of relevant TEV, care must be taken to avoid the problem of “independent piecewise value” estimation (Randall 2002). Because of the complementarities and multiplier effects associated with different impacts, an estimate of the TEV of a particular biological resource should not be based on a piecewise independent valuation of each impact or TEV type and a simple addition of those individual figures, as this would probably lead to double-counting. For example, if a dose-response approach to the value of agro-biodiversity is estimated and then simply added to the value assigned by farmers’ themselves using a state preference technique, it is very likely that double counting would occur. This is a common problem given the multi-attribute nature of agro-biodiversity and its multifaceted services that it provides both on- and off-farm.

Table 6.2 Selected valuation techniques

<table>
<thead>
<tr>
<th>Detail found in Section</th>
<th>Method</th>
<th>Description</th>
<th>Applications</th>
<th>Data requirements</th>
<th>Potential challenges/ limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Revealed-preference methods</td>
<td>Change in productivity</td>
<td>Trace impact of change in ecosystem services on produced goods.</td>
<td>Any impact that affects produced goods.</td>
<td>Lacking data on change in service and consequent impact on production.</td>
</tr>
<tr>
<td>6.2.3</td>
<td></td>
<td></td>
<td></td>
<td>Change in service; impact on production; net value of produced goods.</td>
<td></td>
</tr>
<tr>
<td>6.2.4</td>
<td>Cost of illness, human capital</td>
<td>Change in service</td>
<td>Any impact that affects health (e.g., air or water pollution).</td>
<td>Change in service; impact on health (dose-response functions); cost of illness or value of life.</td>
<td>Lacking dose-response functions linking environmental conditions to health; value of life cannot be estimated.</td>
</tr>
<tr>
<td>6.2.5</td>
<td>Cost-based approaches (replacement/restoration costs)</td>
<td>Use cost of replacing or restoring the service.</td>
<td>Any loss of goods or services; Identification of least cost option to meet given objective.</td>
<td>Extent of loss of goods or services and cost of replacing or restoring them.</td>
<td>Risk of overestimating actual value if unknown benefits are higher than identified costs.</td>
</tr>
<tr>
<td>6.2.6</td>
<td>Travel cost (TCM)</td>
<td>Derive demand curve from data on actual travel costs.</td>
<td>Site-specific recreation; sightseeing (e.g., protected areas).</td>
<td>Survey to collect monetary and time costs of travel to destination, distance travelled.</td>
<td>Limited to described applications; difficult to use when trips are to multiple destinations.</td>
</tr>
<tr>
<td>6.2.7</td>
<td>Hedonic prices</td>
<td>Extract effect of ecosystem service on price of goods that include those factors.</td>
<td>Air quality, scenic beauty, cultural benefits</td>
<td>Prices and characteristics of goods.</td>
<td>Requires transparent and well-working markets, and vast quantities of data; very sensitive to specification.</td>
</tr>
</tbody>
</table>
### Stated-preference methods

<table>
<thead>
<tr>
<th>6.2.8</th>
<th>Contingent valuation (CV)</th>
<th>Ask respondents directly their WTP for a specified service.</th>
<th>In particular in cases where non-use values are deemed to be important.</th>
<th>Survey that presents scenarios and elicits WTP for specified service.</th>
<th>Ensuring that the sample is representative is important but a large survey is time-consuming and costly; knowledge of respondents may be insufficient; potential sources of bias in responses; guidelines exist for reliable application.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2.9</td>
<td>Choice modelling</td>
<td>Respondents choose preferred option from alternatives with particular attributes.</td>
<td>In particular in cases where non-use values are deemed to be important.</td>
<td>Survey of respondents.</td>
<td>Similar to CV, but minimizes some biases; analysis of the data generated is complex.</td>
</tr>
</tbody>
</table>

### Other methods

| 6.2.10 | Benefits transfer | Use results obtained in one case in a different, but very similar case. | Any where suitable comparison studies are available; applicable in cases where savings in time and costs outweigh certain loss of accuracy (e.g., rapid assessments). | High-quality valuation data from similar sites. | Can be very inaccurate when not used cautiously, as many factors may still vary even when cases seem ‘similar’. |

Source: adapted from MA (2005)

### 6.3.3 Changes in productivity

One technique that is widely used, due to its broad applicability and flexibility in using a variety of data sources, is the “change in productivity” technique. It consists of tracing chains of causality so that the impact of changes in the condition of an ecosystem can be related to various measures of human well-being. Such impacts are often reflected in goods or services that contribute directly to human well-being (such as production of crops or clean water) and are relatively easily valued, depending on the type of impact.

The application of this technique includes two steps. The first involves the establishment of a physical relationship between output (production) and inputs (including environmental inputs, for instance ecological services). In the course of the second step, a monetary value is put on the marginal contribution of the environmental input to the output levels that were derived in the first step.5

The impact of hydrological changes on the use of water for human consumption, for example, begins by tracing chains of causality to estimate the changes in the quantity and quality of water available to consumers.

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This is often difficult. For instance, the relationship between tree cover and water productivity in a watershed is complex and not well understood. Further scientific research into chains of causality is a precondition for this type of valuation.

In the case of marketed goods, the actual valuation is relatively straightforward. For instance, the net value in reductions in irrigated crop production resulting from reduced water availability is easy to estimate, as crops are often sold (although a common error is to use the reduction in the gross value of crop production, which omits the costs of production and overestimates the impact rather than the net value).

Where the impact is on a good or service that is not marketed or where observed prices are unreliable indicators of value, the valuation can become more complex. In the example above, the prices charged to consumers for water consumption are typically not reliable measures of the value of the water to consumers, as they are often set administratively, with no regard for supply and demand (indeed, in most cases, water fees do not even cover the cost of delivering the water to consumers, let alone the value of the water itself). The value of an additional unit of water can then be estimated in various ways, such as the cost of alternative sources of supply (cost-based measures) or asking consumers directly how much they would be willing to pay for it (contingent valuation). It is very important to use the value of an additional unit of water, since some amount of water is vital for survival. Thus, an additional unit of water will be very valuable when water is scarce, but less so when water is plentiful, rendering averages misleading.

When the impact is on water quality rather than quantity, the impact on well-being might be reflected in increased morbidity or even mortality. Again, the process begins by tracing through chains of causality, for example by using dose-response functions that tie concentrations of pollutants to human health and value the impact on health.

In some cases, the impact is on relatively intangible aspects of well-being, such as aesthetic benefits or existence value. Since the 1960s, particular efforts have been made to develop techniques to value such impacts. These techniques include hedonic price, travel cost, and contingent valuation methods.

### 6.3.4 Cost of illness and human capital

The economic costs of an increase in morbidity due to increased pollution levels can be estimated using information on various costs associated with the increase. These include any loss of earnings resulting from illness, medical costs (such as for doctors, hospital visits and medication), and other related out-of-pocket expenses. The estimates obtained in this manner are interpreted as lower-bound estimates of the presumed costs or benefits of actions that result in changes in the level of morbidity, since this method disregards the affected individuals’ preference for health versus illness and restrictions on non-work activities. Also, the method assumes that individuals treat health as exogenous and does not recognize that individuals may undertake defensive actions (such as using special air or water filtration systems to reduce exposure to pollution) and incur costs to reduce health risks.

When this approach is extended to estimate the costs associated with pollution-related mortality, it is referred to as the human-capital approach. It is similar to the change-in-productivity approach in that it is based on a damage function relating pollution to productivity, except that in this case the loss in productivity is that of human beings, measured in terms of expected lifetime earnings. Because it reduces the value of life to the present value of an individual’s future income stream, the human-capital approach is extremely controversial when applied to mortality. Many economists prefer, therefore, not to use this approach and to simply measure the changes in the number of deaths or in the probability of death (without monetary values), or measures such as disability-adjusted life years.
6.3.5 Cost-based approaches (restoration and replacement)

The cost of replacing or restoring the services provided by the environmental resource is sometimes relevant in decision-making. For example, if ecosystem change reduces water filtration services, the cost of treating water to meet the required quality standards could be used. The major underlying assumptions of these approaches are that the nature and extent of physical damage expected is predictable (there is an accurate damage function available) and that the costs to replace or restore damaged assets can be estimated with a reasonable degree of accuracy. It is further assumed that the replacement or restoration costs do not exceed the economic value of the service, bearing in mind the potential externalities generated by the replacement options. These assumptions may not be valid in all cases. It simply may cost more to replace or restore a service than it was worth in the first place – for example, because there are few users or because their use of the service was in low-value activities.

Even while there is not necessarily any relationship between the replacement (or restoration) cost and the value of the service, cost-based approaches can provide useful guidance in a number of cases, in particular when the specific decision-making problem calls for a comparison of the costs resulting from all different replacement or restoration options. For instance, in an often-quoted case, the New York City water authority avoided spending US $6-$8 billion on water purification plants by investing US $1.5 billion for the protection and restoration of the upstate watershed in the Catskills Mountains (Postel and Thompson 2005). Here, the decision-making problem was simply to minimize the cost of meeting an objective, by comparing the costs resulting from replacement and from restoration options. The priority given to the objective itself (a reliable supply of drinking water meeting certain quality standards) was unquestionable and not part of the decision-making problem.

An important effect of trade on biodiversity in agricultural landscapes is the increased costs through invasive species, which are recognized as one of the most pervasive and insidious threats to biodiversity in agricultural landscapes by deepening international trade liberalization. The growth of the international trade system has involved a substantial increase in the number of alien species being introduced to ecosystems and the frequency with which such introductions are made (Jenkins, 1996; McNeely, 2001). While in some cases, the introduced species are themselves the object of trade, indirectly trade itself can become a vector for alien species by stowing away in ships, planes, trucks, shipping containers, and packing materials, or by ‘hitchhiking’ on nursery stock, fruits, vegetables, seeds, and other import products (Jenkins, 1996).

**Box 6.2 Estimating the costs of invasive species**

The *ex-ante* assessment calculation of the net costs of a given invasive species is not an easy task. It involves estimating (i) the likelihood of the invasiveness of the species, (ii) the invasibility of the agricultural system, (iii) the effectiveness of any given control programme, and (iv) the responses of those whose life and livelihoods are affected by invasive species and their control, who are the ones which values count. Economic valuation of the effects of invasive species in agricultural systems mainly arise by the calculation of ‘gross’ direct damage costs and may not appropriately approximate ‘net’ costs. The reason is that there are no estimates of any benefits that may have accrued from the economic activities that led to the introduction of invasive species (Perrings, in press). For instance, in the United States, crop areas affected by invasive weeds and arthropod and microbial pests are estimated to be causing an estimated annual loss of about US $60 billion of which, most are in direct damages. For instance, weeds alone cause a reduction 10 per cent in crop yields annually (about US $24 billion in lost crop production plus another US $3 billion in herbicides) (Pimentel *et al.*2001).

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6 See as examples studies II, III, IV, V, and X provided in SCBD (2007).
It is interesting to consider the relative severity of the estimates in rich and poor countries. Taking agricultural GDP in 1999 as the numeraire, the invasive species caused damage costs equal to 53 per cent of agricultural GDP in the United States, 31 per cent in the United Kingdom and 48 per cent in Australia. By contrast, damage costs in South Africa, India and Brazil were 96 per cent, 78 per cent and 112 per cent, respectively, of agricultural GDP. (Perrings, in press).

An alternative valuation approach is to take into account the ‘public expenditure’ on invasive species control. This follows the idea of the ‘remediation cost approach’. In this case, a lower bound estimate of the cost of the problem of invisibility is obtained. While this financial data is not available for most countries, in the United States, for example, such expenditure on invasive species in 1999 was less than US $0.5 billion, or 0.5 per cent of the estimated damage costs in agriculture. This figure contrasts with that based on the ‘direct damage cost’ approach outlined above. This also suggests that the cost of invasive species in agriculture due to increased international trade needs to go beyond the financial costs of controlling the problem (i.e., using the so-called ‘preventive or mitigation expenditure approach’). Furthermore, while most of the estimates have been obtained through the ‘loss of earnings approach’, these valuation studies fail to obtain the ‘net’ cost.

