Resource Requirements for meeting the Aichi Biodiversity Targets in Africa

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EXECUTIVE SUMMARY

Introduction

The Aichi Biodiversity Targets for the 2011-2020 period form part of a revised and updated Strategic Plan for Biodiversity, that was adopted at the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 10). This study is one of several continental scale studies and, based on available evidence, provides a rapid assessment of the benefits of meeting the Aichi targets in Africa, the types of actions required, their costs, and ways in which to secure the benefits in the most cost effective way possible. The key findings are summarised in point form:

Benefits of delivering the Aichi targets

- The primary goal of the Aichi targets is to reduce the loss of valuable biodiversity and ecosystem services. Africa is a key area for action, as it contains a large share of the world's biodiversity but this biodiversity is disappearing at a rapid rate.
- Africa's populations are largely rural and predominantly poor, and depend heavily on provisioning services of ecosystems (e.g. forest, fish and wildlife resources) for their livelihoods. Evidence suggests that harvested natural resources typically provide more than a quarter of rural household incomes.
- Genetic resources are important for sustaining and developing agricultural activities, including aquaculture and horticulture, as well as for pharmaceuticals.
- Ecosystems provide a number of regulating services such as hydrological services, agricultural support services (pollination, control of pests), human health services (control of pathogens), climate regulation (including carbon sequestration), sediment retention, and the provision of critical areas for biodiversity (refugia, nursery areas). Estimates of values exist for most of these, but are mostly fairly preliminary, limited in geographical area and lacking in biophysical evidence.
- There are very few estimates of the cultural value of ecosystems, even though tourism is considered to be an important growth area in Africa. Nature-based tourism contributes a high portion of national income in countries such as Seychelles and Botswana where investment has focused on this sector. Degradation of ecosystems can incur significant costs for society. Examples that have been valued include outbreaks of livestock pests (blackfly) as a result of river degradation, and the loss of water and other ecosystem values as a result of invasive alien plants in the fynbos biome. Unsustainable natural resource use in Malawi costs the equivalent of 5.3% of GDP each year.
- In Africa, the biggest proximate causes of biodiversity loss are (1) the burgeoning pressures of a huge rural subsistence populations on land and resources, most of which are subject to open access, (2) the increasing and poorly managed commercial exploitation of timber and fish resources (3) the loss of land to mineral and oil exploitation and for production of palm oil and biofuels, (4) urban demands fuelling deforestation for timber, charcoal and firewood by the informal sector; (5) illegal international trade in biodiversity and biodiversity products; (6) invasive alien species (7) hydrological alteration due to water demands, (8) water pollution, (9) relatively low levels of understanding and appreciating the value of biodiversity and (10) poor governance including inadequate implementation of existing policies and legislation pertaining to biodiversity conservation and use. These problems will be further exacerbated by climate change.

- Meeting the Aichi targets is expected to increase resilience to future pressures and improve the distribution of benefits from biodiversity.
- Meeting the Aichi targets will also unlock new opportunities for development, for example through better production systems and expansion of tourism. This will support development agendas.

Types of investments and priorities for action

- The required actions for the 20 targets can be summarised into those that guide and prepare for the core actions (research, planning and increasing awareness & capacity), and those pertaining to the actual changes that need to be brought about (direct conservation action, correcting incentives and improving technology).
- Estimating and communicating the value of biodiversity and implications of current trajectories to policy and decisions makers is a critical action required in Africa, in order to strengthen the political will to meet the Aichi targets.
- As long as other strategies continue to falter, the conservation of terrestrial and marine areas in protected area systems needs to remain a core, low risk strategy for conservation, that is relatively easy to finance, for example through tourism investment.
- Along with this, substantially higher-risk investments will need to be made into promoting conservation in buffer and corridor areas. Integrated conservation and development projects (ICDPs) as a means of engendering co-operation with protected areas have mixed success.
- Restoration is often difficult and prohibitively costly, but can be worthwhile under certain circumstances, such as when the carbon or water gains generate financial returns. In particular, investments in the control of invasive alien species have been shown to have clear pay-offs, and the greater the initial investment, the better the rewards over the long term.
- While numerous facilities exist for ex-situ conservation, these are not as effective as they should be: many facilities need to be upgraded, capacity building is required, and operations need to be more co-ordinated nationally, regionally and internationally.
- Property rights, land tenure and governance issues are central to many threats to biodiversity across Africa and need to be resolved in order to develop incentives for sustainable resource use and land management. Community-based management programmes (e.g. CBNRM, CFM, LMMEs) have sound conservation and development objectives but are often fraught with problems and require ongoing support.
- Where land and resource use is practiced on a commercial scale, investment in integrated planning will be key, as well as implementation of standards and certification systems, fiscal incentive measures and strong regulation of practices. Where it is practiced on a small-scale, and property rights are secure, interventions should focus on measures to increase productivity and incomes ('land sparing'), as well as incentives such as charges and payment systems.
- Interventions to reduce the demand for overutilised resources (e.g. charcoal) and endangered species (e.g. bushmeat species, rhinoceros etc) are a very high priority, and need to be carried out on a large scale, and in the appropriate geographic locations (including urban areas and internationally).

- Performance bond and offset systems need to be established for commercial and industrial activities that encroach on habitats and threaten water quality in order to ensure no net loss.
- There is an urgent need to invest in wastewater treatment systems, but localized problems of extreme pollution caused by commercial and informal mining would be extremely costly to address and would be more likely to be driven by human health concerns. Measures to reduce pollution outputs are required on a large scale.
- The knowledge and capacity to achieve the required actions are badly lacking. Significant investments will need to be made in research and in generating the capacity required to meet and maintain the Aichi targets.
- Traditional knowledge is being lost as traditional cultures become eroded by increasing foreign cultural contact. It is thus urgent to document traditional knowledge about the characteristics, properties and behaviour of species, as well as to understand cultural practices that influence the success of policy measures.
- Africa has relied heavily on grants to address its biodiversity issues up to now, and while it should continue to capitalise on global willingness to pay for biodiversity, opportunities to develop sustainable financing mechanisms and to stimulate private sector investment in the restoration and management of ecosystems should also be seen as a priority.
- Given the lack of political will for addressing conservation, which is reflected in poor policy, legislation and enforcement in many countries, and the wide-scale problems of governance and corruption, overcoming Africa's threats to biodiversity will be an extremely challenging exercise. In general, priority investments should be those that have a broadscale impact on biodiversity and attitudes, that deliver visible benefits and that secure highly vulnerable biodiversity.
- Parallel development actions such as education will ultimately be the most important investment in Africa's biodiversity.

Resource requirements

- Estimates of spending requirements are order-of-magnitude estimates at this stage as not enough evidence could be gathered in the time available to produced detailed costings that take geographical variation into account.
- Research and development expenditure could be in the order of $17.5 million. Investments in awareness and capacity probably need to be in the order of $7-8 million per country, and about $5-10 million needs to be spent on integrated land and resource use planning per country.
- Direct protection measures such as expanding protected area systems and restoring important natural habitats may require billions of dollars at the continental scale.
- Costs of achieving sustainable land and resource use are extremely variable, ranging up to $2000 per ha.
- A recent estimate is available of actual spending on conservation by country which suggests that at least US$480 million is currently being spent in Africa as a whole. This is probably a fraction of the investment required.
- All African countries are spending considerably less than 1% of their GDP on direct conservation activities, and the majority spend less than 0.1%. Spending is by far the highest

in South Africa, but South Africa's spending represents among the lowest investments relative to GDP. The top six spenders are countries that have a high level of benefit from nature-based tourism.

- More research is required to establish what countries are spending on all the actions that contribute towards meeting the Aichi targets.

Alignment with other policy and development agendas

- There are strong synergies between biodiversity and global development agendas.
- There is a significant overlap between the Aichi targets (especially targets 4, 6 and 7) and the Millennium Development Goal (MDG7) to ensure environmental sustainability.
- In addition, the Aichi targets as a whole will make important contributions to Millennium Development Goals 1 and 6, though gains in natural capital and the flow of ecosystem services that impact on human health and livelihoods, as well as supporting economic development.
- The above synergies are not fully appreciated and the Aichi targets (particularly target 1) will guard against development agendas focusing on economic output as a means of reducing poverty without considering the role of biodiversity.
- In turn, the pre- and post-2015 development goals will facilitate meeting the Aichi Targets and will be critical to maintaining the achievements in the longer term.
- There are also very strong synergies between the Aichi targets and the UN conventions on addressing climate change and combating desertification, since both of these require addressing and reversing ecosystem degradation.

Achieving cost-effective delivery of the Aichi targets

- There is a high level of synergy between the different Aichi Targets. This means that the costs of delivering all the Aichi targets will be considerably less than the sum of the costs of delivering each in isolation.
- There is evidence that some actions will be more cost-effective than others, both at the broad level (e.g. strict protection versus incentive measures), and at the detailed level (e.g. radio broadcasts versus print media).
- Activities with the highest returns to cost are likely to be raising awareness of biodiversity values and tradeoffs, removal of harmful subsidies, strengthening protected area systems, and sustainable agriculture.
- Cost effectiveness of different actions will vary depending on geographical context and is likely to be lower in poverty-stricken, populous areas.
- Spending time on research will inform strategy and thereby increase cost-effectiveness of the next steps, but there are also trade-offs between the knowledge gained and the costs of delaying actions. Incentive measures should not be delayed where they can be adapted following further research. Protection measures should not be delayed by exhaustive planning.
- Sequencing of actions will be important in for achieving individual targets, but sequencing of addressing the Targets will not be critical in determining overall cost effectiveness, because benefits may be outweighed by the costs of delay.

- Improved governance and a better institutional and policy framework will be very important in achieving the delivery of the Aichi Targets in Africa in a cost effective manner

Overall costs and benefits

- There is little evidence as to the relative scale of the benefits and costs of investments required to meet the Targets for different initiatives, or at different geographical scales.
- The best evidence comes from the literature on restoration, in which costs of clearing invasive alien species or replanting vegetation is compared with the delivery of hydrological and carbon sequestration services.
- The net benefits of implementing sustainable use practices and expanding terrestrial and marine protected areas are generally reported to be positive.
- Because many benefits cannot really be measured in monetary terms, such as awareness of the value of biodiversity, cost-effectiveness analysis is going to be more relevant than cost-benefit analysis in many cases.

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1 INTRODUCTION

1.1 The Aichi Targets

The Aichi Biodiversity Targets for the 2011-2020 period form part of a revised and updated Strategic Plan for Biodiversity, that was adopted at the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 10), held in Aichi Prefecture in Japan. It was agreed that the new plan would be translated into national biodiversity strategies and action plans (NBSAPs) within two years, and that the fifth national reports (due in March 2014), should focus on the implementation of the 2011-2020 Strategic Plan.