When the true net costs are taken into account, it is not always clear that eradication or control is the optimal strategy. An example of Ghana is illustrative of this. The siam weed (*Chromoleana odorata*) was introduced into Ghana in the 1960s and in about four decades had spread to approximately 60 per cent of the land area. While it has led to major ecological costs, the users themselves when asked about such costs in a survey, highlighted that few would support its eradication since it also confers significant benefits in terms of fuel, fibres, building materials and medicinal products. (Rangi 2004)

### 6.3.6 Travel cost

The travel-cost method is an example of a technique that attempts to deduce value from observed behaviour in a surrogate market. It uses information on visitors’ total expenditure to visit a site to derive the recreational value that people attach to a site/ resource for recreation, which is usually unpriced or priced with a very low entrance fee. The travel costs include the direct transport costs (including fares, fuel and other incidentals) but also the value of time travelling to the site and on the site. Through information obtained from a survey of visitors to the site, such as travel cost data, recreational experiences, information on substitute sites, a demand curve for the site’s services/ the resource in question (measured in visit-days per year or visitation rate per 1,000 population) can be derived. From this demand curve, the total benefit visitors obtain can be calculated (the value of the site is not given by the total travel cost, which is only used to derive the demand curve; the total benefit is expressed as the area under the demand curve minus the costs [the sum of the consumer surplus and the producer surplus]). This method was designed to assign a value to the benefits of sightseeing or recreation at particular sites, but has limited relevance to other scenarios.7

### 6.3.7 Hedonic analysis

The prices paid for goods or services that have environmental attributes differ depending on those attributes. Thus, a house in a clean environment will sell for more than an otherwise identical house in a polluted neighbourhood. Hedonic price analysis compares the prices of similar goods to extract the implicit value (“shadow price”) that buyers place on the environmental attributes. The environmental attribute may relate for instance to the level of air or noise pollution in the locality or the distance from the solid wastes disposal area. This method assumes that markets are transparent and work reasonably well, and it would not be applicable where markets are distorted by policy or market failures. Moreover, this method requires a very large number of observations, so its applicability is limited.

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7 See studies I, VII, VIII, XII in SCBD (2007).
6.3.8 Contingent valuation

Contingent valuation (CV) is an example of a stated preference technique. It is carried out by asking consumers directly about their WTP to obtain an environmental service (or, in some circumstances, their willingness-to-accept). A detailed description of the service and how it will be delivered is provided. The valuation can be obtained in a number of ways, such as asking respondents to name a figure (open ended CV), asking them whether they would pay a specific amount (dichotomous or polychotomous choice CV) or having them choose how much they are willing to pay from a list of prices (payment card CV).

By phrasing the question appropriately, CV can be used to value any environmental benefit. Moreover, since it is not limited to deducing preferences from available data, it can be targeted to address specific changes in benefits that a particular change in ecosystem condition might cause. Because of the need to describe in detail the service being valued, interviews in CV surveys are time-consuming. Moreover, in designing CV surveys it is important to identify the relevant population to ensure that the sample is representative, and to pre-test the questionnaire to avoid bias.

A potentially important limitation when applying these methods to ecosystem services is that respondents cannot typically make informed choices if they have a limited understanding of the issue in question. Choosing the right approach to improve the understanding of biological complexity of the sample group, and determining the intensity of effort necessary, is a challenge for stated preference methods.

CV methods have been the subject of severe criticism by some analysts, in particular because of the danger of bias resulting in distorted results whereby CV studies may not reflect true preferences. A “blue-ribbon” panel was organized in the United States following controversy over the use of CV to value damages from the 1989 Exxon Valdez oil spill. The panel’s report (which is generally regarded as authoritative on the appropriate use of CV) concluded that CV can provide useful and reliable information when used carefully, and it provided guidance to help to reduce, or avoid, potential bias (Arrow et al. 1993).

6.3.9 Choice modelling

Choice modelling (also referred to as contingent choice, choice experiments, conjoint analysis, or attribute-based stated choice method) is a newer approach to obtaining stated preferences. It can be used to estimate non-market environmental benefits and costs. It consists of asking respondents to choose their preferred option from a set of alternatives where the alternatives are defined by attributes (including price). The alternatives are designed so that the respondent’s choice reveals the marginal rate of substitution between the attributes and the item that is trade off (for example, money). These approaches are useful in cases where an investigator is interested in the valuation of the attributes of the situation or when a decision lends itself to respondents choosing from a set of alternatives described by attributes.

Choice modelling has several advantages. One advantage is that the control of the stimuli is in the experimenter’s hand, as opposed to the low level of control generated by real market data. Second, the control of the design yields greater statistical efficiency. Third, the attribute range can be wider than found in market data. Fourth, it is less expensive than CV, as respondents usually answer more than one choice modelling exercise in the same questionnaire. Finally, the introduction or removal of products, services and attributes is easily accomplished (Louviere et al. 2000; Holmes and Adamowicz 2003; Bateman et al. 2004, Columbia, 2002). The method also minimizes some of the technical problems (such as strategic behaviour of respondents) that are associated with CV. The disadvantages associated with the technique are that the responses are hypothetical and therefore suffer from problems of hypothetical bias (similar to CV) and the choices can be complex when there are many attributes and alternatives. The econometric analysis of the data generated by choice modelling is also relatively complex.
6.3.10 Benefits transfer

A final category of approach is benefits transfer (BT), which refers to the use of estimates obtained (by whatever method) in one context to estimate values in a different context. For example, an estimate of the benefit obtained by tourists viewing wildlife in one park might be used to estimate the benefit obtained from viewing wildlife in a different park. Alternatively, the relationship used to estimate the benefits in one case might be applied in another, by using adjusted data from this case in conjunction with some data from the site of interest ("benefit function transfer"). For example, a relationship that estimates tourist benefits in one park, based in part on their attributes such as income or national origin, could be used in another park, but with data on income and national origin of that park’s visitors.\(^8\)

BT has been the subject of considerable controversy in the economics literature (Brouwer 2000; Christie et al. 2004) as it has often been used inappropriately. The MA suggests that a consensus is emerging that BT can provide valid and reliable estimates under certain conditions, which include the requirement that the commodity or service being valued is very similar at both the site where the estimates were made and the site where they are applied, and that the affected populations have similar characteristics.\(^9\) The original estimates being transferred must themselves be reliable in order for any attempt at transfer to be meaningful. However, as conditions at the two sites are unlikely to be identical, some transfer error is to be expected.

Nevertheless, BT is useful in decision-making because estimates based on BT can be generated with considerably less time and resources than primary studies and decision makers may be willing to trade quick (and cheaper) numbers against some loss in accuracy, provided that minimum quality standards are met. They may even be more ready to do so when the alternative is to have no estimate at all. Moreover, BT may be attractive when decision makers request quick (but not necessarily final) answers from administrators. It may thus play a role in rapid assessment methodologies.\(^10\)

6.4 Using results of valuation in decision-making

Undertaking valuation has the potential to improve public decision-making on projects, regulations, or policies. When applied carefully and according to best practice, valuation tools can generally provide useful and reliable information on the changes in the value of non-marketed ecosystem services that result (or would result) from management decisions or from other human activities. Data requirements and technical expertise may be demanding for several tools and conducting primary valuation studies is typically time-consuming and costly. The MA suggested that measures based on observed behaviour are generally preferred to measures based on hypothetical behaviour, and more direct measures are preferred to indirect measures. However, it also notes that the choice of a valuation technique in any given instance will be dictated by the characteristics of the case (including its scope) and by data availability.

Existing methods to support decision-making use valuation information to a greater or lesser extent. Economic frameworks such as cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA) involve explicit monetary valuation. An important advantage of the valuation tools reviewed in the last section is that they provide numbers in a common (monetary) metric, which can easily be incorporated into these standard appraisal methods. In contrast, multi-criteria analysis (MCA) typically avoids using a monetary unit of account. Other

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\(^8\) See in particular study XI in SCBD (2007).
\(^9\) Up to a limit, differences in the population’s characteristics can be addressed by using benefits functions transfer.
\(^10\) Christie et al. (2004) note that: “Finding acceptable BT methods is essential to the wider use of environmental valuation in policy. However, the standards of accuracy required in academic work may exceed those viewed as tolerable by policy-makers. (...) The key question is: how close is close enough for policy purposes?”
non-economic approaches to prioritization include deliberative processes, scorecard approaches, expert judgment and satisficing.

All of these approaches are tools to support decision-making. They all have advantages and limitations, and it cannot be claimed that one tool is generally superior, or that it should be used as an exclusive tool in decision-making. For instance, with respect to CBA, economic efficiency is seldom the sole criterion for public investment decisions. The distributional impacts of decisions are often also important. While CBA can be helpful in clarifying distributional impacts, it does not deliver recommendations with regard to preferable decisions from a distributional perspective. Nevertheless, different methods may be used in a complementary manner in order to support decision-making.

6.4.1 Cost-benefit analysis and cost-effectiveness analysis

Cost-Benefit Analysis compares monetary costs and benefits. This comparison is sometimes expressed as a cost-benefit ratio, where benefits are the numerator and costs are the denominator. Alternative options can then be ranked in accordance with their cost-benefit-ratio. Depending on the specific activities under investigation, the value associated with ecosystem services will be included as a cost or as a benefit. For instance, if the cost-benefit-ratios of different conservation projects were compared, the value of improved ecosystem services would be included as benefits of the individual projects. If, however, different development projects were considered (for example, different options to invest in public infrastructure with negative impacts on biodiversity) the value of the associated loss of ecosystem services would be included as a cost to the individual option. It may not be necessary to explore the full range of services of a given ecosystem to have an influence on a policy outcome. This will be the case when, in the context of CBA, the benefits associated with the most important ecosystem services are already high enough to tip the balance against a specific development option.

As costs and benefits typically occur at different points in time, it is necessary to collapse the recognized cost and benefit flows to a commensurate basis. This is done through a conventional economic process called ‘time discounting’ and the outcome of the process is called the ‘present value’ of costs and benefits. A crucial variable in the calculation of present value is the choice of a discount rate (the value that is used to collapse future values to their present equivalents). A positive discount rate is tantamount to saying that the future (costs and benefits) are worth less in relative terms than costs and benefits that are realized immediately.

Even if future preferences for biodiversity are uncertain, current trends mean that the future of many biodiversity components and resources is bleak, implying that they will be increasingly scarce, or more valuable, in the future. As future generations will place a higher value on scarcer resources than do current generations, this reasoning gives rise to a positive premium on the future, which offsets the discounting process.

Cost-effectiveness analysis (CEA) leaves the numerator in qualitative terms and simply compares the different costs of attaining an objective stated in the numerator. Different options that deliver the same objective are then compared and prioritized based on their cost-effectiveness-ratio. CEA, therefore, does not ask (or attempt to answer) the question of whether the goal of the policy is justified, in the sense that the social benefits expected from this goal exceed the costs necessary to reach the goal. Indeed, none of the options may be economically efficient, in the sense of monetary economic costs outweighing economic benefits. Hence, CEA is appropriate whenever there are good reasons to believe that the benefits of meeting the

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11 For example, while the benefits of conservation occur at the national and international levels (such as carbon sequestration or the existence value associated with charismatic mega-fauna) the costs associated with conservation (such as foregone exploitation of resources or of use of land) are often borne by local populations. On the other hand, local ecosystem services (those that benefit local communities) are severely undervalued in many cases. By disaggregating the numbers obtained, valuation studies and CBA can help quantify the shares of local vs national vs regional or international benefits and costs under different options.
objective outweigh the costs, and the priority given to meet the objective is therefore not under doubt (such as in the Catskills example discussed above). In other cases, however, CEA may only be helping to select the least-worst option among a list of (potentially) inefficient options. Even in those cases, CEA is sometimes used as a second-best option when a full-blown CBA would be desirable, but many benefits cannot easily be monetized.

Both CBA and CEA are common governmental appraisal methods in OECD countries and among international organizations. While the methods were originally developed for appraising basic infrastructure, many government guidance documents now include advice on the inclusion of environmental and social costs and benefits.

6.4.2 Non-economic frameworks

The following approaches are more qualitative in nature but may occasionally use valuation information in the decision process.

(a) Multi-criteria analysis

Multi-criteria analysis (MCA) is a family of methods that use different scoring approaches to weigh the different attributes of a decision. They are used to structure a policy problem in terms of possible policy alternatives and to assess each alternative under various criteria. Most of the variants of MCA are structured approaches used to determine overall preferences among different policy measures, where each measure may pursue several objectives. Participants in the analysis are typically given the criteria that define different options and are asked to score or weigh these criteria using some pre-determined points system. MCA appeared in the 1960s as a decision-making tool. It can be used in complex situations and several criteria can be taken into consideration simultaneously.

CBA and MCA are not mutually exclusive. CBA can be used to define a set of efficient options where net benefits are positive (that is, gross benefits are greater than costs). Options with net economic benefits of similar magnitude could be further assessed by MCA, to identify non-economic trade-offs associated with alternative courses of action.

(b) Deliberative and inclusionary approaches

Deliberative and inclusionary approaches (DIPs) include participatory appraisal, focus groups, the Delphi approach, consensus conferences and citizen’s juries. These methods are aimed at creating better informed decisions that are owned by, and have the broad consent of, all relevant actors and stakeholders. They stand in contrast to the more ‘technocratic’ approaches such as CBA, CEA, or MCA. DIPs seek to build a process of defining and redefining interests that stakeholders introduce as the collective experience of participation evolves. As participants become more empowered (i.e., more respected and more self-confident), it is assumed they may become more able to adjust to, listen to, and learn from others, and accommodate to a greater consensus.12

Traditional knowledge of ecosystem services is often not adequately received by the wider public and DIPs may play an important role to promote the wider recognition of this knowledge and contribute (with the approval and involvement of these communities) to its wider application, including within economic valuation studies. DIPs can also complement other techniques. For instance, one limitation of stated preference techniques is that respondents cannot typically make informed choices if they have a limited understanding of

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12 Ramsar/CBD 2006 p.19 describes in detail the process of identifying and involving relevant stakeholders.
the issue in question, by disseminating pertinent knowledge, DIPs may play an important role to broaden the understanding on the issue for all stakeholders.13

(c) Satisficing

A satisficing approach can be described as an assessment procedure to obtain an outcome that is good enough, rather than seeking the best solution. The approach can be contrasted with an optimizing approach, which seeks to identify the “best” solution (such as with CBA or MCA). For the implementation of a satisficing approach, one or more criteria need to be identified that the measure is expected to fulfil. The subsequent analysis can investigate all possible measures to achieve this objective(s) and list the successful options without ranking them, or it can be terminated once the first option has been identified that fulfils the requirement(s).

6.4.3 Linking a participatory approach with economic valuation techniques

Conventional economic valuation techniques can be fused with participatory approaches. For example, Rodriguez et al. (2006) have recently attempted to estimate the use-value of the Opuntia scrublands in Peru by initially exploring the ‘cultural domain’ of Opuntia by local communities in order to identify their perception of the ecosystem goods and services. This information was applied within a ‘cultural domain’ analysis for subsequent valuation. Cultural domain analysis provides a set of techniques to investigate knowledge structure. Borgatti (1998) ‘freelisting’ and ‘triad’ techniques can be applied to elicit the elements of the cultural domain and the attributes that local land-users apply to distinguish among the different uses of a particular biological resource.

The information obtained in this analysis by Rodriguez et al. (2006) was then used to characterize the different services provided by Opuntia from the point of view of the users themselves. Box 6.3 shows how to value and then aggregate the ecosystem services of agro-biodiversity.

Box 6.3 Avoiding independent valuation: Opuntia scrubland from Ayacucho, Peru

The Opuntia scrublands are especially important because they host cochineal insects, the source of carminic acid, a natural dye used in the food, textile, and pharmaceutical industries. Although the direct use value of the Opuntia scrubs includes mainly the value of cochineal exports and manufactured dyes, its total use value, includes other indirect use values to the local farming community. The Opuntia scrubland performs a major environmental role protecting slopes against erosion and flooding, as well as rehabilitating marginal lands by improving the levels of humidity and soil retention capabilities. In addition, the scrublands are used for animal grazing all year round (and can become an emergency feedstock in case of drought) and its fruits and young cladodes have a considerable nutritional value and provide food for Andean farmers.

The direct use value of Opuntias in terms of their production of food, fruit, cochineal, fodder, fuel and ornamental goods can be derived using direct market prices and, if necessary, the value of the closest substitute goods. The habitat function value of its nursery and refugium services can be assessed using a supply-side approach by applying the avoided cost analysis. An estimate of the indirect use value regarding the regulation function of the on-farm erosion control service can be provided through a CV method. This illustrates how various values associated with different ecological functions can be assessed applying methods from the demand-and supply-side toolkits.

13 SCBD (2007) provides case study examples of the application of deliberative approaches within economic valuation – see cases IV and IX.
- **Valuation of provisioning services** (food, feedstock and fuel wood). Once the yearly quantity and quality of yields of scrubland products (e.g., cochineal and fruit) and the area used in the collection is calculated, market prices can be used to derive the direct use value of the products collected in a given year. The use value of Opuntia scrublands as a source of fuel can be quantified considering the wage rate as a broad approximation of the opportunity cost of time employed by households in periodic working hours that generate supply of fuel.

- **Value of regulating services.** The value of the Cochineal cash-crop is a sessile parasitic insect living on Opuntia plants which allow farmers to collect the cochineal by withdrawing them from their host plants. Those not harvested are used to repopulate the scrubs for later harvests. This ‘nursery’ function is valuable as it represents an investment in future crops. The value of the service of nursery and refugium is quantified based on the costs avoided by farmers if the host plants should be infested by hand at the prevailing labourers' wages that represent the opportunity cost of time.

- **Value of supporting services** (soil erosion control). This is a key function that is valuable for farmers in the high sloped Andean area. Soil loss affects productivity of crops, but any change in productivity will be evident only after many years of severe soil loss. Farmers' interest in soil erosion is primarily concerned with on-farm impacts such as increased production costs, decreased profitability owing to soil fertility decline, and financial costs of implementing needed soil conservation measures. One way of eliciting such value is through the employment of state preference techniques. This allows obtaining a broad monetary idea of the households' WTP for the service of soil erosion control provided by the Opuntia scrubland.

Even if only some of the intangible benefits are considered, the value of these ecosystem services provided by Opuntia scrubland is relatively higher than the computable direct financial revenues from agriculture. The valuation analysis shows that the share of direct use value through the collection of items from the scrubland on farmers' income is as high as 36 per cent. With the indirect use value (regulation of soil erosion), the value of Opuntia scrubland for farmers accounts for over 55 per cent of their income.

Source: Adapted from Rodríguez et al. (2006).

Table 6.3 offers a different approach to selecting a valuation method. This table allows a user to select an ecosystem service that they wish to value and then decide on the most appropriate method for valuation.

**Table 6.3 Economic methods of valuation for ecosystem services**

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Amenability to economic valuation</th>
<th>Most appropriate method for valuation</th>
<th>Transferability across sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>High</td>
<td>M, P</td>
<td>High</td>
</tr>
<tr>
<td>Fresh water</td>
<td>High</td>
<td>AC, RC, M, TC</td>
<td>Medium</td>
</tr>
<tr>
<td>Biochemical, natural medicines and pharmaceuticals</td>
<td>High</td>
<td>AC, RC, P</td>
<td>High</td>
</tr>
<tr>
<td>Genetic resources</td>
<td>Low</td>
<td>M, AC</td>
<td>Low</td>
</tr>
<tr>
<td>Fuel and fibre</td>
<td>High</td>
<td>M, P</td>
<td>High</td>
</tr>
<tr>
<td>Regulating services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air quality regulation</td>
<td>Medium</td>
<td>CV, C, RC</td>
<td>High</td>
</tr>
<tr>
<td>Climate regulation</td>
<td>Low</td>
<td>CV</td>
<td>High</td>
</tr>
</tbody>
</table>
Ecosystem service | Amenability to economic valuation | Most appropriate method for valuation | Transferability across sites
---|---|---|---
Natural hazard regulation | High | AC | Medium
Water regulation | High | M, AC, RC, H, P, CV | Medium
Waste regulation | High | RC, AC, CV | Medium to high
Pollination, pest regulation, herbivory and predation and seed dispersal | Medium | AC, P | High

Cultural services

| Spiritual and cultural heritage values | Low | CV, ranking | Low
| Educational values and knowledge systems | Low | Ranking | High
| Aesthetic values | High | H, CV, TC, ranking | Low
| Recreation and tourism | High | TC, CV, ranking | Low
| Ornamental resources | High | AC, RC, H | Medium

Supporting services

| Soil formation | Medium | AC, RC, H | Medium
| Nutrient regulation | Medium | AC, CV | Medium

AC avoided cost; CV contingent valuation; H hedonic pricing; M market prices; P production approach; RC replacement cost; TC travel cost

Source: Adapted from Farber et al (2006).

The use of formal appraisal methods and the nature of decision-making processes generally vary among countries. Even when formally documented procedures are in place it is impossible to generalize how and when different methods are most appropriate. In general, methods such as CBA seem to be less controversial and are commonly applied when financial costs and benefits are relatively clear and when social impacts are relatively small. There seems to be a need to include decision-making tools that are more consensual and participation-oriented, in particular when external costs have significant social consequences, when they are captured by traditional knowledge that is not widely available, and/or when the local socio-cultural systems pose a serious limitation to valuation based solely on economic terms. The combination of different decision making tools may be useful. Mirroring the research progress made in developing reliable tools and methodologies, valuation studies in many countries play an increasing role in contemporary environmental policies as they provide additional knowledge to support better decision-making.
7. Further Tools used in Integrated Assessments

Key points

- A range of tools and techniques can be used to provide information to decision-makers on actual impacts of trade policy.
- Tools include Computable General Equilibrium (CGE) and partial equilibrium economic models, Cross Impact Matrix (CIM), Root Cause Analysis (RCA), Causal Chain Analysis (CCA), Stakeholder Analysis and Mapping (SAM), Poverty and Social Impact Analysis (PSIA), gender analysis, Strategic Environmental Assessment (SEA) and scenario building.

The process for Integrated Assessment is constantly evolving as existing tools and techniques are refined and new tools are developed. As a result, a large body of literature has been produced, which outlines and compares the relevant tools and methods. A set of the different tools which might be considered by those undertaking an assessment is provided in the table 7.1 below, including the tools discussed in chapter 6.

It is generally advisable to select the simplest tools that will provide the necessary information for assessment. In most cases, a combination of quantitative and qualitative analysis, consultations and expert judgement will be appropriate. When selecting a tool, consideration should be given to the following questions:

- Are the data available that the tool requires?
- Can the tool deal with the uncertainties in the dataset?
- Is the tool fit-for-purpose?
- Is the tool acceptable by decision-makers and stakeholders involved in the assessment process?
- Is the tool complementary to other tools already used in the assessment process?
- Is the tool applicable? That is, does the assessment team have experience or access to someone with experience in using the tool selected?
- What are the costs and time required to use the tool?
- Will the tool contribute to the transparency of the process and the outputs of the Integrated Assessment?
### Table 7.1 Examples of different tools that may be used to assist in carrying out an Integrated Assessment