A total of 20 targets were agreed by the 193 signatories to the CBD at COP 10, which are grouped under five strategic goals (Box 1).

Box 1. The Aichi Targets in brief (as summarised by UN-EMG 2013)

A. Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

1. Aware of the values of biodiversity
2. Integration of biodiversity
3. Elimination of incentives harmful to biodiversity
4. Development and/or implementation of plans for sustainable production and consumption

B. Reduce the direct pressures on biodiversity and promote sustainable use

5. Halving the rate of loss of all natural habitats
6. All fish and invertebrate stocks and aquatic plants are managed and harvested sustainably
7. Areas under agriculture, aquaculture and forestry are managed and harvested sustainably
8. Reducing pollution
9. Invasive alien species and pathways are identified and prioritized
10. (2015) minimize the anthropogenic pressures on coral reefs, and other vulnerable ecosystems

C. Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

11. Conservation of terrestrial and marine areas
12. Prevent extinction of known threatened species
13. Minimizing genetic erosion and safeguarding genetic diversity

D. Enhance the benefits to all from biodiversity and ecosystem services

14. Restoring and safeguarding ecosystems
15. Enhanced ecosystem resilience
16. Implementation of Nagoya Protocol on access to genetic resources

E. Enhance implementation through participatory planning, knowledge management and capacity building

17. Implementation of national biodiversity strategy and action plan
18. Traditional knowledge, innovations and practices of indigenous and local communities respected
19. Knowledge, the science base and technologies relating to biodiversity, improved
20. Mobilization of financial resources

1.2 Background to this study

In order to achieve these targets, significant financial investment will be required from all sectors, including government, industry and civil society. In 2010, studies were conducted to produce estimates of the levels of investment required for each of the targets at a global level. The results of these studies were reported by the Phase 1 High-Level Panel on Global Assessment of Resources for Implementing the Strategic Plan for Biodiversity 2011-2020 to COP-11. However these investments have not been considered at all scales for all targets, and the return derived from meeting the targets also requires further investigation. A Phase 2 High-Level Panel was constituted in 2013, with a mandate to assess the benefits of meeting the Aichi Biodiversity Targets- and recommend financial resources needed to achieve the targets. The work considers the range of the costs of implementing the activities needed to achieve the targets, and identifies the opportunities to most cost effectively secure such benefits through actions both within and outside the biodiversity sector.

The work of Phase 2 builds on the earlier work assessing these targets individually at a global scale, and will help the High Level Panel to:

- Develop an assessment of the benefits of meeting the Aichi targets, examining both direct biodiversity benefits and wider benefits to society that result from the investments and policy developments required.
- Assess the range of the costs of implementing the activities needed to achieve the targets, taking into account the further work proposed in the High Level Panel report to COP-11.
- Identify opportunities to secure the benefits most cost effectively through actions in both the biodiversity sector and across economies as a whole that can mobilize / make better use of resources, to deliver greatest progress towards meeting the Aichi targets.

While the previous research outlined overall programmes of investment designed to meet each of the Aichi targets globally, this research provides examples of requirements identified in different countries and initiatives that can be compared with the needs proposed in the previous global assessment. The HLP's first report found that it was difficult to quantify current allocations of resources for the delivery of the Aichi Targets or to compare them with the estimated resource requirements. This study examines evidence of allocations compared to needs within different countries to help address this question. The HLP is expected to ensure the alignment of its work with the Post-2015 UN Development Agenda and the Sustainable Development Goals. The extent that meeting the Aichi Targets contributes to these agendas also has implications for net resource requirements and funding strategies, in that synergies between the Aichi Targets and development objectives will reduce the extra resources required to deliver them, whereas managing potential conflicts between biodiversity and development goals could make the Aichi Targets more difficult and costly to deliver. The first phase report presented separate cost estimates for different Target clusters, and assumed that these actions would proceed simultaneously. However, it also noted that: (i) synergies and overlaps between Targets and with wider policy agendas mean that a more integrated approach to delivery could reduce overall resource needs, and that (ii) the sequence in which investments are made will affect the overall cost, particularly if there is an initial focus on the Targets that deliver the right enabling conditions for subsequent action. It is also likely that some investments will deliver greater biodiversity gain than others relative to the costs incurred. This

study thus investigates what strategies should be put in place in order to deliver the targets at least cost.

1.3 Key questions

The **key questions** addressed by this study are:

- What will be the benefits of delivering the Aichi targets?
- What investments need to be made to deliver the Aichi targets and to secure these benefits?
- What evidence is there of resource needs at the project and country level?
- How do the identified investment needs and the benefits they will achieve align with other policy agendas, such as the Post-2015 UN Development Agenda and the Sustainable Development Goals?
- How can the Aichi Targets be delivered at least cost, taking account of the synergies between the targets and the investments required, the sequencing of actions and the synergies with other policy agendas?
- What does the evidence as identified above tell us about the balance between the benefits and costs of meeting the Targets?

1.4 Study approach

The study was undertaken as a desk-based analysis, using available data collected from a variety of sources, including academic papers, government studies, NBSAPs, country submissions to CBD on resource requirements, regional studies (e.g. EU, ADB), TEEB country studies, international organisations (e.g. OECD, UNEP, UNDP, World Bank), international programmes (e.g. GEF), multi-country assessments (e.g. BIOFIN, WAVES, Natural Capital Project), global assessments (e.g. GBO-4), NGO assessments, international databases (e.g. EVRI), and unpublished data and reports as might be obtained through consultation with organisations and individuals identified in the course of the study. The above sources were used to compile and summarise the evidence required for the research questions, but no attempt was made to aggregate or standardise the evidence.

Actions required to meet all 20 Aichi targets were considered, but recognising that their relative importance and priority will differ between geographic areas, which will affect the strength of evidence as well as the strategies that need to be employed in meeting them. In gathering evidence, the focus was on the various actions/investments that would be required to meet the Aichi targets, whether or not they were specifically intended to meet the targets. Any types of actions/investments for which evidence could not be found was noted as a gap.

Information was collected from different sources for a variety of countries, regions and initiatives at different geographical scales as far as possible in order to address the research questions. As well as an overall review, the chapters include case studies relating to particular countries, initiatives, locations or themes.

Costs and benefits are presented in qualitative and quantitative or semi-quantitative terms as far as data allow. Emphasis is on drawing different insights at different geographical levels, examining linkages between targets and addressing gaps and issues raised in the first report, rather than the quantification and aggregation of resource needs at a global level. Nevertheless, some comparison is made between the findings of this research and the previous assessments where possible. The sources and methods of the evidence is included and emphasis is also placed on providing critical review of the robustness of the evidence provided.

1.5 Limitations

A key challenge was that research and reports were biased toward countries with more developed infrastructure, and so many countries without reports or case studies are under-represented, potentially skewing costs towards countries with monitoring/assessment capacity. Also, very little information is available on the costs of investments made, or on their effectiveness.

2 BENEFITS OF DELIVERING THE AICHI TARGETS

2.1 Key points

- The primary goal of the Aichi targets is to reduce the loss of valuable biodiversity and ecosystem services. Africa is a key area for action, as it contains a large share of the world's biodiversity but this biodiversity is disappearing at a rapid rate.
- Africa's populations are largely rural and predominantly poor, and depend heavily on provisioning services of ecosystems (e.g. forest, fish and wildlife resources) for their livelihoods. Evidence suggests that harvested natural resources typically provide more than a quarter of rural household incomes.
- Genetic resources are important for sustaining and developing agricultural activities, including aquaculture and horticulture, as well as for pharmaceuticals.
- Ecosystems provide a number of regulating services such as hydrological services, agricultural support services (pollination, control of pests), human health services (control of pathogens), climate regulation (including carbon sequestration), sediment retention, and the provision of critical areas for biodiversity (refugia, nursery areas). Estimates of values exist for most of these, but are mostly fairly preliminary, limited in geographical area and lacking in biophysical evidence.
- There are very few estimates of the cultural value of ecosystems, even though tourism is considered to be an important growth area in Africa. Nature-based tourism contributes a high portion of national income in countries such as Seychelles and Botswana where investment has focused on this sector. Degradation of ecosystems can incur significant costs for society. Examples that have been valued include outbreaks of livestock pests (blackfly) as a result of river degradation, and the loss of water and other ecosystem values as a result of invasive alien plants in the fynbos biome. Unsustainable natural resource use in Malawi costs the equivalent of 5.3% of GDP each year.
- In Africa, the biggest proximate causes of biodiversity loss are (1) the burgeoning pressures of a huge rural subsistence populations on land and resources, most of which are subject to open access, (2) the increasing and poorly managed commercial exploitation of timber and fish resources (3) the loss of land to mineral and oil exploitation and for production of palm oil and biofuels, (4) urban demands fuelling deforestation for timber, charcoal and firewood by the informal sector; (5) illegal international trade in biodiversity and biodiversity products; (6) invasive alien species (7) hydrological alteration due to water demands, (8) water pollution, (9) relatively low levels of understanding and appreciating the value of biodiversity and (10) poor governance including inadequate implementation of existing policies and legislation pertaining to biodiversity conservation and use. These problems will be further exacerbated by climate change.
- Meeting the Aichi targets is expected to increase resilience to future pressures and improve the distribution of benefits from biodiversity.
- Meeting the Aichi targets will also unlock new opportunities for development, for example through better production systems and expansion of tourism. This will support development agendas.

2.2 Africa's biodiversity and its value

Africa has a particularly large biodiversity endowment, with one sixth of the world's endemic plant species, nearly a quarter of the world's mammal species and more than a fifth of the world's bird species. It has the highest number of freshwater fish species in the world. Its 40,000 km of coastline is rich in marine biodiversity (UNEP 2006), and its islands hold extraordinary biodiversity wealth. Africa's biodiversity is not uniformly distributed, but is concentrated in key centres of diversity that cover only 1% of the Sub-Saharan land surface (UNEP 2006). These include 8 of the world's 34 biodiversity hotspots. Certain countries, such as Democratic Republic of Congo, Madagascar and South Africa are considered "megadiverse" countries which rate among the top 17 in the world, are much higher in biodiversity than others (Lee et al. 2012).

Natural systems and biodiversity provide numerous benefits to society. They support local livelihoods, often providing fall-back options for stricken families that have little access to government welfare, provide inputs into economic production, save on engineering expenses such as coastal and flood protection measures, and underpin major revenue generating activities such as tourism. At the same time they provide many intangible values to society, which manifest in the form of scientific knowledge, cultural and spiritual value. As such, biodiversity makes a major contribution to societal wellbeing, both in Africa and globally. The provisioning, regulating and cultural services provided by African ecosystems are briefly outlined below.