<table>
<thead>
<tr>
<th>Tool</th>
<th>Purpose</th>
<th>Main advantages</th>
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<tr>
<td><strong>QUANTITATIVE ANALYTICAL TOOLS</strong></td>
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<tr>
<td>CGE and PE economic models</td>
<td>General equilibrium and partial economic models may be used to give quantitative estimates of the increase or decrease in agricultural production in a given country that would result from a reduction of import tariffs, subsidies or other trade barriers. This enables quantitative estimates to be made of potential changes in land use and other impacts on biodiversity.</td>
<td>Enables quantitative estimates of the magnitude of biodiversity impacts resulting from a trade agreement or other change in trade policy. The results of many modelling studies of proposed trade agreements are available in the literature.</td>
<td>Applicable only to tariff changes, subsidies and a limited number of other trade measures. Cannot reliably model dynamic effects.</td>
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<tr>
<td>Cost-Benefit Analysis (CBA)</td>
<td>CBA estimates and compares the equivalent monetary value of the total benefits and costs associated with a project. It aims to enable a decision maker to determine whether the project is worthwhile. Including environmental and social costs and benefits requiring special valuation techniques.</td>
<td>Relatively easy to undertake and little interpretation of the results necessary.</td>
<td>Facing difficulties in the valuation of environmental and social impacts and uncertainties associated with discounting over future generations.</td>
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<tr>
<td>Cross Impact Matrix (CIM)</td>
<td>CIM creates and assesses different scenarios for the development of a policy, taking into account multiple factors. It aims to reveal the likelihood of an event given that various events have or have not occurred.</td>
<td>Multiple events and trends can be thought and analysed together, allowing for the identification of enhancing and inhibiting developments and policies. It is based on expert consensus.</td>
<td>Relatively demanding in terms of data, time, and human resource requirements.</td>
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<tr>
<td>Regression Analysis (RA)</td>
<td>RA identifies the relationship between two or more factors (or variables) and how this relationship can be characterized. It aims to enable a decision maker to take necessary actions in order to effect desired changes.</td>
<td>Widely accepted, can be done relatively cheaply with easy to use software like MS Excel or SPSS, and results are instantaneously available. Is used more for ex-post analysis, but it can diagnose past experiences and then inform ex-ante analysis.</td>
<td>Requires knowledge in econometrics and statistical treatment of data. Data have to fulfil certain conditions to allow the application. Quantification of qualitative aspects tends to reduce the multidimensionality of the qualitative phenomenon. Correlation is not causation.</td>
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<td>Tool</td>
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<td>Causal Chain Analysis (CCA)</td>
<td>CCA identifies significant cause-effect links between a proposal and its economic, social, and environmental outcomes in a qualitative manner. It aims to enable a decision maker to consider the chain of effects that may be triggered by his or her decision. It can be used at the assessment stage.</td>
<td>CCA is flexible with respect to depth and scope of analysis and thus can meet the varying analytical needs.</td>
<td>There is a danger of drawing cause-effect links that are not well-grounded, and of overloading the analysis with potentially negligible factors.</td>
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<tr>
<td>Multi-criteria analysis (MCA)</td>
<td>MCA evaluates alternative options against several, often conflicting, criteria, and combine the separate evaluations into one overall evaluation. It can be used to identify a single most preferred option, to rank options, to short-list a limited number of options for subsequent detailed appraisal, or simply to distinguish acceptable and unacceptable options.</td>
<td>MCA takes into account different criteria at the same time, which is impossible with the usual decision making process based on only one criterion.</td>
<td>By presenting quantitative information (aggregated scores), it may create a false impression of accuracy even though application of MCA heavily depends on value judgements; disputed MCA may direct public discourse on the proposal towards ineffective discussions on how weights of criteria were established and how performance of each option against these criteria was measured; does not facilitate consensus on very controversial decisions; and results may be manipulated by those who master the techniques.</td>
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<tr>
<td>Objective-led appraisal (OLA)</td>
<td>OLA evaluates consistency of a proposed policy or project with its proclaimed objectives. OLA is an appraisal method that aims to ensure that relevant objectives (in the case of IAP those would be sustainable development objectives) are considered at all stages of the policy process. It can be used when the objectives of the target for assessment are questioned, when alternatives are compared against established objectives, and when specific actions are evaluated.</td>
<td>OLA enables early reviews and an early opportunity for discussing objectives. OLA also breaks consultations into more easily manageable separate discussions on proposed objectives and implementation arrangements.</td>
<td>Quality may be significantly limited by ill-defined objectives; poorly defined objectives, if directly used as the main reference points for the appraisal, will generate poor or misleading results; and OLA offers only a preliminary analysis, which does not capture all the specific effects of proposed actions.</td>
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<td>Root Cause Analysis (RCA)</td>
<td>RCA is a structured investigation that aims to identify the true causes of a problem, and the options or actions necessary to eliminate it. It is often considered an academic exercise, as it does not directly lead to solutions. However, knowing the root causes and the actors involved is an essential starting point for designing sustainable solution strategies.</td>
<td>Simple, and yet provides important insight and can be used simultaneously to raise awareness and involve stakeholders.</td>
<td>May become an academic exercise as the list of possible root causes is potentially very long.</td>
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<tr>
<td>Stakeholder Analysis and Mapping (SAM)</td>
<td>Stakeholders are individuals, groups or institutions with specific rights and interests in an issue or sector, and related powers, knowledge, and skills. SAM identifies and analyses stakeholders to enable decisions on who to involve in addressing particular issues. It can be used when key stakeholders need to be identified. It is also an essential input to gender analysis and poverty analysis.</td>
<td>SAM is a well-established approach and is frequently used. Various tools and schemes exist for portraying the results of a stakeholder analysis in a visible and simple manner and one can get good preliminary insights with limited time.</td>
<td>Every classification of stakeholder may be criticised, there is no perfect fit; conflicting interests and power relations may be too sensitive to assess or discuss; one can easily spend too much time on SAM; SAM does not provide any solutions and more detailed information requires social or cultural expertise.</td>
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<tr>
<td>Sustainability Framework and Benchmarks (SFB)</td>
<td>Sustainability frameworks present indicators and benchmarks to enable measuring of sustainability performance and assessing impacts of projects and policies against a reference framework. To be practical, general sustainability principles must be translated into concrete indicators and benchmarks.</td>
<td>Sustainability frameworks are one way of putting sustainability into practice and designing a sustainability framework through a participatory process that enhances awareness.</td>
<td>The focus is on quantitative measurements, while some sustainability issues are difficult to measure.</td>
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<tr>
<td>Analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT Analysis)</td>
<td>SWOT aims to raise key issues for consideration in assessing the current situation. It can be used in the Integrated Assessment preparation stage when contextual information is provided.</td>
<td>SWOT reduces a large quantity into a simple overview of key issues that could be considered during an Integrated Assessment and is a useful tool for obtaining various viewpoints on the current situation and can be used in participatory processes.</td>
<td>There is a tendency for SWOT to oversimplify issues. SWOT also does not explain why strengths and weaknesses occur and whether there are any linkages between them. Classification of external factors as opportunities or threats is somewhat arbitrary - the same point may feature both as strength and as a weakness. For example, ’increased exports’ may be presented as a strength and ‘reliance on exports’ as a weakness.</td>
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## Further Tools used in Integrated Assessments

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<tr>
<td>Trend Analysis</td>
<td>Trend analysis is a basic requirement for any assessment or planning exercise. It is “an analysis of the variation in data or values over time, with the major purpose of extracting relevant information about changes in time, and where possible expressing this quantitatively”.</td>
<td>Trend analysis can be used in a simple and qualitative manner; trend lines can be a powerful awareness-raising tool; trend analysis can structure a large set of available data and information; and trend analysis can raise awareness on the need for proper monitoring.</td>
<td>Extrapolation and forecasting of trend lines are not always reliable, statistical analyses are tedious, yet necessary in many cases to draw firm conclusions; trend lines are often established based on poor data sets, without mentioning the uncertainties involved; the variable methods used to collect data are a major problem in establishing trends and expert judgements on trends should be backed by quantitative data, because human memory is unreliable.</td>
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<tr>
<td>Expert Panel (EP)</td>
<td>EP is a form of organizing expert opinions. It aims to synthesize complex information and provide a vision or recommendations for future possibilities for the topic(s) under analysis.</td>
<td>Relatively easy to organize (low cost and time requirements).</td>
<td>Result dependent on composition of EP and availability of relevant experts.</td>
</tr>
<tr>
<td>Focus Groups</td>
<td>A focus group is a form of organizing a planned discussion among a small group (4-12 persons) of stakeholders facilitated by a moderator. It aims to obtain information about a range of preferences and values pertaining to a defined topic by observing the structured discussion of an interactive group in a permissive environment.</td>
<td>Relatively simple and easy to organize.</td>
<td>The multiple voices of the participants and the flexibility may result in limited control over the focus group process. Sometimes group expression can interfere with individual expression and the results may reflect “groupthink”.</td>
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<tr>
<td>Household Surveys</td>
<td>A survey generates detailed information. The purpose is to enable investigating and describing a topic of interest. It can be used when basic qualitative data and information needs to be gathered.</td>
<td>Stakeholder participation with detailed analysis of an issue and the opportunity to gather data in a structured manner on complex and sensitive topics, including opinions and feeling.</td>
<td>Data needs to be compiled and analysed to find entry into the decision-making process; interview-based surveys require a great deal of time and depending on circumstances can be costly; and results of the survey depend on the selection of the sample and the willingness of participants to cooperate.</td>
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<tr>
<td>Tool</td>
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<td><strong>Gender Analysis</strong></td>
<td>Gender analysis considers the relationships between men and women, their access to resources, their roles and activities, and the constraints they face. It reveals the different patterns of involvement and activities that women and men have in economic, social and legal structures. The aim is to enable decision makers to understand the different effects that public projects, programmes, policies may have on men and women because of their different situations. It can also be used in the assessment stage to evaluate the gender effects of various options and make recommendations that integrate gender issues.</td>
<td>Gender analysis is practical and can be done in a participatory manner. A distinction is made between access to and control over resources and can be easily adapted to a variety of settings and situations.</td>
<td>Some gender issues may be highly sensitive and there is a risk of oversimplification based on a superficial ‘tick-the-boxes’ approach to data collection. Results may also give a rather static picture without reference to changes in gender relations.</td>
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<tr>
<td><strong>Health Assessment (HA)</strong></td>
<td>HA is an approach (not a tool per se) to assess the linkages between the environment and health. HA aims to enable decision makers to arrive at decisions based on comprehensive knowledge about health issues.</td>
<td>HA is highly participatory and has a strong focus on process.</td>
<td>HA can be costly and take a long time to implement.</td>
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<tr>
<td><strong>Poverty Measurement and Analysis</strong></td>
<td>Poverty measurement is the first step for any decision-maker who seriously wants to reduce poverty. Data can then be used by decision-makers to know what the situation is, to understand the factors determining the situation, to design interventions best adapted to the issues, to assess proposed policies against poverty impacts, and to set a baseline and measure change.</td>
<td>An essential tool to gain insight on basic social and economic conditions; is easy to do in a participatory manner; both quantitative and qualitative methods are available; and there is a large amount of experience and literature available.</td>
<td>Data from household surveys form the basis of poverty analysis, but are time consuming to collect and generate unreliable data if not undertaken with great care; and concepts like vulnerability are difficult to measure.</td>
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8. Policy Responses

Key points

- Policy responses at the national level can help countries mitigate negative impacts or capture the positive impacts trade policies may have on biodiversity and ecosystem services.
- Policy responses may be classified as either trade or non-trade related. It is recommended that a policy response should reflect understanding of: important values of biodiversity, including ecosystem services, ownership of biodiversity and genetic resources that might be affected, protection of traditional knowledge, the ecosystem approach and the integration of biodiversity into economic sectors.
- Capacity building is an essential component of developing policy responses. It also contributes to economic growth and poverty reduction.

8.1 Possible policy responses

This chapter outlines policy responses that might be made at the national level to help mitigate any negative impacts on biodiversity from trade policies in the agricultural sector or to achieve positive outcomes. It distinguishes between trade and non-trade related responses and between economic, legal and institutional, and technological responses. A range of instruments is available to address trade impacts on biodiversity in the agricultural sector. Most of these are market-based instruments, as opposed to command-and-control measures. Several of the market-based instruments are dependent on the valuation of ecosystem services and on the internalisation of environmental externalities, which takes environmental (and social) costs into account when pricing products.

Most legal and institutional responses to trade impacts on biodiversity in the agricultural sector involve the application of international instruments, the establishment of national legal and policy frameworks (such as strategic and environmental impact assessment), issues of governance and enforcement, stakeholder rights and participation, transparency and decentralization. Technological responses include those that apply technologies and techniques as opposed to economic instruments or legal mechanisms for responding to impacts of trade-related policies on biodiversity. While technological responses (such as farming practices) will be implemented mainly at the local level, some might be applied rather at the national level aimed at stakeholders such as farmers and consumers. Technological responses require supportive economic and legal policy frameworks at the national or international level.
The distinction between economic, legal and institutional, and technological policies is not always clear and a response can fall under more than one heading. In addition, the different response types are often closely linked and should be applied jointly. The success of a technological response, for example, will depend on a favourable economic and legal policy framework.

There are five key approaches that should be considered in order to make sure that biodiversity considerations are effectively addressed in the policy responses:

**Valuation of ecosystem services.** It has increasingly been recognised that biodiversity provides significant ecosystem services including the provision of food, fresh water and fuel; climate, flood and disease regulation; nutrient cycling; and primary production. To a large extent, these ecosystem services have not been valued and their use has often been regarded as free. Placing an economic value on these services provides an incentive to protect them from degradation and makes them compete with economic goods.14

**Ownership over biodiversity and genetic resources.** Securing biodiversity values requires ownership over natural resources. It is only when communities and local biodiversity managers participate in decision-making affecting the resources they are involved with, that they become stewards of the resources. Equal participation of local communities, indigenous groups and local managers helps secure the success of policies responding to the trade-related impacts on biodiversity. This is particularly true for genetic resources affected by trade-related policies.