2.2.1 Provisioning services

Many natural resources are harvested on a commercial scale, contributing to economic outputs and foreign income. These include timber, fish, game, medicines and indigenous resources such as flowers from the fynbos vegetation of South Africa. These values are generally recorded in the national accounts. However, in addition to these, a great deal of resources are obtained from ecosystems that are not accounted for in national statistics and do not enter into decision making processes. It is these values, in particular, that need to be communicated.

Most African economies rely heavily on agriculture. In Sub-Saharan Africa, the agriculture sector accounted for 12.7% of GDP in 2009, and employed more than 60% of the labour force. Globally, agriculture's share in GDP is only 3.2%. Although the proportional output of agriculture has been declining as a result of increased outputs in the mining and services sectors, 60% of Africa's population remains largely rural. This proportion is highest in eastern Africa (76.4%), followed by central Africa (65.9%), western Africa (55.1%), northern Africa (48.8%) and southern Africa (41.3)[1].

While farming usually forms the core activity, these rural livelihoods are often highly dependent on access to a range of natural resources as a means of spreading risk and meeting household needs for food, shelter and cash income. Since many poor and vulnerable households are in remote areas and

[1] http://www.geohive.com/earth/pop_urban.aspx

lack access to services and government welfare, indigenous natural resources can provide a critical welfare function. Not all of these benefits are recorded in the national accounts, however. Much of the use of land and natural resources is of a subsistence nature, or forms part of the informal economy, which in Africa is between 25 and 50% of GDP. For example, in Mtanza-Msona Village in **Tanzania**, more than a third of households live below the poverty line, and the surrounding wetlands and woodland resources are critical to their well-being, supplying fuel, raw materials, wild foods, and providing opportunities for generating cash income. These harvested resources are worth some $107 per capita per year, or 37% of income (Kasthala et al. 2008). Similarly, in the **Democratic Republic of the Congo** (DRC), wild foods account for about a third of household production and generating twice as much cash income as crop sales (de Merode et al. 2003). In rural areas of Oyo state in **Nigeria**, one study has showed that indigenous fruits and vegetables contribute at least 25% to household income (Oladele 2011). In **Cameroon**, the **Central African Republic,** the **Republic of the Congo** and the **Democratic Republic of the Congo**, edible insects—especially caterpillars—are a main source of protein for communities living around forests. Their trade also provides income for rural people, especially women (Vantomme et al. 2004). The miombo woodlands of southern and eastern Africa provide fuelwood and other resources for approximately 100 million people (Boucher et al. 2011). In South Africa, it is has been shown that the annual value of wild edible herbs consumed in one area was $167 per household, and exceeded the opportunity cost of farm labour (Dovie et al. 2007).

About 10 million people are employed in the fisheries sector in Africa (World Bank 2009). These include major freshwater fisheries in the lakes and floodplain areas as well as those in coastal areas. For example, in **Madagascar**, many of the country's coastal areas are very poor and rely on fisheries for food security. Officially, the fisheries sector contributed US$146 million in 2011, or nearly 2% of GDP, but this is based on a gross underestimate of the full effort and catches. The current policy and legislative framework is incoherent and incomplete and is not based on a clear understanding of the true value of the country's resources. There would be significant benefits from improving the management and sustainability of Madagascar's fisheries, for which properly accounting for the value of the resource will be essential (Le Manach et al. 2013).

Agricultural activities, including aquaculture and horticulture, are also reliant on natural stocks for their continued output. Genetic resources provide the basis for the development of improved varieties and enhanced production. Genetic diversity allows farming systems to adapt to ever-changing conditions and to overcome the constraints caused by pests, diseases and abiotic stresses (Smith 2012). Indigenous species and breeds may be less productive but often fulfil a wider range of functions and are easier to manage, but this is sometimes overlooked by policy makers (Lemma 2012). For example, the Borana cattle in southern **Ethiopia** and northern **Kenya** are particularly suitable for the harsh environment in the lowlands and are part of the cultural identity of the area, but genetic erosion of this breed has become a significant problem requiring conservation action (Zander and Drucker 2008).

2.2.2 *Regulating services*

Ecosystems provide a number of services (sometimes termed 'regulating services') that either form inputs into economic production processes elsewhere or that save on expenditure. These include hydrological services (regulation of water flows, flood attenuation), agricultural support services (pollination, control of pests), human health services (control of pathogens), climate regulation (including carbon sequestration), sediment retention, water quality improvement and the provision of critical areas for biodiversity (refugia, nursery areas). These values are seldom quantified and are generally missing from national accounts.

For example, it was found that the **Nakivubu urban wetland** in **Uganda** provides up to US$1.3 million in water treatment and purification benefits annually to 100,000 local residents and nearby Kampala (Emerton et al. 1999).

The **montane forests of Kenya** produce significant benefits, but these have been unrecognised in the past. Deforestation of these areas amounted to about 50 000ha over the period 2000-2010, bringing economic benefits of approximately KSh1,362 million per year. However, by 2010, the cumulative negative effect of deforestation on the economy through reduction in regulating services was an estimated KSh3,652 million/yr, more than 2.8 times the cash revenue of deforestation. The reduction in dry-season river flows reduced agricultural output by KSh2,626 million in 2010, and lowered hydropower generation by KSh12 million (before including multiplier effects on the rest of the economy). The increased siltation and nutrients running off the degraded land reduced inland fish catches by KSh86 million and increased the cost of water treatment for potable use by KSh192 million. Incidence of malaria as a result of deforestation was estimated to have cost KSh395 million by 2010. The above-ground carbon storage value forgone through deforestation was estimated at KSh341 million in 2010 (UNEP 2012a). Taking into account interdependencies between sectors, the decrease of regulating services due to deforestation caused a total impact of KSh5.8 billion in 2010, which is 4.2 times higher than the actual cash revenue of KSh1.3 billion (UNEP 2012b; Crafford et al. 2012).

2.2.3 *Cultural services*

Ecosystems also provide **cultural services**, which are based on their various attributes including diversity, rarity and beauty. Cultural services include tourism value as well as many less tangible values that nevertheless contribute to human wellbeing.

Tourism is one of the most rapidly-growing sectors in Africa, and accounts for about 5.8% of employment in sub-Saharan Africa (WTTC 2012). Much of this tourism is nature-based, and some is species based. The Okavango Delta, virtually unknown in the 1970s, now contributes 2% to Botswana's economy (Box 2). In the **Seychelles**, marine biodiversity is the main draw for a tourism industry that is now the mainstay of the economy and accounts for a third of all government revenues (Emerton 1997). Species-based tourism is of particularly high value, examples being gorilla and shark tourism. In **South Africa**, birding tourism in is estimated to be worth $79-152 million per year and is regarded as an area for investment (even though it has among the *lowest* levels of bird diversity in Africa; Turpie et al. 2010). Much of the tourism potential of Africa's biodiversity remains

untapped. Ecotourism is thus an important development opportunity that would be threatened by biodiversity loss.

Box 2. The growing tourism value of biodiversity

The wildlife-based tourism industry is now **Botswana's** second largest income earner after diamond mining, contributing 5% of the country's Gross Domestic Product (GDP) and 40% of employment in northern Botswana. Botswana's first Tourism Policy (1990) pursued a high value/low volume tourism strategy which has been very successful in the north. Tourism in the Okavango Delta has grown dramatically since the 1970s when it was almost non-existent. Visitors stay in luxurious photographic safari camps, hunting camps or fishing camps, all of which are temporary structures. Camp owners either pay a lease (a percentage of turnover) to the local government or to the communities, as well as royalties for hunting. Overall, the Okavango Delta area is estimated to generate a gross income of some $112 million, making a direct contribution of $40 million in terms of direct value added, about 2% of GDP. An estimated 81.0% of tourism value accrues to photographic tourism companies, 15.5% to hunting safari companies, and 3.5% accrues to communities through CBNRM arrangements. (Source: Turpie et al. 2006)

2.2.4 Estimates of total economic value

A number of valuation studies have been carried out in Africa, though very few of these have been undertaken on a broad geographic scale, and many are fairly preliminary estimates that are lacking in biophysical evidence. Nevertheless they serve to provide some evidence of the value of ecosystems. A few studies have taken place at a national scale, while other focus on ecosystems, particularly forests and wetlands.

In **South Africa**, a very preliminary study was undertaken to estimate and map ecosystem services at a national scale (Turpie et al. 2008). This study suggested that that the value of biodiversity was in the order of 7% of GDP, but admitted to some aspects that were undervalued. In a more detailed study, the value of rivers, wetlands and estuaries of the three basins in the north-east of the country were estimated and mapped based on biophysical and social data collection and modelling, and were found to be worth a total of $286 million per annum (Turpie et al. 2010). Provision of water for domestic use accounted for 43% of this value, and other provisioning services for another 20%. Regulating services made up 1% of the value ($4.25 million), and cultural services accounted for 3.5% ($98.9 million). Spatial variation in the value was mapped in detail, to facilitate water resource planning in the area.

Forests provide direct use values in the form of timber, fuelwood, charcoal and other non-timber forest products such as grazing, wild foods and medicines. They provide indirect values in the form of regulating services such as hydrological services, pest control, pollination and refugia, as well as carbon sequestration and storage. They are also an integral part of the nature-based tourism experience. Several studies have attempted to estimate the total economic value of forests in Africa:

- In **Tunisia**, the Total Economic Value (TEV) of forests was estimated to be US$142 million or US$120/ha (Daly-Hassen 2013). This TEV represents 0.3% of GDP, and 20 times the value of net benefits generated by forest products sold by the state. Forage production made up 55% of the value, followed by protection against soil erosion (21%). Local populations are the

main forest beneficiaries, capturing 61% of total benefits, mainly through livestock grazing. Tunisian society captures 22% of TEV, in the form of soil and water conservation. The international community receives 12% of the TEV through carbon sequestration and biodiversity conservation. Finally, the state of Tunisia benefits from 5% of the forest benefits through sales of forest products, such as cork and wood (Daly-Hassen 2013).

- In **Kenya** a study of three of the Mau forest blocks (146 400 ha) estimated their total economic value to be US$238 million per annum ($1626.80/ha), of which direct use values accounted for 12.4% (Kipkoech et al. 2011).

Wetlands provide a wide range of ecosystem services including water quality amelioration, flood control, fisheries, tourism and coastal protection. Estimates of the economic value of wetlands across Africa reveal considerable benefits from a range of different systems:

- The Hadejia-Nguru wetlands, a floodplain in northeast **Nigeria** provides US$11 million in agricultural activities, $3.5 million in fishing and $1.6 million in fuel wood, annually (Barbier et al. 1997).
- The Okavango Delta in **Botswana** generates an estimated US$111.5 million in tourism revenues, $1.8 million in income to households from agriculture and natural resources, $1.6 million in groundwater recharge, P86 million in Carbon sequestration, $7.7 million in refuge value, $0.22 million for water purification and $1.8 million in scientific and educational value. Overall, it contributes 2.1% to the country's GNP, including direct and indirect impacts (Turpie et al. 2006).
- The **Zambezi Basin** wetlands provide over US$70 million in livestock grazing, almost US$80 million in fish production, and US$50 million in flood plain agriculture (Braat et al. 2008).
- The capacity of natural wetlands in the Western Cape, **South Africa** to remove excess nutrients was estimated to be worth US$1913 per ha per year (Turpie 2010).
- As study of the mangrove forests of Gazi Bay, **Kenya**, estimated a total economic value of US1092 per ha per year. Of this, direct use values accounted for 20%, indirect use values 25% and existence value for 55% of the total (Hoberg 2011).