**Protection of traditional knowledge.** Local and/or indigenous communities’ traditional knowledge of natural resources has proven to be very effective in understanding and conserving ecosystem services. Together with ecosystems and genetic resources, traditional knowledge in itself is being eroded. Its protection is essential and relevant to supporting the outcome of policy activities for biodiversity conservation in the agricultural sector. The protection of traditional knowledge provides an opportunity to give local communities a stake in the outcomes.

**Ecosystem approach.** The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems. The CBD has adopted the ecosystem approach, containing 12 principles and operational guidance for the application of the approach (Box 8.1).

**Integration of biodiversity into economic sectors.** There is a danger that responses to the impacts of trade-related policies on biodiversity fail to reach beyond the biodiversity sector. The responses should include all sectors that have an impact on biodiversity and through which trade-related policies are affected, in particular economic sectors. Integration of the conservation and sustainable use of biodiversity into relevant sectoral or cross-sectoral plans, programmes and policies is a requirement for Parties to the CBD (Article 6b).

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14 See Chapter 6 for further details on valuation methods.
8.2 Trade-related policy responses

8.2.1 Economic Responses

*Subsidies, taxes and financial incentives.* Subsidies, taxes and financial incentives have a long history in the management of natural resources. Often, they have supported policies detrimental to biodiversity (perverse incentives). Over US $300 billion are paid annually in the OECD countries in the form of subsidies to the agricultural sector. This has resulted not only in overproduction, threatening the agricultural sector in developing countries, but also leads to an overuse of fertilizers and pesticides. However, increasingly, subsidies and incentives have been recognised as tools for giving value to natural resources and supporting their accession to markets. Damaging subsidies in the agricultural sector (such as those on pesticide use) could be removed, while positive subsidies (such as subsidies on products produced in an environmentally-friendly way) could help offset the negative environmental impacts of expanded agricultural production due to trade liberalization.

Tax policies may include the following:
- environmental taxes to promote pricing that takes account of the social and environmental costs of an action, the externality, as well as the private costs;
Incentives might include, *inter alia*, payments for ecosystem services and compensation for environmentally-friendly measures. They include the creation of alternative incomes through financing of projects that enable local communities to conserve biodiversity by finding markets for goods produced from the sustainable use of biological resources (Box 8.2). In particular, incentives might favour the reduction of biodiversity-damaging pesticide and fertilizer applications and the protection of vulnerable and ecologically significant lands from being converted to agricultural fields or pastures.

**Box 8.2 BioTrade Initiative**

*Biotrade* refers to those activities of collection, production, transformation, and commercialisation of goods and services derived from native biodiversity under the criteria of environmental, social and economic sustainability. Since its launch in 1996, the *UNCTAD BioTrade Initiative* has been promoting sustainable biotrade in support of the objectives of the CBD. Its mission is to stimulate trade and investment in biological resources to further sustainable development in line with the objectives of the CBD.

The BioTrade Initiative has established a number of *partnerships* with national and regional organisations to set up programmes that enhance the capability of developing countries to produce value-added products and services derived from biodiversity, for both domestic and international markets. *Regional BioTrade Programmes* currently supported by UNCTAD include the Amazon BioTrade Programme and the Andean BioTrade Programme. *National BioTrade Programmes* have been created in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Peru, Uganda and Venezuela. Since 2003, the BioTrade Initiative has also hosted the *BioTrade Facilitation Programme* (BTFP), which focuses on enhancing sustainable bio-resources management, product development, value adding processing and marketing.

The BioTrade Initiative and the BTFP have adopted a set of *biotrade principles* regarding products and services:

- Conservation of biodiversity.
- Sustainable use of biodiversity.
- Equitable sharing of benefits derived from the use of biodiversity.
- Socio-economic sustainability (management, production and markets).
- Compliance with national and international legislation and agreements.
- Respect for the rights of actors involved in BioTrade activities.
- Clarity about land tenure, use and access to natural resources and knowledge.

For further information see [www.biotrade.org](http://www.biotrade.org)

**Certification schemes.** Certification of environmentally-friendly produced goods from natural resources has become a major tool for addressing biodiversity loss in agricultural landscapes. This ranges from organic products to those derived from nature-friendly production methods such as low-intensity farming and protection of natural areas within agricultural landscapes.

**Direct payments.** Direct payments to farmers could support the retention or set-aside of land for conservation purposes such as the restoration of vulnerable habitats or the recovery of threatened species. Such payments are an important part of agri-environmental schemes (see Section 8.3 Non-trade policy responses).
8.2.2 Legal and institutional responses

Applying international mechanisms/instruments/agreements. Various international agreements can help shape policy responses at the national level. This applies to trade agreements, such as the agreements under the WTO, but also to biodiversity-related agreements. The CBD, with its three objectives of biodiversity conservation, sustainable use, and fair sharing of benefits arising from the use of genetic resources, has developed a range of instruments such as work programmes and guidelines. The CBD’s Programme of Work on Agricultural Biodiversity includes the identification of appropriate marketing and trade policies, legal and economic measures which may support beneficial agricultural practices, at international and national levels, in close collaboration with relevant international organizations.

Laws, regulations and policies. Legal systems form a key part of policy responses. They might consist of laws and regulations that are legally-binding, but ‘soft law’ such as guidelines, codes of conduct and policy frameworks play an important role as well and might in many cases be more appropriate than legally-binding instruments. Customary systems, for example indigenous peoples, which are often powerful tools at the local level, should be fully recognized as part of the policy set addressing trade and biodiversity. These systems might, for example, secure the application of local and traditional knowledge on biodiversity. At the national level, the development of legal frameworks for access and benefit-sharing related to the use of genetic resources has been encouraged by the CBD. Those regimes could become significant tools for addressing the trade-related impacts on biodiversity in the agricultural sector.

8.3 Policy responses that are not trade-related

8.3.1 Economic responses

Property rights. Trade liberalization may impose adverse impacts on local people or resources where the individual or collective property rights are weak or not sufficiently recognized. An important strand of offsetting instruments includes those that either recognize such rights in law, and create or strengthen institutions that may help enforce such rights (Box 8.3). In many cases around the world, when the local community is involved in biodiversity protection, it is most successful when appropriate property rights systems are in place. It has been found that property rights are closely linked to local communities gaining the benefits of biodiversity conservation and hence the incentives to protect the biodiversity (MA 2005). Where weak property rights exist, the community’s involvement in the protection of biodiversity is undermined as they are unable to restrict external access to local resources and there is little incentive to adopt long term strategies to manage these resources leading to short term and opportunistic decision-making (MA 2005).

Box 8.3 Property rights: a policy response for Bangladesh’s shrimp farming industry

Land use rights favouring local people are one of the pre-requisites for sustainable shrimp culture activity. At present, khas government lands are leased out to the shrimp cultivators on flexible terms, leading to inefficient use of land. Expanded programmes in land registration and titling are needed to clarify property rights. Adequate compensation for those people who lose lands to shrimp cultivation should be ensured. The government can introduce a minimum cost for per-unit leasing of agricultural land for shrimp farming. Securing property rights will reduce institutional constraints that prevent ‘buy-outs’ or prevent the mixing of shrimp and rice farming activities. Strengthening of security rights may also be attractive for equity reasons.

8.3.2 Legal and institutional responses

*Increased international cooperation.* Establishing systems of international cooperation can be a very useful tool for exchanging information on experiences and good practices. Those systems can be informal and could be facilitated through regional organizations, such as the UNEP Regional Offices. They might also be established in the framework of regional or global agreements, such as the CBD. In any case, if there is a need, countries should invite organizations, mechanisms or agreements to support the setting up of systems of international cooperation.

*Increased coordination between multilateral environmental agreements and other international policy frameworks.* Lack of coordination between multilateral environmental agreements and other policy frameworks, including those on trade and development has been widely recognized as a stumbling block to successful implementation of international obligations. This coordination is needed at the international level, where governing bodies of agreements need to mandate convention bodies such as secretariats and subsidiary bodies to enhance cooperation. However, coordination is also required at the national level. Ministries, agencies and focal points for different instruments should establish systems of regular communication, with a view to informing each other on significant developments in the respective sectors and to agree on positions that are taken forward to the governing bodies of agreements and other mechanisms.

*Governance.* Governance approaches to address the impacts on biodiversity of trade-related policies in the agricultural sector may be a key part of response options. The ecosystem approach recommends the decentralization of management to the lowest appropriate level, leading to greater efficiency, effectiveness and equity. Such management practices, however, need to be enhanced and protected by national laws and national and sub-national policies. Institutions should be strengthened at all levels, providing for authority and stakeholder involvement at lower levels. A particularly important aspect of governance is the provision of secure tenure rights to indigenous and local stakeholders. This can enable communities to sustainably use the natural resources and thus become responsible players in the field of agricultural biodiversity.

*Agri-environment schemes.* Agri-environment schemes, supporting the conservation and sustainable use of agricultural biodiversity, are able to contribute to internalise positive external effects of agricultural production on biodiversity (Box 8.4). This provides agri-environment schemes with an advantage compared with other types of domestic support measures in the agricultural sector. Those schemes would benefit from a number of features:

- Specifying clear environmental objectives for the programmes
- Clarifying underlying property rights
- Ensuring transparency in designing and implementing agri-environmental programmes
- Ensuring technical efficiency of the instrument in achieving the objective
- Monitoring and evaluating programmes based on valid scientific research
- Probing for less trade-distorting alternatives as an integral part of the process to design and implement agri-environmental measures.
Box 8.4 Environmental Stewardship in England (United Kingdom)

Environmental Stewardship is a new agri-environment scheme within the framework of the national implementation of the CAP in the EU. It provides funding to farmers and other land managers in England (United Kingdom) who deliver effective environmental management on their land. Its primary objectives are to:

- Conserve wildlife (biodiversity);
- Maintain and enhance landscape quality and character;
- Protect the historic environment and natural resources;
- Promote public access and understanding of the countryside; and,
- Protect natural resources.

Within the primary objectives it also has the secondary objectives of:

- Genetic conservation; and,
- Flood management.

Environmental Stewardship has three elements: Entry Level Stewardship, Organic Entry Level Stewardship, and Higher Level Stewardship. The Entry Level Stewardship is the most important element for biodiversity and has the following features:

- Open to all farmers and landowners;
- Simple and effective land management;
- The aim is to encourage a large number of farmers across a wide area of farmland to deliver simple yet effective environmental management;
- Requires a basic level of environmental management;
- Payment of £30 per hectare, per year across the whole farm (except in extensively grazed upland areas); and,
- A wide range of over 50 options to choose from (e.g. hedgerow management, stone wall maintenance, low input grassland, buffer strips, and arable options), to cover all farming types.


Strategic and environmental impact assessment. Strategic and environmental impact assessments are significant tools for steering developments associated with changes in the agricultural production induced by trade-related policies. An example is the increased transportation network, resulting from the expansion of agriculture into natural areas. Roads connecting new agricultural areas within tropical and subtropical forests have had an extremely detrimental impact on the conservation of tropical and subtropical biodiversity, through encouraging further deforestation as well as illegal exploitation of wildlife, and illegal logging. Strategic and environmental impact assessments could help to address those concerns at the general and case-specific planning stage.

Transparency and accountability in decision-making. Transparent and accountable institutions are a precondition for the successful application of legal responses. They are also key for sustainable efforts in enforcement. Transparency includes the involvement of stakeholders, the establishment of communication lines with stakeholders, and the regular provision of information to stakeholders and the wider public.

Stakeholders include farmers, local landowners and government, the private sector, non-governmental organizations and consumers. Indigenous peoples play a particular important role as they often hold land rights. Any policy response should involve those stakeholders and, to the extent possible, give them ownership.
in the process. The focus might be on enabling vulnerable and weak stakeholders, and prioritising women, who play a vital role in the agricultural sector (particularly in developing countries) (Box 8.5). Key steps to improve participatory processes include increased transparency, improving the understanding of issues by stakeholders, engaging them in the development of policy objectives and prioritisation of implementation activities, as well as providing space for deliberation and learning about multiple perspectives.

**Box 8.5 Gender and Agriculture**

A fundamental problem in decision-making and policy development in the agriculture sector is the understanding of the role of gender. In developing countries, rural women are the main producers of staple crops like rice, wheat and maize, which provide up to 90% of the food intake of the rural poor. Women also make a far greater contribution to the production of secondary crops such as legumes and vegetables. Rural women also provide most of the post-harvest labour in activities such as taking responsibility for storage, handling, stocking, processing and marketing. In the livestock sector, women feed and milk the larger animals, while raising poultry and small animals such as sheep, goats, rabbits and guinea pigs. Women are also responsible for firewood and water collection, and cooking; hence, women are the major contributors to the nutrition of the household.

Many FAO studies have demonstrated that while women in developing countries are central to the agricultural sectors, they are the last to benefit from or have been negatively affected by the prevailing economic growth and development processes and policies. Farmers are generally perceived as male by policy-makers, development planners and agricultural extension, which contributes to the persisting gender blindness. This results in women finding it more difficult compared to men to gain access to valuable resources that enhance productivity, such as land, credit, agricultural inputs, technology, extension, training and services.

Source: MA (2005)

**Addressing unsustainable consumption patterns.** Addressing unsustainable consumption patterns have long been recognized as a precondition for safeguarding the ability of ecosystems to continue the provision of services. Unsustainable consumption patterns are strong driving forces for the extension of intensive agriculture, putting further pressure on ecosystems. Consumption patterns are particularly relevant in urban populations that are disconnected from but nevertheless highly dependent on agricultural production. On a global scale, the challenge of how to address these patterns has not been well understood. At different scales, it would involve not only issues of educating the public and to raise awareness about the power of consumer choice. Solutions involve a range of economic, legal and technological tools as outlined above and in the next section.

**8.3.3 Technological responses**

**Farming practices.** Favourable farming practices and ‘eco-agriculture’ (Box 8.6) include the reduction of biodiversity-damaging pesticide and fertilizer application and the protection of vulnerable and ecologically significant lands from being taken into agricultural production. Those measures cannot be taken by individual farmers, however, as they depend on economic frameworks, in particular on favourable incentives. Those incentives may also allow the retention of traditional biodiversity-friendly farming with low inputs of fertilizers and pesticides. Without supporting measures, traditional farming in many countries is not able to compete with intensive high-technology farming. Payments to farmers to encourage environmentally-friendly practices, as widely applied within the European Union, help to offset negative impacts of agricultural practices on biodiversity.
Box 8.6 Eco-agriculture

‘Eco-agriculture’ is a term coined in 2000 to convey a vision of rural communities managing their resources to jointly achieve three broad goals at a landscape scale - what is referred to as the ‘three pillars’ of eco-agriculture:

- Enhancing rural livelihoods;
- Protecting or enhancing biodiversity and ecosystem services; and,
- Developing more sustainable and productive agricultural systems (crops, livestock, forests, fish).

Eco-agriculture is both a conservation strategy and a rural development strategy. It recognizes agricultural producers and communities as key stewards of ecosystems and biodiversity and enables them to play those roles effectively. Eco-agriculture applies an integrated ecosystem approach to agricultural landscapes to address all three pillars, drawing on diverse elements of production and conservation management systems. Meeting the goals of eco-agriculture usually requires collaboration or coordination between diverse stakeholders who are collectively responsible for managing key components of a landscape.

Source: www.ecoagriculture.org

Promotion of sustainable intensification of agriculture. With trade liberalization, a trend towards more concentrated, modern and specialized agricultural production methods, depending on highly developed technologies, have been observed. The tendency towards improved production efficiency is not necessarily detrimental to biodiversity (Box 8.7). In order to keep areas of high significance for biodiversity off the pressure of being converted to agricultural land, the intensification of agricultural production on already existing agricultural land could be supportive. Intensification of existing production systems is a more realistic alternative for enhancing food production than undertaking further extensions. In regions where agricultural expansion takes place, the development, assessment, and diffusion of technologies that could increase the production of food per unit area sustainably, without harmful trade-offs related to excessive consumption of water or use of nutrients or pesticides, would significantly lessen pressure on biodiversity. In many cases, appropriate technologies already exist that could be applied more widely (for example precision agriculture), but countries lack the financial resources and institutional capabilities to gain and use these technologies. Again, accompanying economic and legal policies, such as incentives, could minimize the negative environmental impacts of high-intensity farming.

Box 8.7 Regenerating Native Pine Forest Habitat in Honduras through Improved Crop Technology

The central region of Honduras covers about 8,900 square kilometres, of which more than 90 percent is rugged hillside. All of it was originally forested, but today about half of the area is covered by native pine forest, with scattered deciduous forest stands. Significant deforestation occurred prior to the mid-1970s, due to over-logging and frontier agricultural settlement. Since then, commercial logging has been sharply controlled. However, conversion of forest to farmland has continued as a result of a 2.3 percent annual rural population growth rate, agricultural demand from the even faster-growing capital city nearby, and widespread erosion and nutrient depletion in steep fields used for low-value staple food crops. Forest habitat and wild populations of deer, agouti, raccoon, various squirrels (which have traditionally provided an important source of animal protein for local diets), and other native fauna and flora have declined sharply.

But a different pattern of land use has emerged in some of the region’s communities as a result of research and extension by the National Coffee Program of Honduras and the local Pan-American Agricultural School of Zamorano. In the 1980s, the Zamorano School identified many fruit and vegetable varieties suitable for local steepland conditions, and developed integrated nutrient and pest management strategies and sprinkler...
irrigation and conservation practices. The Coffee Program encouraged coffee-growing communities to intensify production of basic grains, in order to free up farmland to expand the area for shade coffee, and to replace traditional coffee with higher-yielding varieties. In the late 1980s and early 1990s, communities occupying a third of the area of the central region adopted and modified these new technologies. Higher incomes from vegetables and coffee enabled farmers to purchase fertilizers to replenish soil nutrients both in their commercial fields and in subsistence staple food crops, thus nearly doubling maize yields on permanent fields. The increases in income also allowed farmers to abandon marginal fallowed fields, which reverted to forest. Aerial photograph analysis shows that the net area under forest cover remained stable during this period in the coffee-growing communities and declined only slightly in the horticultural communities. This contrasts with a decline in the forest cover of at least 13 percent, and in some cases as high as 20 percent, in the basic grains communities. Unlike the extensive farming communities, the latter did not report a decline in wild game over the period.

Establishment of protected areas and ecological networks. In many countries, the pressures from international agricultural trade have resulted in the expansion of agriculture into areas of specific significance for biodiversity, resulting in the clearing of primary forests, the drainage of wetlands, and the conversion of natural steppes and grasslands. An important policy response to such pressure is the establishment of protected areas. A protected area is defined as an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, managed through legal or other effective means. It is important to establish effective governance and management systems for protected areas in order to ensure they withstand the pressure from surrounding areas. Increasingly, the involvement of indigenous and local communities in the establishment and management of protected areas has been recognized as a precondition for ensuring the sustained ability of those areas to deliver biodiversity and ecosystem services objectives (Box 8.8). Ecological networks could supplement protected areas. Ecological networks represent an ecologically representative and coherent mix of land and/or sea areas that may include protected areas, corridors and buffer zones, and which provides connectivity for species and ecosystems in order to achieve their satisfactory conservation status. Through the integration of areas of agricultural production, ecological networks allow for the sustainable use of natural resources.

Box 8.8 Livestock and Wildlife Coexisting In A World Heritage Site: The Ngorongoro Conservation Area, Tanzania

The grazing ecosystems that are favoured by livestock are also often those especially productive for large mammals (and their predators). The Ngorongoro Conservation Area in Tanzania is one of the few protected areas in eastern Africa. It was established explicitly to promote multiple-land use including grazing of domestic stock, which demonstrates that coexistence is not only possible, but productive. Inscribed on the World Heritage List in 1979, this vast area of 828,800 ha is contiguous to the much larger Serengeti National Park and to Maasai Mara National Park in Kenya. One of the great wildlife spectacles in the world is the annual migration of about 1.8 million wildebeest, 300,000 zebra, and 450,000 gazelles (though the actual numbers vary considerably from year to year), along with their predators (lions, hyenas and cheetahs). The Ngorongoro Crater attracted over 200,000 visitors in 2000, including 125,000 foreigners. Some farms adjacent to the site host tourists for bird-watching, while the rest of the site is shared by wildlife and livestock (cattle, sheep and goats) tended by some 40,000 Maasai herders. Pastoralism is an ancient practice in the Ngorongoro region, stretching back at least 2,000 years, though the Maasai have lived in the area for only two centuries.
Maasai settlements dot the region outside the crater, with the herdsmen actively protecting their livestock from predators. The site is specifically designed under the Ngorongoro Conservation Area Ordinance of 1959, revised in 1975, to ensure that appropriate benefits are provided to the Maasai, along with conserving wildlife populations, and promoting tourism. While permanent agriculture is discouraged, grazing is actively supported. The forested parts of the site also need to be protected to ensure permanent water flow to downstream farmers who grow high-value crops such as coffee.

To ensure that the Maasai have a voice in the management of the protected area, or understanding of its management objectives, and a platform for presenting their interests, the conservation area agency set up an extension unit and a community development department. As a result of negotiations, food security has been improved by subsidizing grain sales, veterinary services have been provided, water resources have been further developed or rehabilitated, employment by tourism agencies (including as guides for walking tours) and income from tourism has also benefited the Maasai.

A livestock marketing system, dairy industry and tsetse fly eradication programmes have been established, all of which are highly popular with the Maasai. This has greatly improved the relationship between the protected area management and the local people, who now help to control poaching, though land ownership by the Conservator of Ngorongoro remains an issue for the Maasai. Lessons learned from Ngorongoro Conservation Area on joint management of wildlife, tourists, indigenous people and domestic livestock are already being applied elsewhere in Tanzania, including around Selous Game Reserve and the Ruaha National Park.


Set-aside of agricultural land. Setting areas of agricultural land aside and providing compensation payments to farmers has become a common measure for reducing over-production, in particular within the EU Common Agricultural Policy. Set-aside areas are very important for biodiversity, allowing for recovery of species that have been impacted upon negatively by agricultural intensification. The extent to which set-aside perform positive impacts on biodiversity depends, however, on a number of features, including the choice of areas for set-aside, the timeframe, the ease of reversibility of the set-aside, and the extent of additional conservation management measures. In general, set-aside schemes are more effective for biodiversity conservation as part of agri-environmental schemes than purely as measures to reduce production.

Diversification of genetic resources for food and agriculture. Modern agriculture has resulted in a drastic reduction in the diversity of genetic resources for food and agriculture and the reliance on an ever-smaller number of crop varieties. That brings with it a higher risk of genetic vulnerability as the reliance on widely planted mono-crops, susceptible to pests, pathogens or environmental hazards, is in danger of facing widespread crop losses. Encouraging a wider use of genetic varieties of crops is therefore an important response that needs to be supported by incentives and appropriate legal measures (Box 8.9).
Box 8.9 Agricultural Gene Sanctuaries Protect Wild Biodiversity in Turkey

Agriculture was born over 10,000 years ago in the Fertile Crescent, which encompasses modern-day southeastern Anatolia, the Asian part of Turkey. Today, more than 8,700 species of vascular plants are found in Turkey, about 30 percent endemic. In the early 1990s, a project funded under the auspices of the Global Environment Facility (GEF) was established to conserve plant genetic resources in their natural habitats, that is, in situ. In situ conservation maintains interactions between plants and their natural pests, predators, and environmental conditions, and is thus crucial to efforts to provide resistance to new pest and pathogen mutations as they arise. The GEF project in Turkey was the first of its kind in the world to protect multiple wild crop relatives – both woody and non-woody – using an integrated, multi-species, multi-site approach.

A key feature of the project was the establishment of Gene Management Zones (GMZs) based on ecogeographic surveys and inventories of state-owned land. Protected areas with specific management requirements adapted to individual plant species and environmental conditions, GMZs serve as reserves for one or more endangered or economically important plant species, and are large enough to encompass considerable genetic variation within populations. The GMZ concept was first used in California in the 1960s, but is a new concept to most of the rest of the world. Based on findings on genetic diversity, project planners designated 22 GMZs. Kazdagi National Park was home to 10 GMZs covering five target species, including wild plum, chestnut, Turkey red pine, Anatolian black pine, and Kazdagi fir. Seven GMZs were designated at Ceylanpinar State Farm, containing five species of wild wheat relatives. The Bolkar Mountains contained five GMZs covering Anatolian black pine, Turkey red pine, two types of Taurus fir, and Taurus cedar.