Apart from forests, freshwater wetlands and estuaries, total economic valuation studies of other habitats such as coral reefs and arid ecosystems that are based on empirical data are rare.

2.2.5 Insights gained after degradation

In some cases, it is only when ecosystems become degraded that the value of maintaining them is recognised. For example, in South Africa it is estimated that invasive alien species in mountain catchment areas and riparian zones have resulted in the loss of 695 million m^3 in water yields, or 4.1% of the registered total water use, and that if not controlled, this could increase to 16.1% (Cullis et al. 2007). Another example is the impact of neglecting to provide for flow requirements in river systems in South Africa on pest populations affecting livestock production (see Box 1).

Box 3. The costs of environmental degradation

Blackfly outbreaks have developed along many **South African** rivers in the wake of dam constructions, irrigation schemes and inter-basin transfers (Nevill 1988, Myburgh and Nevill 2003, Rivers-Moore *et al.* 2008). Changing the natural flow of rivers to a more constant and perennial regime allows black-fly larvae to develop in ideal conditions throughout the year, resulting in populations reaching pest proportions in many areas (Rivers-Moore *et al.* 2008). Blackflies are disease vectors for a number of human diseases, and are themselves highly irritating due to their habit of crawling into hair, eyes, nose and mouth (Rivers-Moore *et al.* 2008). They are also carriers of livestock diseases, and can be such a nuisance to livestock that they inhibit feeding and mating, which results in production losses (Palmer *et al.* 2007). Recent work has evaluated the cost associated with black-fly outbreaks along the Orange River in the Northern Cape Province of South Africa (Palmer *et al.* 2007). In the case of the Orange River, costs were comprised not only of productivity losses and livestock (sheep) deaths, but also of tourism and labour loss, as well as the cost of the government-implemented control programme (Palmer *et al.* 2007). The costs incurred due to livestock death and loss of productivity came to $6.8 million. This means that a healthy lower order river has an estimated disease control value of R51 200/km (Turpie et al. 2012).

2.3 Threats to biodiversity

The reliance and pressures on Africa's natural systems are immense. Africa has the world's fastest growing population, with an average annual rate of increase of 2.53 % (Lee et al. 2012). Highest growth rates are experienced in West and Central Africa. Population growth is an important driver of biodiversity loss. If development does not keep pace, then bigger populations mean more land under agricultural production, and increased demand for resources such as water, fuel, timber, bushmeat and fisheries. Rapid urbanisation in Africa helps to alleviate some of these pressures, but increases the demand for resources such as charcoal and water.

The proximate threats to ecosystems and biodiversity are the same as the world over. **Habitat loss and degradation** are the most important in Africa, driven by growing populations, poor land use planning and management, and increasingly from international investments in commercial food and energy crops (Cordeiro 2007). Agriculture and harvesting result in deforestation rates averaging 0.49% per annum, and are highest in west and eastern Africa (1.12 % and 1.01 % respectively; UNEP 2012). Agriculture and timber plantations also threaten grasslands in eastern and southern Africa. Even habitats that have already been transformed are experiencing further soil degradation. Wetlands are drained for agriculture and urban development. Coastal ecosystems are threatened by development, land conversion, water abstraction and pollution, particularly in west and southern Africa (Bryant et al. 1995; UNEP 2006, Lee et al. 2012). Coral reefs are being damaged by bad fishing practices, siltation, pollution and tourism. **Hydrological alteration** for power generation and water abstraction threatens river and wetland systems throughout much of Africa, with impacts extending to coral reefs and offshore fisheries. **Overexploitation** by both commercial and subsistence users threatens a wide range of species and ecosystems, such that many stocks have declined to critical levels (Heck et al. 2007). Much exploitation is illegal, and often fuelled by international trade. Of current concern is the upsurge in demand for rhino, elephant and lion products as well as the on-going trade in many endangered primates. **Invasive alien species** are a ubiquitous problem, of particular concern in freshwater systems and on small islands, but also in some terrestrial systems, where they can have significant impacts on the supply of water, grazing and other resources, as well as on fire regimes. **Pollution** is an increasing threat to Africa's inland and coastal aquatic systems, with important ramifications for human health as well as biodiversity (Gachanja et al. 2010). Much of

this is as a result of agriculture and underinvestment in wastewater treatment. In addition to all of the above, **climate change** poses a significant threat to biodiversity, both directly through changing the conditions for survival, and indirectly through increasing poverty and reliance on natural resources.

As it stands now, some 1,023 invertebrate, 357 amphibian, 377 fish, 729 mammal and 706 bird species are listed as threatened in Sub-Saharan Africa (IUCN 2011), which gives an indication of the state of natural systems in general. The outlook remains bleak. In last the few decades, Africa's development has not kept pace with the rest of the world, with the result that there has been an on-going decline in the level of development, and an increasing demand for land and natural resources. Dependence on the export of natural resources has also been a problem for development, particularly since prices fell during the global recession. It is argued that foreign interests in natural resources have buoyed these economies to the extent that they have failed to invest enough in human capital and technological advancement (Habiyaremye & Soete 2010).

2.4 The potential benefits of meeting the Aichi targets

If the Aichi targets are met, then it can be broadly assumed that policy makers, decision makers and the public will understand the value of biodiversity, and take it into account in making plans and decisions about the allocation of land and use of resources, as well as production methods. Both producers and consumers will respond to changed incentives brought about by the implementation of better policies and strategies. All of this will result in a much reduced rate of loss of biodiversity and the ecosystem services that it supplies. As a result, ecosystems and societies will be likely to have greater resilience to future pressures, including climate change. Meeting the Aichi targets and achieving the sustainable use and conservation of biodiversity will therefore be essential for sustainable development. Note that the benefits of achieving the targets cannot sensibly be broken down by target, since the targets act synergistically to achieve an overall set of goals. However, some reference to different targets is included below.

The primary benefits of conservation and sustainable use are expected to be a slow-down in the rate of loss of biodiversity and the loss of the values that it generates. However, the benefit of meeting the Aichi targets is not only the avoided loss of the biodiversity values described above, but also includes achieving increased resilience to climate change, improved distribution of biodiversity benefits, improved sustainability and productivity of natural resource-based production systems and new opportunities for business. These are explored briefly in the following sections.

2.4.1 Avoided loss of biodiversity value

Many of the targets will directly or indirectly lead to a reduction in the rate of biodiversity loss. Those that have a particular focus on reducing biodiversity loss include targets for **ecosystem/habitat and species protection (targets 5, 19, 11, 12, 14 and 15),** the **control of alien invasive species (target 9)** and other **restoration measures (target 14)**. Although our knowledge is patchy, studies on the value of ecosystem services give an indication of the values at stake.

Understanding the actual benefits of meeting the Aichi targets requires an understanding of the likely rates of loss without intervention, which is considerably more difficult to assess.

Even if one optimistically assumes that the rate of biodiversity loss would remain relatively steady in a business-as-usual scenario, it is clear that halving the rate of biodiversity loss would have significant implications for future generations. There is no single measure for biodiversity, but the loss of forested areas is something that is easily measured and can be used as an illustration. If the rate of loss could be halved by 2020, then, if one assumes that the current rate of loss of 0.8% per annum described for its tropical forests can be applied to biodiversity generally, then we would see some 1.4% of our currently remaining biodiversity saved by the end of the Aichi implementation period. However, if that reduced rate could be sustained into the future, then by 2040 this would represent a saving of nearly 8% what currently remains of our biodiversity and its value.

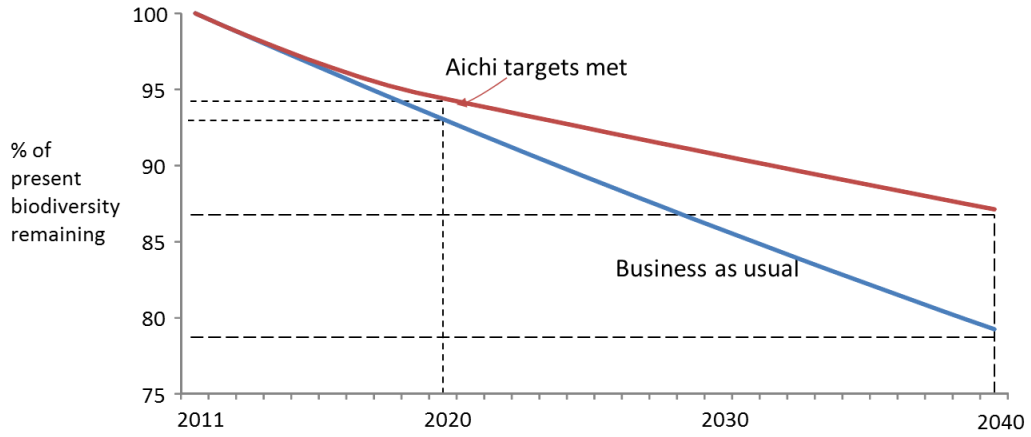

Figure 1. Hypothetical illustration of potential impact of meeting the Aichi targets on biodiversity, compared with the business as usual scenario

Many valuation studies are conducted for the purpose of demonstrating the potential costs of degradation and/or inaction, or the benefits of conservation measures. For example, in **Kenya**, Kipkoech et al. (2011) showed that converting forest into other land uses in the Mau Forest area would lead to a net economic loss to the economy. Many studies in **South Africa** and elsewhere have demonstrated that investment in the control of alien invasive species would have a positive economic outcome. This includes removal of alien trees that reduce water supply (Marais and Wannenburgh 2008), Turpie et al. 2008), removal of invasive alien plants that reduce grazing capacity, and the removal of water weeds that impede fishing activities. Restoration projects can also yield significant benefits. In the Drakensberg mountains, South Africa, restoration of grassland ecosystems and their burning regimes has been estimated to yield $340 million worth of additional water, cost savings of $2 million from sediment control and carbon sequestration values of $3 million)_(Aronson & Blignaut 2011)

2.4.2 Resilience to future pressures and climate change

In addition, it is increasingly being recognised that natural capital could play an important role in protecting society from the impacts of climate change. Where climate change may involve engineering and other adaptive responses, these are likely to be less necessary in areas where natural capital is more intact. The potential future benefits provided by 'ecological infrastructure' include the coastal protection and flood mitigation functions provided by mangroves and wetlands, for example. Furthermore, biodiversity may provide some degree of insurance in the form of fall-back options to help mitigate the impacts of climate change, such as fisheries that can be utilised as a source of food or income when crops fail.