A vital element of GMZ management is local community participation, which preserves local people’s access to the GMZ and enables them to practice traditional activities important to local livelihoods. Grazing in many cases can continue with some modifications. During some parts of the year, grazing animals actually enhance a GMZ’s desired vegetation pattern by shattering the seed and trampling it into the soil for germination the following year (‘natural seeding’). Similarly, the local practice of harvesting chestnuts was incorporated into the management plan for the GMZs for this target species. Lessons learned in this project are informing the development of a large GEF biodiversity project in Turkey and other projects elsewhere.


8.4 Capacity building

Capacity building, training and communication, education and public awareness should all be considered when developing policy responses, which are also key components for economic growth and poverty reduction.

The development of capacity of actors and stakeholders supports their effective involvement as well as effective decision-making. Activities addressing the trade-related impacts on biodiversity in the agricultural sector will be more successful if those involved have an improved capacity for participation. Capacity building is much more than training and includes:

- human resource development, the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively;
- organizational development, the elaboration of management structures, processes and procedures, not only within organizations but also the management of relationships between the different organizations and sectors (public, private and community); and
- institutional and legal framework development, making legal and regulatory changes to enable organizations, institutions and agencies at all levels and in all sectors to enhance their capacities.
Further information about capacity building and policy responses can be found in UNEP’s 2005 *Handbook on Integrated Assessment of Trade-related Measures: The Agriculture Sector*.

**Training.** Training is related to stakeholder participation and capacity development. It can provide actors at all levels with improved understanding of the issue, experience in dealing with challenging situations and willingness to take up the tasks needed. Training can take various forms and can include, inter alia, one-off efforts, regular workshops and seminars and interactive electronic courses.

**Communication, education and public awareness.** Communication, education and public awareness are significant components of capacity development and training, aimed at informing, educating and empowering stakeholders involved in policy responses. Stakeholders learn not only about the background of the issue, but also about implications of their own choices and actions. Education programmes should be built on sound science, which might involve traditional knowledge.

### 8.5 Selecting a policy response

A range of policy choices are available to policy-makers. Policy-makers should take into account the following criteria when selecting a policy response (UNEP 2001):

- **Sustainable development priorities:** Policies should address the country’s sustainable development priorities including development interests, environmental protection priorities, capacity and institutional dimensions, and the impact on poverty.

- **Regulatory consistency:** Policies should be practical and consistent with domestic and international legal regimes.

- **Policy coherence and co-ordination:** Policies should be designed to avoid duplication and be consistent with other measures proposed.

- **Level of resources:** Policies should be cost effective and should be prioritised according to urgency and the level of resources available.

- **Existing capacity:** Policy decisions should reflect the existing regulatory, institutional and financial capacities in the affected areas.

The Policy Responses volume of the MA (2005) and MA Methods Manual contain very helpful advice on selecting a policy response. This is a careful balance which necessarily involves compromise between many different needs. Often high levels of government make the final policy response; the role of analysts is to help them make the best possible decision based on the available evidence. Integrated Assessment is a strong tool for persuading policy-makers of appropriate responses in the agricultural sector.
9. **Glossary of Terms**

**Abundance:** The total number of individuals of a taxon or taxa in an area, population, or community. Relative abundance refers to the total number of individuals of one taxon compared with the total number of individuals of all other taxa in an area, volume, or community.

**Active adaptive management:** See *Adaptive management*.

**Adaptation:** Adjustment in natural or human systems to a new or changing environment. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

**Adaptive management:** A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, management is treated as a deliberate experiment for purposes of learning.

**Agro-biodiversity** (or Agricultural biodiversity): It is a sub-set of biodiversity and comprises all elements of biological diversity of relevance to food and agriculture. This includes a variety of animals, plants and micro-organisms, such as crops, livestock, weeds, forestry and fisheries. It is often divided into planned/cultivated biodiversity, associated biodiversity, additional biodiversity and wild biodiversity outside agricultural ecosystems.

**Agro-forestry systems:** Mixed systems of crops and trees providing wood, non-wood forest products, food, fuel, fodder, and shelter.

**Alien species:** Species introduced outside its normal distribution.

**Alien invasive species:** See *Invasive alien species*.

**Benefits transfer approach:** Economic valuation approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context.

**Biodiversity** (a contraction of biological diversity): The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species, and between ecosystems.

**Biodiversity regulation:** The regulation of ecosystem processes and services by the different components of biodiversity.

**Biodiversity resources:** Biodiversity resources include not just the elements of biodiversity, but also, institutions, the experts, collections, and datasets available.

**Biodiversity services:** See *Ecosystem services*.

**Biological diversity:** See *Biodiversity*. 
Biome: The largest unit of ecological classification that can be described after considering the entire planet. Terrestrial biomes are typically based on dominant vegetation structure (e.g., forest, grassland). Ecosystems within a biome function in a broadly similar way, although they may have very different species composition. For example, all forests share certain properties regarding nutrient cycling, disturbance, and biomass that are different from the properties of grasslands. Marine biomes are typically based on biogeochemical properties. The WWF biome classification is used in the Millennium Ecosystem Assessment.

Capacity building: A process of strengthening or developing human resources, institutions, organizations, or networks. Also referred to as capacity development or capacity enhancement.

Carbon sequestration: It refers to the process of removing carbon from the atmosphere and depositing it in a reservoir.

Choice experiments: Examines human behaviour in relation to changes in policy. It is an individualistic method and deems results of collective behaviour to be the result of individual actions.

Community (ecological): An assemblage of species occurring in the same space or time, often linked by biotic interactions such as competition or predation.

Community (human, local): A collection of human beings who have something in common. A local community is a fairly small group of people who share a common place of residence and a set of institutions based on this fact, but the word ‘community’ is also used to refer to larger collections of people who have something else in common (e.g., national community, donor community).

Constituents of well-being: The experiential aspects of well-being, such as health, basic material for good life, happiness, and freedom to be and do, and, more broadly, basic liberties.

Consumer surplus: The difference between the price consumers are willing to pay (or reservation price) and the actual price. If someone is willing to pay more than the actual price, their benefit in a transaction is how much they saved when they did not pay that price. For example, a person is willing to pay a tremendous amount for water for reasons of survival, but since there are competing suppliers of water he is able to purchase it for less than he is willing to pay. The difference between the two prices is the consumer surplus.

Contingent valuation: Economic valuation technique used for the valuation of non-market resources and based on a survey asking respondents how much they would be willing to pay for specific environmental services and goods, for instance for an improvement in the environment or the avoidance of environmental degradation.

Cost-benefit analysis: A technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits.

Critically endangered species: Species that face an extremely high risk of extinction in the wild. See also Threatened species.

Cultivar (a contraction of cultivated variety): A variety of a plant developed from a natural species and maintained under cultivation.

Cultivated system: Areas of landscape or seascape actively managed for the production of food, feed, fibre, or biofuels.

Cultural landscape: See Landscape.

Cultural services: The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.
Decision-maker: A person whose decisions, and the actions that follow from them, can influence a condition, process, or issue under consideration.

Deforestation: Conversion of forest to non-forest.

Degradation of an ecosystem service: For provisioning services, degradation is the decreased production of the service through changes in the area over which the services are provided, or decreased production per unit area. For regulating and supporting services, degradation is a reduction in the benefits obtained from the service, either through a change in the service or through human pressures on the service exceeding its limits. For cultural services, degradation is a change in the ecosystem features that decreases the cultural benefits provided by the ecosystem.

Degradation of ecosystems: A persistent reduction in the capacity to provide ecosystem services.

Determinants of well-being: Inputs into the production of well-being, such as food, clothing, potable water, and access to knowledge and information.

Direct use value (of ecosystems): The benefits derived from the services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting goods) and non-consumptive uses (e.g., enjoyment of scenic beauty). Agents are often physically present in an ecosystem to receive direct use value. (Compare Indirect use value.)

Discounting process: This is the process by means of assigning different weights or values to cost expected to be incurred in different future time periods.

Diversity: The variety and relative abundance of different entities in a sample.

Driver: Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.

Driver, direct: A driver that unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. (Compare Driver, indirect.) Important direct drivers in ecosystems are habitat change, overexploitation, invasive alien species, pollution, as well as climate change.

Driver, indirect: A driver that operates by altering the level or rate of change of one or more direct drivers. (Compare Driver, direct.) They indirectly have an impact on biodiversity. There are five key indirect drivers, namely population and technology change, socio-political and cultural factors, as well as changes in economic activity.

Ecosystem: A dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit. A grain of soil, a forest, a desert, a biome or the entire biosphere, for instance, could all be ecosystems.

Ecosystem approach: A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use. An ecosystem approach is based on the application of appropriate scientific methods focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

Ecosystem function: See Ecosystem process.

Ecosystem process: An intrinsic ecosystem characteristic whereby an ecosystem maintains its integrity. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

Ecosystem resilience: See Resilience.

Ecosystem resistance: See Resistance.

Ecosystem robustness: See Ecosystem stability.
Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept “ecosystem goods and services” is synonymous with ecosystem services.

Ecosystem stability (or ecosystem robustness): A description of the dynamic properties of an ecosystem. An ecosystem is considered stable or robust if it returns to its original state after a perturbation, exhibits low temporal variability, or does not change dramatically in the face of a perturbation.

Endangered species: Species that face a very high risk of extinction in the wild. See also Threatened species.

Endemic (in ecology): A species or higher taxonomic unit found only within a specific area.

Equity: Fairness of rights, distribution, and access. Depending on the context, this can refer to resources, services, or power.

Eutrophication: The increase in nutrient additions to freshwater or marine systems, which leads to increases in plant growth and often to undesirable changes in the ecosystem structure and function.

Existence value: The value that individuals place on knowing that a resource exists, even if they never use that resource (also sometimes known as conservation value or passive use value).

Exotic species: See Alien species.

Food security: As defined by the World Food Summit it is a situation “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food, and to meet their dietary needs and food preference for an active and healthy life.”

Governance: The process of regulating human behaviour in accordance with shared objectives. The term includes both governmental and non-governmental mechanisms.

Human well-being: See Well-being.

Income poverty: See Poverty.

Indicator: Information based on measured data used to represent a particular attribute, characteristic, or property of a system. “It is a statistic which, beyond its direct meaning, can be used to derive information about an underlying situation. They are particularly useful when primary data would be impossible to collect, or could only be used after a time lag. Indicators can provide a useful early indication of trends, and suggest causal relationships. Their use can reduce the amount of information that needs to be collected to monitor a situation, and may also provide a simplified way of presenting results.” (UNEP, 2001, p.20, source: OECD, “Towards sustainable development. Environmental Indicators” (1998))

Indigenous knowledge (or local knowledge): The knowledge that is unique to a given culture or society.

Indirect use value: The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. (Compare Direct use value.)

Integrated pest management: Any practices that attempt to capitalize on natural processes that reduce pest abundance and minimize the use of pesticides with a view to growing healthy crops. Sometimes used to refer to monitoring programs where farmers apply pesticides to improve economic efficiency (reducing application rates and improving profitability).

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Glossary of Terms

**Intrinsic value:** The value of someone or something in and for itself, irrespective of its utility for people.

**Invasive alien species:** An alien species whose establishment and spread modifies ecosystems, habitats, or species. Invasive alien species are considered to be one of the key direct drivers of biodiversity loss.

**Land cover:** The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Related to, but not synonymous with, land use.

**Land use:** The human use of a piece of land for a certain purpose (such as irrigated agriculture or recreation). Influenced by, but not synonymous with, land cover.

**Local knowledge:** See Indigenous knowledge.

**Marginal change:** Is often referred to as the limit producing or consuming a good at the edge of its total production/consumption.

**Market-based instruments:** Mechanisms that create a market for ecosystem services in order to improve the efficiency in the way the service is used. The term is used for mechanisms that create new markets, but also for responses such as taxes, subsidies, or regulations that affect existing markets. Market-based instruments can be used to address market failures arising from environmental externalities. They include a variety of macroeconomic and microeconomic policies, such as tax policies, subsidies, deposit refund systems, environmental funds, user fees and administrative charges, as well as monetary and credit policies.