2.4.3 Improved distribution of biodiversity benefits

The Aichi targets also seek to ensure that the **distribution of the benefits** gained from biodiversity are more equitably distributed. Specifically this includes ensuring that the **Nagoya protocol is implemented (Target 16)** and ensuring benefits from **traditional knowledge systems (Target 18).** In southern Africa alone, the informal trade in medicinal plants is worth an estimated $35 million, and a further $280 million is generated though re-sale of plant materials by secondary users. Traditional knowledge thus presents a very real opportunity for communities to generate income (Daya and Vink 2006).

2.4.4 Improved and sustainable agricultural outputs

Several targets will help to improve the **sustainability of land- and natural-resource based production systems (particularly targets 6 and 7)**. This includes the harvesting of natural resources (e.g. fisheries, forestry), grazing and culture systems (agriculture, aquaculture, silviculture). In the former cases, improved management can lead to improve resource rents, and in the latter cases the improvement of culture methods may also lead to increases in production and revenues (Harding et al. 2012). Improved management is also likely to lead to more resilient production systems (Soto 2009).

For example, in **Malawi** it has been estimated that unsustainable natural resource use costs the equivalent of 5.3% of GDP each year (Yaron et al. 2011). This means that Malawi could gain US$191 million if resources were used sustainably. The largest costs result from the impact of soil degradation on agricultural productivity, the loss of fuel as a result of deforestation around urban centres, unsustainable fishing and reduced economic activity caused by indoor air pollution (Yaron et al. 2011).

2.4.5 New opportunities for 'biodiversity business'

Several of the actions required to meet the Aichi targets will create new opportunities. For example, agricultural intensification and technological development is likely to improve incomes, establishing protected areas will create new opportunities for tourism-related business and employment, and some activities such as control of invasive alien species and restoration may be labour intensive. Some of the best examples in this regard are provided by South Africa's "Working for…" programmes (e.g. Working for Wetlands, Working on Fire, Working for Water). These are long-standing

environmental restoration programmes which have specifically sought to provide opportunities for the unemployed and have created jobs for 486 000 people since 1995 (Turpie et al. 2008, SANBI 2012).

Furthermore, there are at least eight biodiversity offset programs in development in Africa - in Uganda, Madagascar, Namibia, and South Africa, and countries such as Madagascar, Ghana, Guinea, Mozambique, Egypt, and Uganda are creating new regulations that consider economic instruments like biodiversity offsets. These developments will create new business opportunities (White 2011).

3 TYPES OF INVESTMENTS AND PRIORITIES FOR ACTION

3.1 Key points

- The required actions for the 20 targets can be summarised into those that guide and prepare for the core actions (research, planning and increasing awareness & capacity), and those pertaining to the actual changes that need to be brought about (direct conservation action, correcting incentives and improving technology).
- Estimating and communicating the value of biodiversity and implications of current trajectories to policy and decisions makers is a critical action required in Africa, in order to strengthen the political will to meet the Aichi targets.
- As long as other strategies continue to falter, the conservation of terrestrial and marine areas in protected area systems needs to remain a core, low risk strategy for conservation, that is relatively easy to finance, for example through tourism investment.
- Along with this, substantially higher-risk investments will need to be made into promoting conservation in buffer and corridor areas. Integrated conservation and development projects (ICDPs) as a means of engendering co-operation with protected areas have mixed success.
- Restoration is often difficult and prohibitively costly, but can be worthwhile under certain circumstances, such as when the carbon or water gains generate financial returns. In particular, investments in the control of invasive alien species have been shown to have clear pay-offs, and the greater the initial investment, the better the rewards over the long term.
- While numerous facilities exist for ex-situ conservation, these are not as effective as they should be: many facilities need to be upgraded, capacity building is required, and operations need to be more co-ordinated nationally, regionally and internationally.
- Property rights, land tenure and governance issues are central to many threats to biodiversity across Africa and need to be resolved in order to develop incentives for sustainable resource use and land management. Community-based management programmes (e.g. CBNRM, CFM, LMMEs) have sound conservation and development objectives but are often fraught with problems and require ongoing support.
- Where land and resource use is practiced on a commercial scale, investment in integrated planning will be key, as well as implementation of standards and certification systems, fiscal incentive measures and strong regulation of practices. Where it is on a small-scale, and property rights are secure, interventions should focus on measures to increase productivity and incomes ('land sparing'), as well as incentives such as charges and payment systems.
- Interventions to reduce the demand for overutilised resources (e.g. charcoal) and endangered species (e.g. bushmeat species, rhinoceros etc) are a very high priority, and need to be carried out on a large scale, and in the appropriate geographic locations (including urban areas and internationally).
- Performance bond and offset systems need to be established for commercial and industrial activities that encroach on habitats and threaten water quality in order to ensure no net loss.

- There is an urgent need to invest in wastewater treatment systems, but localized problems of extreme pollution caused by commercial and informal mining would be extremely costly to address and would be more likely to be driven by human health concerns. Measures to reduce pollution outputs are required on a large scale.
- The knowledge and capacity to achieve the required actions are badly lacking. Significant investments will need to be made in research and in generating the capacity required to meet and maintain the Aichi targets.
- Traditional knowledge is being lost as traditional cultures become eroded by increasing foreign cultural contact. It is thus urgent to document traditional knowledge about the characteristics, properties and behaviour of species, as well as to understand cultural practices that influence the success of policy measures.
- Africa has relied heavily on grants to address its biodiversity issues up to now, and while it should continue to capitalise on global willingness to pay for biodiversity, opportunities to develop sustainable financing mechanisms and to stimulate private sector investment in the restoration and management of ecosystems should also be seen as a priority.
- Given the lack of political will for addressing conservation, which is reflected in poor policy, legislation and enforcement in many countries, and the wide-scale problems of governance and corruption, overcoming Africa's threats to biodiversity will be an extremely challenging exercise. In general, priority investments should be those that have a broadscale impact on biodiversity and attitudes, deliver visible benefits and secure highly vulnerable biodiversity.
- Parallel development actions such as education will ultimately be the most important investment in Africa's biodiversity.

3.2 Identifying and grouping actions required to meet the targets

The actions required for meeting the different Aichi Targets were described in the first round assessment for the HLP. Based on these reports, but with some further interpretation, a list of the actions required for each target is provided in Appendix 2. Many of these are common to more than one target. The main actions required to meet all the targets are summarised in Table 1.

It should be noted that while actions listed deal with all the proximate threats to biodiversity, the underlying causes of problematic human behaviour will also need to be addressed if they are ultimately to succeed. Actions such as the development of human capital through education, formulating international agreements to address shared problems and illegal trade, and addressing conflict and economic instability are of paramount importance to the successful outcomes of meeting the Aichi targets, but are not discussed further here as they are addressed by other initiatives and are presumed to be outside of the CBD investment portfolio.

These can be summarised into about half a dozen broad categories of actions (Table 1). The way in which the groups of actions relate to each other is shown in Figure 2. The first three groups of actions are to guide and carry out planning and decision making and prepare for action, while the last three pertain to the actual changes that need to be brought about in order to achieve the ultimate goals of the CBD. These broad categories are fairly distinct in terms of the types of activities they involve, and their costs.

Table 1. Integrated summary of actions required to meet Aichi Targets

Broad group	Category	Actions
Research and development		Valuation of biodiversity Biodiversity and socio-ecological systems Priority areas and IAS for conservation action Indigenous knowledge Impacts of policy measures More efficient and cleaner production technologies Product development Monitoring and information systems Natural resource accounting
Develop strategies and plans	Integrated land and resource planning	Integrated conservation and development planning (including prioritisation of conservation/restoration efforts) Integrated catchment, water and waste management Integrated coastal zone management
	Sustainable development strategies	Strategies to reduce negative impacts of production and consumption Sustainable harvesting strategies Sustainable agri-, aqua- and silviculture strategies
	Enable implementation	Update/revise policies, legislation and institutions Financing strategies
Awareness and capacity		Educate children, users, public, policy makers, extension officers about values, trade-offs, strategies and management measures Capacity building to foster participation of indigenous local communities
Direct protection and management	Strengthen PA systems	Acquire land Improve management and enforcement Conservation easements/contractual arrangements Measures to gain co-operation of communities around parks
	Ex-situ conservation	Breeding programmes for endangered species Ex-situ maintenance and expansion of existing collections for genetic diversity
	Restoration and clean up	Marine debris clean-up Control and eradication of invasive alien species Species reintroduction, recovery and management actions Restoration of degraded terrestrial vegetation, drainage systems and soils Restoration and reestablishment of coastal and marine systems (e.g. dune systems, mangroves and coral reefs)
	Border/port protection	Prevention of alien introductions Monitoring for illegal trade
	Management of land and resource use	Integrated catchment management (incl agriculture, forestry, fire, water, pollution) Integrated coastal management Management of natural resource harvesting (forestry, fisheries, etc)
Indirect protection through standards and incentives	Correct incentives	Removal of harmful subsidies Allocation of property rights (e.g. forestry, fisheries, pollution, grazing, water, wildlife) Financial incentives/measures (taxes/charges, subsidies/payments, deposit-refund, buyouts) Introduction of eco-labelling and other measures of recognition
	Certification & offset systems	Definition of minimum standards and certification systems No net loss/offset systems
Improved technology and infrastructure		Change to biodegradable plastic production Improve wastewater treatment capacity and stormwater systems Install better technologies for stationary and mobile sources of pollution Ballast water treatment

Many of the biodiversity problems to be solved, such as reducing the impacts of agriculture, require all six categories of actions. This means that there are also many overlaps in the requirements of the different targets. Some of these can be lumped, such as making policy makers aware of a whole range of interlinked issues, rather than just focused awareness campaigns. Others will need to be separate, focused actions.