**Mitigation:** An anthropogenic intervention to reduce negative or unsustainable uses of ecosystems or to enhance sustainable practices.

**Nutrient cycling:** The processes by which elements are extracted from their mineral, aquatic, or atmospheric sources or recycled from their organic forms, converting them to the ionic form in which biotic uptake occurs and ultimately returning them to the atmosphere, water, or soil.

**Opportunity cost:** The benefits forgone by undertaking one activity instead of another.

**Option value:** The value of preserving the option to use services in the future either by oneself (option value) or by others or heirs (bequest value). Quasi-option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values society is not currently aware of.

**Organic farming:** Crop and livestock production systems that do not make use of synthetic fertilizers, pesticides, or herbicides. May also include restrictions on the use of transgenic crops (genetically modified organisms).

**Policy failure:** A situation in which government policies create inefficiencies in the use of goods and services.

**Policy-maker:** A person with power to influence or determine policies and practices at an international, national, regional, or local level.

**Pollination:** A process in the sexual phase of reproduction in some plants caused by the transportation of pollen. In the context of ecosystem services, pollination generally refers to animal-assisted pollination, such as that done by bees, rather than wind pollination.

**Population, biological:** A group of individuals of the same species, occupying a defined area, and usually isolated to some degree from other similar groups. Populations can be relatively reproductively isolated and adapted to local environments.

**Poverty:** The pronounced deprivation of well-being. Income poverty refers to a particular formulation expressed solely in terms of per capita or household income.

**Precautionary principle:** The management concept stating that in cases “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation,” as defined in the Rio Declaration.
Precision agriculture: is an integrated information- and production-based farming system that is designed to increase long term, site-specific and whole farm production efficiency, productivity and profitability while minimizing unintended impacts on wildlife and the environment.

Property rights: The right to specific uses, perhaps including exchange in a market, of ecosystems and their services.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fibre, and fresh water.

Regulating services: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

Resilience: The level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.

Resistance: The capacity of an ecosystem to withstand the impacts of drivers without displacement from its present state.

Responses: Human actions, including policies, strategies, and interventions, to address specific issues, needs, opportunities, or problems. In the context of ecosystem management, responses may be of legal, technical, institutional, economic, and behavioural nature and may operate at various spatial and time scales.

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technology change, prices) and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a “narrative storyline.” Scenarios may include projections but are often based on additional information from other sources.

Security: Access to resources, safety, and the ability to live in a predictable and controllable environment.

Service: See Ecosystem services.

Shadow price: The opportunity cost to society of participating in some form of economic activity. It is applied in circumstances where actual prices cannot be charged, or where prices do not reflect the true scarcity value of a good.

Species: An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term species is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity, that once described and accepted is associated with a unique scientific name.

Species diversity: Biodiversity at the species level, often combining aspects of species richness, their relative abundance, and their dissimilarity.

Species richness: The number of species within a given sample, community, or area.

Strategies: See Responses.

Subsidy: Transfer of resources to an entity, which either reduces the operating costs or increases the revenues of such entity for the purpose of achieving an objective.

Subsistence: An activity in which the output is mostly for the use of the individual persons carrying it out, or their family, and which is a significant component of their livelihood.

Subspecies: A population that is distinct from, and partially reproductively isolated from, other populations of a species but that has not yet diverged sufficiently that interbreeding is impossible.
Supporting services: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Sustainable use (of an ecosystem): Human use of an ecosystem so that it may yield a continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.

Sustainability: A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Tenure: See Property rights, although also sometimes used more specifically in reference to the temporal dimensions and security of property rights.

Threatened species: Species that face a high (vulnerable species), very high (endangered species), or extremely high (critically endangered species) risk of extinction in the wild.

Threshold: A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behavior, especially at group levels, sometimes exhibits threshold effects. Thresholds at which irreversible changes occur are especially of concern to decision-makers. (Compare Non-linearity.)

Total economic value framework: A widely used framework to disaggregate the components of utilitarian value, including direct use value, indirect use value, option value, quasi-option value, and existence value.

Trade-off: Management choices that intentionally or otherwise change the type, magnitude, and relative mix of services provided by ecosystems.

Travel cost methods: Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination.

Trend: A pattern of change over time, over and above short-term fluctuations.

Uncertainty: An expression of the degree to which a future condition (e.g., of an ecosystem) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined terminology or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).

Utility: In economics, the measure of the degree of satisfaction or happiness of a person.

Valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on). See also Value.

Value: The contribution of an action or object to user-specified goals, objectives, or conditions. (Compare Valuation.)

Value systems: Norms and precepts that guide human judgment and action.

Vulnerability: Exposure to contingencies and stress, and the difficulty in coping with them. Three major dimensions of vulnerability are involved: exposure to stresses, perturbations, and shocks; the sensitivity of people, places, ecosystems, and species to the stress or perturbation, including their capacity to anticipate and cope with the stress; and the resilience of the exposed people, places, ecosystems, and species in terms of their capacity to absorb shocks and perturbations while maintaining function.
Vulnerable species: Species that face a high risk of extinction in the wild. See also Threatened species.

Watershed (also catchment basin): The land area that drains into a particular watercourse or body of water. Sometimes used to describe the dividing line of high ground between two catchment basins.

Well-being: A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience.
10. References and Resources

Global Resources

Global Environment Outlook (GEO). A participatory and regionally distributed assessment process with a strong capacity building process. A variety of publications are produced for this process and can be downloaded from: www.unep.org/geo

- Ecosystems and human well-being: Current state and trends.
- Ecosystems and human well-being: Scenarios.
- Ecosystems and human well-being: Summary for decision makers.


Agriculture Resources


References and Resources


Wood, D. and J. M. Lenne (in press) “‘Received Wisdom’ in agricultural land use policy: 10 years on from Rio.” Land Use Policy.


Assessment Resources


Impact Assessment and Project Appraisal Special Issue on biodiversity and impact assessment, Volume 23(1), March 2005.

Journal of Environmental Assessment Policy and Management (JEAPM) Special Issue on Strategic Environmental Assessment and Biodiversity, Volume 7(2), June 2005. Available at: worldscinet.com/jeapm


Treweek et al.,(2005) Principles for the Use of Strategic Environmental Assessment as a Tool for Promoting the Conservation and Sustainable Use of Biodiversity. Journal of Environmental Assessment Policy and Management. 7(2).


Stakeholder Consultation


Tools for Assessment

AIDEnviron has developed a systematic approach for analysis of root causes, which can be applied to social or environmental problems. See for guidelines and checklists: www.seanplatform.org/products/toolbox/full/Steps/Step%206.htm


Bhushan, A. Harward Analytical Framework: to collect and analyse gender data. ILO/SEAPAT. Available at: www.ilo.org/public/english/region/asro/mdtmanila/training/unit1/harvrdfw.htm


Kemp-Benedict (2003) Traveling along the Environmental Kuznets Curve, IPAT. Available at: ipat-s.kb-creative.net/Resources/IPAT-S_CaseStudy_EKC.pdf


The Role of Integrated Assessment in Trade Policy

Special Issue on Trade Impact Assessment, Impact Assessment and Project Appraisal (December 2006).

Biodiversity Resources


**Prioritisation of Biodiversity Conservation**


**Indicator Resources**


References and Resources


Livelihood/Poverty Alleviation Resources

Clayton, A. Millennium Development Goals in the Caribbean: Goal 7, ensure environmental sustainability International Advisory Group.


Trade Policy and Access to Resources


IUCN (2004) Intellectual property rights (IPRs) and regimes on access to genetic resources and benefit sharing. Trade & Policy Brief, IUCN. Available at: www.iucn.org


IUCN (2004) Ensuring that WTO and MEA rules are mutually supportive. Trade & Policy Brief, IUCN, Available at: www.iucn.org


Valuation

Anuradha, R.V. (1998) *Sharing with the Kanis: a case study from India*. Secretariat to the Convention on Biological Diversity, Fourth Meeting of the Conference of the Parties to the CBD, Bratislava, Slovakia.


References and Resources


IUCN (1998) Economic Values of Protected Areas. Guidelines for Protected Area Managers. World Commission on Protected Areas (WCPA), Best Practice Protected Area Guidelines Series No. 2.


Secretariat of the Convention on Biological Diversity (2007) An Exploration of Tools and Methodologies for Valuation of Biodiversity and Biodiversity Resources and Functions. (CBD Technical Series no. 28), Montreal, Canada.


TEEB (2008), The Economics of Ecosystems and Biodiversity, An Interim Report, European Communities, Germany.


References and Resources

Websites

Data Resources

Biodiversity Economics: www.biodiversityeconomics.org
Biodiversity Hotspots: www.biodiversityhotspots.org/xp/Hotspots
Ecosystem Valuation: www.ecosystemvaluation.org/default.htm
Environmental valuation and Cost-Benefit News: envirovaluation.org/
FAOLEX, a searchable database with MEAs and national laws and regulations on food, agriculture, and renewable natural resources: faolex.fao.org/faolex/
Global Ecoregions: www.worldwildlife.org/science/ecoregions.cfm
UN Commodity Trade Statistics Database (comtrade): unstats.un.org/unsd/comtrade/
Valuation Study Database for Environmental Change: www.beijer.kva.se/valuebase.htm

Organisations

Assessments of impacts and adaptations to climate change in multiple regions and sectors: www.aiaccproject.org
Biodiversity Economics and Valuation Network: www.bioecon.ucl.ac.uk
BioTrade: www.biotrade.org/
BirdLife International: www.birdlife.org/index.html
International Development Research Center: http://www.idrc.ca/EN/Pages/default.aspx
  Biological diversity in food and agriculture programme: www.fao.org/biodiversity
  Trade in agriculture, fisheries and forestry programme: www.fao.org/trade
International Association for Impact Assessment: www.iaia.org
Millennium Development Goals (MDGs): www.un.org/millenniumgoals
National Center for Environmental Economics: yosemite.epa.gov/EE/epa/eed.nsf/webpages/btworkshop.html
OECD: www.oecd.org
  Agri-env indicators: http://www.oecd.org/topic/0,3899,en_2649_33793_1_1_1_1_37401,00.html
UNEP Economics and Trade Branch (UNEP-ETB): www.unep.ch/etb/
UNEP World Conservation Monitoring Centre (UNEP-WCMC): www.unep-wcmc.org
World Agroforestry Centre: www.worldagroforestry.org
World Trade Organisation (WTO): www.wto.org
World Database on Protected Areas: http://www.wdpa.org/

Convention Secretariats

Convention on Biological Diversity: http://www.cbd.int/
Convention on Environmental Impact Assessment in a Transboundary Context (Espoo):
  www.unece.org/env/eia/
International Plant Protection Convention (IPPC): www.ippc.int/IPP/En/default.jsp
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar):
  www.ramsar.org/
World Heritage Convention: whc.unesco.org/
About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

> sustainable consumption and production
> the efficient use of renewable energy
> adequate management of chemicals,
> the integration of environmental costs in development policies

The Office of the Director, located in Paris, coordinates activities through:

> The International Environmental Technology Centre - IETC (Osaka), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.

> Sustainable Consumption and Production (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.

> Chemicals (Geneva), which catalyses global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.

> Energy (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.

> OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.

> Economics and Trade (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEPI DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships and implementing international conventions and agreements.

For more information, see [www.unep.fr](http://www.unep.fr)
With trade in agricultural products increasing and the world's biodiversity being lost at an alarming rate, it is vital for long-term sustainability that biodiversity considerations are included in trade discussions and policies. At the same time, agricultural expansion needs to be accompanied by proactive measures that promote the sustainable use and conservation of biodiversity. This two-volume manual provides to government officials, practitioners and analysts a framework for a comprehensive analysis of the complex issues linking trade policies, agricultural production, and biodiversity. Volume I provides a practical, step-by-step, approach to undertaking an integrated assessment of trade policy in the agricultural sector. Volume II is an accompanying reference document that explains in more detail the importance of biodiversity and ecosystem services and the complex linkages that exist between trade in the agriculture sector and biodiversity. It provides relevant information for undertaking policy assessments, including aspects related to the development of conceptual frameworks, stakeholder consultations, indicators and assessment techniques.