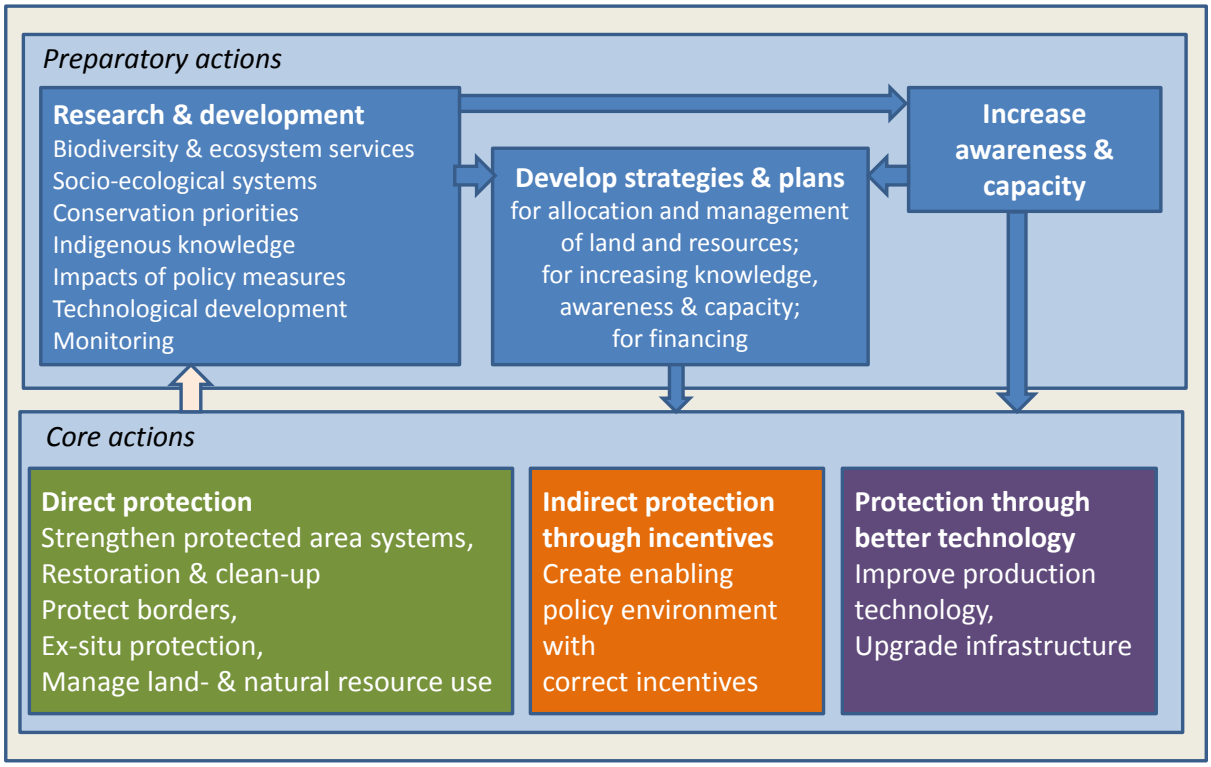

Figure 2. Broad categories of actions required to meet the Aichi targets and how they relate to one another (Source: Author's interpretation)

It is particularly important to note that all of the core actions need to be addressed together in integrated local level planning, catchment scale planning, in coastal zone management, and in marine ecosystem management. For example, marine ecosystem management involves protected areas, control of IAS, control of marine pollution, ensuring sustainable harvesting of stocks and promoting sustainable aquaculture. The same issues are addressed in coastal systems and in terrestrial areas (ideally river basins), usually by adapting similar principles. This is gradually becoming the case as the value of integrated management systems is becoming more accepted by policy makers, but is by no means the norm at this stage. Integrating the actions in national development planning will ultimately lead to greater cost efficiency.

Because of the high degree of overlap between actions required for different targets, a target-based assessment would be repetitive and would easily lead to overestimates of the actions required and their costs. Rather than assess the actions required on a target-by-target basis, the actions required are discussed within logical groupings.

3.3 Research and development

The first group of activities, relating to knowledge and capacity, is common to nearly all the targets. This includes the important first steps of putting values to biodiversity, introducing them into national accounting systems, and monitoring these over time. It also includes all the research that is required to inform strategies for dealing with biodiversity loss, in order to inform planning and management.

In Africa, research efforts are hampered by a dearth of good universities and lack of government funding. There is heavy reliance on involvement of the international scientific community. Research has probably also tended to be focussed in the more developed of the African nations, and in the biodiversity-rich island states. All African countries are in need of comprehensive national assessments of ecosystem services and of the dynamics of land use and socio-ecological systems. While research and understanding of many important issues are lacking in Africa as a whole, this should not stand in the way of or be used as an excuse to delay action, especially where international experience can be used as a guide. Rather, research should be an on-going activity that can be used to modify actions as better understanding comes to light.

Monitoring, which is fundamental to many types of research, is particularly neglected in many parts of Africa. For example, hydrological gauging stations for measuring stream flows and which were set up during the early part of last century in many countries, have fallen into disrepair, hampering catchment and water resource planning efforts and even the understanding of impacts of land use on water flows. While monitoring of certain resources such as timber are generally carried out in most countries along with other national primary sector activities, monitoring of small scale activities such as inland fisheries tends to be very poor and records are often not computerised or completely missing. Monitoring also includes the formal inclusion of biodiversity values into national accounts.

The most important research and monitoring actions required to support the delivery of the Aichi targets are discussed further below.

3.3.1 National assessments and accounting of biodiversity values

Understanding the value of biodiversity or natural systems is a necessary (though not sufficient) condition to bring about sustainable development. While the valuation of biodiversity remains somewhat controversial, as it is a difficult and potentially misleading exercise, it is imperative that society understands the trade-offs involved in planning and decision making in order to make choices that maximise the wellbeing of society. Rather than just put a number to biodiversity, it is best to demonstrate how changes in biodiversity change the supply and value of ecosystem services (Department of Environmental Affairs 2012), and how this links to economic outputs and societal wellbeing.

The inclusion of these values in the System of National Accounts (SNA) is also essential in order for the implications to be communicated at the highest level. Without this, the role of depletion and degradation of natural resources and the natural environment in contributing to GDP is ignored,

giving rise to complacency (Hamilton 2013). This is of particular concern in developing countries, where natural resources and the natural environment constitute 21%-35% of total wealth (Hamilton 2013). The WAVES programme (see Box 4) has set the process of natural resource accounting in Africa, and has garnered government support.

Box 4. Wealth Accounting and the Valuation of Ecosystem Services (WAVES)

WAVES is a global partnership that aims to promote sustainable development by ensuring that natural resources are mainstreamed in development planning and national economic accounts. The WAVES programme includes Botswana and Madagascar. Botswana was one of the first counties to pilot environmental and natural resource accounting, starting in the 1990s, with monetary accounts constructed for minerals, and physical accounts only constructed for minerals, water and livestock. Wealth accounts (more complete measures of wealth including natural capital values) show that whereas Namibia's per capita wealth has declined over the last two decades, Botswana's has increased dramatically over the same time period, probably due to reinvestment of mineral resource gains. This illustrates how more complete measures of wealth can give a better picture and help policy-makers to determine the levels of investment needed to maintain sustainable development, and guide long-term policy (Allebone-Webb et al. 2013). In Madagascar the first priority was developing macroeconomic indicators like adjusted net savings and adjusted net national income to assess whether Madagascar is building or depleting national wealth. The sectors that were identified for creating detailed accounts included the mining sector, fishing sector, tourism, and water (WAVES 2012). In addition to the funding provide by WAVES, Madagascar committed $500 000 in co-financing.

Comprehensive valuation studies require a large amount of information. This includes ecological data, often requiring time series or cross sectional data on ecological variables such as vegetation cover, soil transport and river flows, ecological studies on the behaviour of organisms such as pollinators, to understand the capacity of ecosystems to supply services, as well as studies to shed light on the demand for these services. The latter includes a range of studies from spatial data on populations and infrastructure, to studies of behaviour and questionnaire surveys. In general it is the ecological data that is most difficult to acquire, but all data collection and modelling can be an expensive exercise. Some off-the-shelf models are available in various stages of development to help with the rapid assessment of ecosystem values. In time, these will reduce the costs of such assessments, but they do require costly experts and training.

3.3.2 Research and monitoring

Meeting the Aichi targets will require better understanding on biodiversity, ecosystems, alien invasive species, resources, indigenous knowledge, socio-ecological systems, the drivers of degradation and the impacts of policy measures, through research and monitoring. Many developing countries lack environmental data and information, or the information that is available may be unreliable (Sanford and Vijge 2008).

Biodiversity inventories and ecological research will be able to feed into and update valuation studies, better understand invasive alien species and assess the stock dynamics of utilized species (e.g. fisheries). In addition, there is a need for an improved evidence base for defining biodiversity metrics specifically in the context of agriculture (Moran et al. 2012). These studies will also help

determine priorities and focus conservation and restoration efforts and are essential to the implementation of certain conservation measures such as REDD+ projects.

While the importance of understanding socio-ecological systems and indigenous knowledge is recognized, much research on these areas is needed to better understand pressures and inform conservation strategy. Furthermore, it is important to understand the inter-sectoral trade-offs in the use of natural systems and the implications for distribution of benefits is important to inform policy and decision making (see Box 5). Socio-economics research of this nature receives very little funding at present. Basic socio-economic statistics are, however, collected regularly in most African countries. There is a need for multidisciplinary research to meet the Aichi Targets.

Box 5. Tourism development does not necessarily reduce pressure on resources

Zanzibar's population of 1.1 million is highly dependent on its marine environment, which accounts for 30% of GDP. Since 1985, the tourism industry has grown rapidly to become the mainstay of the economy. However, the impact of this development path on the marine environment and local communities, the stewards of the marine ecosystem, were not carefully considered. The marine systems upon which the economy depends are now seriously degraded and local coastal communities are suffering the consequences. While 47% of Zanzibar's GDP is from tourism, only 20% accrues to these communities, with most going to government in the form of fees and taxes (15%), to Zanzibaris from outside the fishing communities (12%) and to non-Zanzibaris (53%). Overfishing and destructive fishing practices are the main reasons for the degradation of Zanzibar's coral reefs and fish populations. However, given the open access nature of the fisheries and low levels of income, the fishing communities have little incentive to change their fishing practices (Schmidt-Soltau 2003). Greater involvement in, and income from, activities that depend on a healthy marine ecosystem is needed in order to change this situation (Lange and Jiddawi 2009).

Indigenous knowledge is being lost as traditional cultures become eroded by increasing foreign cultural contact (Enwelu et al. 2012, Decher 1997). While traditional management systems have often become outdated and inadequate under modern circumstances, there is still an opportunity to document traditional knowledge about the characteristics, properties and behaviour of species to inform the development of better management systems. For instance, an estimated 80% of the African population uses traditional medicine for their health needs, including those who also visit modern health facilities, and numerous countries are now integrating traditional medicine into their official healthcare programmes (CBD 2007a). Traditional knowledge is also valuable to modern industry and agriculture, in that many widely-used products, such as plant-based medicines, health products and cosmetics, are have been identified through traditional knowledge (Sharma et al. 2012c). Understanding traditional beliefs and cultures can also contribute to the success of protected areas (Sharma et al. 2012c; Box 6).

Box 6. Importance of recognising traditional knowledge and beliefs in managing protected area systems

It is argued that traditional knowledge and beliefs can be key to the conservation of biodiversity when cultures are conserved. For example, in **Malawi**, villagers living in Chindozwa village on the northern end of Lake Malawi have long understood that trees call the rain that falls on their crops and feeds the lake, calling the fish back into the lake. They believe that trees need to be strategically kept in order to ensure rainfall and its flow. In addition, their fishing rituals require specific plants from particular vegetation types found around the village. Their beliefs and rituals give the villagers cause to monitor and conserve terrestrial and aquatic biodiversity. Concern over recent deforestation led the fishers to plant trees and undertake other conservation activities. A movement that began at the household level in 1988 consolidated in 2009 into CHI-MO (Chindozwa Home-based Initiative) and is rapidly expanding to neighbouring villages, various government offices and local NGOs (Nakayana 2010).

In **Ghana** the tendency to downplay link between traditional and scientific conservation approaches has been blamed for rendering most conservation initiatives fairly ineffective (Attuquayefio and Fobil 2005).

In **Kenya**, the Kivaa Hill is a sacred site that was once well protected but had become degraded. The African Biodiversity Network (ABN) helped to reinstate rituals at the site after 40 years, and the site was rehabilitated. The project worked to strengthen customary laws, including the stories, and revitalise the traditional cosmologies of the community. There were some challenges, however, in the form resistance from mainstream faiths, the slow pace of adoption by young people, and delays in conducting the rituals due to the changed lifestyles of elders who had the knowledge, but were not performing the rituals (CBD 2012).

Indeed, in most areas, the influence of foreign cultures has started to erode traditional beliefs with the result that this kind of protection has started to be less effective. In **Benin**, there are 2,940 sacred forests covering 18,360 hectares that are outside of official protected areas, and that have been preserved up till now largely because of traditional beliefs. However, this is now no longer the case, and an NGO has had to step in to protect some of these forests in partnership with traditional authorities and the Government, using more modern arguments about ecological services and social justice (CBD 2011).

3.3.3 Technological development

Research is needed for the development of more efficient and cleaner production technologies that are appropriate to local situations. This includes the development of technology for treating waste water and ballast water, as well as for more resource-efficient farming and aquaculture methods and processing. Research and development should also focus on appropriate technologies that take local realities into account.

3.3.4 Biodiversity product development

Research is also required for the development of products that encourage the conservation of indigenous species and ecosystems. This includes the creation of marketable goods and services from forest conservation, SFM, forest restoration and the avoidance of habitat loss (African Development Fund 2013), as well as improved use of genetic resources (selective breeding and potential genetics and GM) to improve resource use efficiency, a component of sustainable intensification.

3.4 Increasing awareness and capacity

3.4.1 Education and awareness raising

Biodiversity values are still very poorly understood in many African countries. For example, a study of four municipalities in South Africa showed that people's understanding of the term "biodiversity" is very limited. The concept of "sustainability" is much better understood, but only marginally connected to nature. Thus biodiversity and the natural environment are generally not perceived as components of sustainable development, and preservation of nature is regarded as fundamentally in opposition to socio-economic development (Wilhelm-Rechmann and Cowling 2011). Broad public awareness and education campaigns are needed at all levels in Africa, from communities and school children to national decision- and policy-makers and donor organisations (Solh et al. 2003).

The low level of awareness of importance of biodiversity at all levels in Africa, and the prevailing belief that biodiversity conservation and human development are conflicting goals, means that there is little public pressure, and little political will to invest in conservation. Awareness-raising is therefore a very important investment, and **education of decision-makers** on the importance of biodiversity and sustainable use of natural resources is the highest priority. An understanding and appreciation of the value of biodiversity and demonstrating that investment in conservation measures can bring socio-economic development will be essential before these values will be integrated into policies and strategies (see Box 7). To this end, investing in ecosystem services valuation and natural capital accounting (see above) will be a very important step.

Box 7. The importance of raising awareness for success of MPAs (Gabrié et al. 2010)

In **Senegal** the Narou Heuleuk Project was implemented to protect fishing resource and enhance biodiversity in four sites along the coast. In the end, only one MPA was established at one of these sites. The reasons for failure were given as lack of local community involvement, and lack of political commitment. This highlights the importance of raising awareness among decision-makers about the benefits of biodiversity conservation.

In **Tanzania**, in spite of having agreed to the creation of the Mnazi Bay MPA, local villagers have been reticent to cooperate, partly because of a number of unfulfilled promises but also because of political differences. Over the course of the project, this escalated into outright hostility and rejection of the MPA and its rules. Part of the reason for this was through to be the weak institutional context and management unit, and inadequate technical support for the project.

In **Mozambique**, the creation of the Quirimbas National Park project benefited from a favourable legislative environment, the political will to make the conservation sector a driving force of the economy, support of the local communities who wanted the park in order to conserve their resources and reduce conflicts with migrant fishermen, good technical support for the management unit and well-coordinated partnership between co-funding agencies. However, failure to involve the Ministry of Fisheries in the project led to a many problems that were only resolved after 5 years.

In addition, the success of conservation efforts and measures to achieve sustainable production and consumption generally, will depend to a large degree on **public awareness** and understanding of biodiversity. Raising public awareness involves the development of national communication strategies, undertaking awareness raising activities and using media (print, audio, visual, and

electronic) engagement and promotions of biodiversity conservation and benefits, etc. In particular, public awareness needs to be targeted towards raising demand for Responsible Investment (Box 7).

Box 8 Responsible investment

One of the ways of enabling sustainable development is if investors and fund managers could be persuaded to follow the Principles for Responsible Investment (PRI) (Lambooy and Levashova 2011). Responsible investment (RI) is investment that actively takes environmental, social and governance issues into account in investment decisions, with a view to driving the demand for sustainability in corporate decision-making. For example, the Nigerian banking sector has developed a set of Nigerian Sustainable Banking Principles under the stewardship of the Central Bank. All banks are now required to manage and mitigate the environmental and social risks associated with their activities and operations. In South Africa, mandatory disclosure of sustainability information is required for stock exchange listing, in compliance with the King Code on Corporate Governance (UNEP 2011). However, a survey of investors in South Africa showed that while investors appreciate the need for these considerations, knowledge gaps and lack of evidence hampers progress in this regard. Principal officers of pension funds generally concurred that the most important barriers were related to the belief that RI necessarily meant lower financial return. Asset managers and advisors generally suggested that their most important barrier was a lack of demand from customers (institutional and retail). Respondents indicated that more stringent legislation would drive further participation. However, this could be avoided by increasing demand **through investments in public awareness**. It is arguably in the African continent, where acute environmental, social and governance (ESG) pressures exist, that the benefits of responsible investment could have most impact (UNEP 2013).

Inclusion of biodiversity in **school curricula** from pre-school through to tertiary education levels should be part of a long-term strategy to increase awareness. This requires both inputs into teaching materials as well as direct exposure to biodiversity, for example in the form of visits to environmental education centres. The great majority of schools in Africa seldom go on any outings for lack of funding. Investments in education would thus require the building of environmental education centres, transportation to them and the provision of staff to carry out education programmes at the centre.

3.4.2 Capacity building

Many of the activities to be undertaken for the Aichi Targets will require capacity building. This applies particularly to increasing and improving conventional conservation measures such as protected areas, restoration, control of IAS, etc., as well as to agricultural activities (see also extension). For example, Hardcastle and Baird (2008) noted that the technical capability for measuring and monitoring forests generally has been severely eroded in many countries.

There is also lack of capacity within government regarding the mainstreaming of biodiversity into planning and decision-making (Swiderska 2002). Lack of capacity is a very big issue in Africa, where illiteracy rates are high and where standards of education are often very poor. Significant investments will need to be made in generating the capacity required to meet and maintain the Aichi targets.

Workshops and affordable training programmes, targeted improving capacity among government officials, would be required for several activities, including:

- Biodiversity monitoring and ecological survey methods
- Social and valuation survey methods
- Natural resource inventorying and accounting
- Integrated river basin management
- Integrated coastal zone management
- Sustainable development
- Protected area management and enforcement (terrestrial and marine)
- Ecosystem management (wetlands, forests, IAS, fires etc)
- Ecosystem-based approaches to development planning and implementation, land-use etc
- Sustainable agricultural, aquaculture and forestry practices

3.4.3 Extension services

Since many of the actions will require changes to agriculture, aquaculture and silvicuture systems, it will be essential to provide support in the form of extension officers, who themselves will need to be capacitated in terms of rationale and strategies, best management practices and in meeting the standards for certification.

3.5 Developing plans and strategies

3.5.1 Plans for sustainable production and consumption

Fuelled by consumer demand, firms have an immense impact on the state of the world's biodiversity and ecosystems. Thus influencing the behaviour of both consumers and firms could make a substantial difference in reducing their negative impacts and contributing to the restoration and conservation of natural systems. Increasing attention is being paid to how new developments, even clean energy developments, should be induced to take responsibility for their impacts on biodiversity though means such as performance bonds, banking and offset systems. Producer and consumer choices can also be swayed by information and financial incentives, including the removal of harmful subsidies. Note that the Aichi targets only focus on the development of plans, rather than their implementation, which will require further investment.

3.5.2 Integrate biodiversity into development planning

Integrated land and resource planning is fundamental to achieving efficiency and other goals. Part of the reason for the lack of mainstreaming of biodiversity in planning generally has been the lack of understanding of the value of ecosystems, how they contribute to development objectives, and the full trade-offs involved in following alternative development paths. Once trade-offs are better understood so better decisions can be made in the allocation of resources and prioritisation of conservation efforts. Moving towards the mainstreaming of biodiversity in development plans will require more multidisciplinary approaches to planning, involving a large number of actors and institutions, which will in turn require more capacity and resources (Rayment 2012).

Although integrated planning and management frameworks already exist (such as 'integrated land use planning', 'integrated water resource management' and 'integrated coastal zone management'),

in reality most planning is still very strongly sectoral and seldom takes the role and values of ecosystems and biodiversity into account. Mainstreaming of biodiversity into planning will force consideration of the relationships between sectors and will go a long way towards shifting mindsets. This is also essential in order for policy makers to see the value of eliminating harmful incentives and putting plans in place for sustainable production and consumption. This needs to be done both openly as well as overtly.

Furthermore, water, land use, coastal and marine planning need to be understood to be intricately linked. Land use planning affects water resources and *vice versa*, and both land and water resources planning affects coastal and marine processes. **Integrated River Basin Management** (IRBM) takes a more ecological approach to land use and water resource planning by using ecological (watershed) rather than administrative boundaries. Recognizing the important linkages, in some countries, the concept of **Integrated Coastal Zone Management** (ICZM) has been extended to **Coastal Area and River Basin Management** (ICARM) (UNCHS 1996, UNEP-MAP-PAP 1999).

While the need for integrated planning is recognised, it has not yet been widely implemented. For example, in Namibia, the Ministry of Lands and Resettlement (MLR) has the mandate to manage all land resources through Integrated Land Use Planning. In South Africa, it is now obligatory for all municipalities to develop **Integrated Development Plans** which include spatial planning, as well as for coastal municipalities to prepare **Integrated Coastal Zone Management Plans**. However, there is little capacity for integrating biodiversity in local level planning. In order to achieve this, the conservation sector will need to establish trustful, long-term relationships with local government, rather than relying on simple provision of information and brief training events (Roux et al. 2006). It has also been noted that attempts to mainstream biodiversity in land- use planning decision-making will be considerably improved if the maps would include ecosystem services and refer to a nontechnical term that highlights the aspect of “service provision” from nature to people (Wilhelm-Rechmann and Cowling 2011).

Progress has probably been greatest in the area of water resources planning, because of water scarcity and the need to plan across internationally-shared river basins. There have been several international initiatives for water resource planning in shared basins, such as the Nile, Orange, Limpopo, Zambezi, Ruvuma, Pangani and Okavango Basins. However, few of these have given more than a minor consideration to biodiversity. The need to set aside water to maintain aquatic ecosystems and support rural populations that depend on instream flows is increasingly on the agenda and has been recognised in water policy and law in some countries, such as South Africa and Tanzania. However, environmental flows still tend to be viewed as a requirement to meet the criterion of sustainability and allocated at minimum levels. The consideration of biodiversity and ecosystem services in the analysis of trade-offs in water allocation decisions is a relatively new development in Africa (and globally), which has been tested in the Pangani and Okavango Basins, as well as in South Africa (Box 7). Because of the links to land use, coastal and marine processes, integrated water resources planning is an important first step towards mainstreaming biodiversity in development planning generally.

Box 9. The Pangani River Basin Management Project (Source Cross and Förster 2011; Author).

The Pangani River Basin Management Project (PRBMP) was a project initiated in Tanzania by IUCN in order to generate technical information and develop participatory forums to strengthen Integrated Water Resources Management in the Pangani Basin. The aim of the project was to provide information to the Tanzanian government on the costs and benefits of different water-resource management strategies. This information is intended to guide decisions on a fair balance between water development on the one hand and protection of the river and its ecosystems on the other. The process involved the assessment of the value of water in different uses and the value of services provided by aquatic ecosystems. A tool was developed and applied to analyse the implications of alternative flow allocation scenarios for people living in different parts of the basin as well as the region as a whole. The whole exercise not only raised awareness among river basin managers of the tradeoffs involved in water allocation decisions allowing better decision-making, but also of the importance of monitoring water use in the basin.

3.6 Direct protection

On reserve, off-reserve, ex situ conservation, restoration actions and border protection remain the core of conservation strategy, but actions in Africa to date fall well short of the targets necessary to make them effective. Management and enforcement have also been integral to natural resources, protected areas and buffer zones, but systems need to be improved and expanded to include more provision for integrated catchment and coastal management. Better protection at borders is required for prevention of alien introductions and trade in endangered species.

3.6.1 Strengthen protected area systems (expansion and management)

Protected areas are the main strategy for biodiversity conservation in Africa. In addition to the protection of vulnerable species and areas, they secure the supply of a number of ecosystem services such as flow regulation and flood amelioration, nursery areas for fisheries, carbon sequestration and coastal protection, as well as opportunities for research, recreation and tourism. In particular, there is a large body of evidence to support the role of marine protected areas (MPAs) in the recovery of depleted stocks and contribution to fisheries (e.g. Kamukuru et al. 2004, McClanahan et al. 2007). Nevertheless, this does come at the cost of access to natural resources, which can lead to the requirement for additional investments to gain the cooperation of communities whose access to those resources has been curtailed.

Aichi Target 11 includes specific targets for the coverage of terrestrial and marine protected areas. In addition, it requires an improvement in the management effectiveness of these areas. Thus investment in protected area systems will depend on the degree to which existing PA systems fall short of area targets as well as the level of management effectiveness. The latter is strongly influenced by the geographic and socio-economic context of the protected areas. In addition to formally designated, state-owned protected areas the protected area system also includes private reserves and indigenous and community conserved areas (ICCAs), but these are taken to be outside of the spatial targets and overlap strongly with developing mechanisms and incentives for biodiversity-friendly activities outside of the formal protected area system. Nevertheless, these activities can be targeted in areas around protected areas in order to strengthen their effectiveness.

Investments required to strengthen protected area systems include:

- Acquisition of land and marine areas to meet spatial targets for protected area systems (by outright purchase, easements or contractual arrangements);
- Measures to improve management and enforcement (increases in staff numbers, capacity, equipment, monitoring systems, etc.);
- Measures (e.g. ICDPs, co-management) to improve co-operation of communities around parks; and
- Measures to improve connectivity through conservation outside formal protected areas (community-based management).

Development of surrounding communities (ICDPs)

Whereas parks are for the national or international benefit, the communities living around them often bear the costs of conservation. Several studies have documented clear costs to communities in terms of livelihood options lost, expulsion from traditional fishing or hunting grounds and living spaces, and violation of human/community rights. For example, research conducted on five MPAs in **South Africa** indicated that traditional, small-scale fishing communities living in, or adjacent to, MPAs are bearing the costs of marine conservation with few benefits accruing to them (Sunde & Isaacs 2008). This greatly reduces the chances of local communities co-operating with protected area managers. Many parks agencies and donors therefore make considerable investments in the communities around parks, such as sharing of revenues, access to resources, infrastructure development, service provision, and training in tourism and alternative livelihoods in order to compensate costs and reduce pressures on resources in parks. However, this has been with mixed results, and success depends heavily on strong institutions (Box 9).

Box 10. ICDPs – some successes and failures

In **Rwanda** it has been found that **c**ommunities who earned a high income from diversified agricultural lands were much less dependent on forest resources from the Nyungwe Forest Reserve than communities who earned a low income from agriculture, thus reducing pressure on the biodiversity of the forest. Although agroforestry systems cannot stand alone as conservation areas, they can buffer existing reserves and provide corridors for persistence and movement of species across landscapes. Such systems offer a useful means for combating species loss as a result of tropical forest fragmentation (Masozera and Alavalapati 2004).

The Ankeniheny-Zahamena Corridor (CAZ) is a new protected area that encompasses one of the largest remaining blocks of rainforest in **Madagascar**, within an area that includes multiple zones and land designations. In helping to establish the area, Conservation International (CI) put significant **effort put into developing partnerships**. This has ensured that the protected area now benefits from a broad alliance of diverse stakeholders that share a common vision. There has been emphasis on building the capacity of organizations and developing good, effective governance at a landscape scale. Incentives for conservation were introduced in the form of conservation agreements, grants linked to natural resource stewardship, and nature-based enterprises such as ecotourism. Another factor contributing to the project's success has been CI's sustained presence and investment in the corridor combined with a recognition that long term financial sustainability is a key element to success (Conservation International 2011).

Experience in the Mkuze Wetlands in **South Africa** shows that in spite of the correct rhetoric voiced by the conservation authority about combining conservation and community development there are gaps between this and the reality. For local communities to accept what is offered by parks, this must be regarded as the outcome of fair negotiations. Otherwise outcomes might be regarded as unfair and enforced from above, and

therefore rejected outright. The risk increases if past relationships between conservation authorities and local people have been characterised by distrust, as across much of Africa. Investments to **promote transparent and fair negotiations** are thus a priority in any expansion of protected areas in Africa (Dahlberg & Burlando 2009)

In **Mozambique**, communities surveyed in MPA areas all agreed that marine resources were declining and that something needed to be done, but did not support MPAs as an appropriate measure to address the problem. The local communities felt that fishing by outside fishers, industrial and semi-industrial fishing, and poor law enforcement by government authorities were to blame, and that they themselves should not have to be excluded from these areas. They were not interested in proposed generation of alternative income-generating activities. There is a strong view that where parks are planned based primarily on conservation targets and for promotion of tourism, they are unlikely alleviate poverty, and may also have limited success in conserving biodiversity as a result. Park should be established with local communities, rather than being imposed on them (Rosendo et al. 2011).

Developing strong and strong and sustainable local institutions are essential to achieving long term success in the establishment of protected areas. This was the conclusion of a review of three protected area projects in **East Africa** (Bwindi Impenetrable National Park and Mgahinga Gorilla National Park Conservation Project, Reducing Biodiversity Loss at Cross-Border Sites in East Africa Project, and the Lewa Wildlife Conservancy Project)**.** Strong institutions provide the necessary continuity and fund-raising capability to consolidate and scale up the project activities after project closure. This is especially important when dealing with integrated conservation and development initiatives, which require many years before achieving significant livelihood benefits let alone global environmental impacts. Since the typical length of a GEF project (3-5 years) is insufficient time to develop sustainable community-based institutions and new conservation-compatible livelihood strategies, continued support is needed to consolidate and develop these (GEF Evaluation Office 2008).

Investment in ecotourism is seen as an important opportunity not only for financing protected areas but also for developing alternative livelihoods for communities that bear the costs of parks. However, whether these benefits actually achieve this and reduce pressure on parks is quite case-specific. For example:

- In **Egypt**, community-based eco-tourism development appears to have been successful in the case of the St. Katherine Protectorate, a traditional Bedouin area. This has included a craft programme in order to diversify income and maintain cultural diversity. Local communities have come to realise the value of the protected area as a drawcard for visitors, and are now interested in maintaining and protecting the area, even reporting violations and using peer pressure to discourage damaging activities (CBD 2011);
- On Wasini Island off the coast of **Kenya**, nature-based tourism has led to an increase in income and living standards. However, it has made other traditional livelihoods nearly redundant and has resulted in local population growth above the national average, mainly through immigration of workers from nearby coastal areas, and has thus failed to reduce the pressure on resources (Job & Pesler 2013).

Much of the expansion of protected areas will occur in places already occupied by people. Realising the benefits of tourism is seen as one way of offsetting the expected costs (Job & Pesler 2013). For this strategy to be effective, local participants involved in tourism businesses need appropriate knowledge, skill training and assistance in reaching fair institutional arrangements (Job & Pesler 2013). The risk of this strategy is that tourism can be significantly impacted by external crises, and it is therefore important to avoid a total dependence on nature-based tourism, by maintaining a subsistence economy for times of crisis.

Ecotourism is more likely to achieve conservation benefits if: (a) it only requires modest changes in land or resource use, (b) it can leverage more protection (e.g. the government of Mozambique is establishing large conservation areas as a key element of tourism development), and (c) if the benefits are sufficiently high to out-compete basic livelihoods that may not be biodiversity-friendly (Kiss 2004) In practice, ecotourism has often failed to deliver the expected benefits to indigenous communities due to a number of factors, including lack of human, financial and social capital within local communities, lack of mechanisms for the fair distribution of benefits, and land insecurity (Coria and Calfucura 2012). Revenues have to be very large and accessible to provide the economic incentive to preserve natural habitats (Coria and Calfucura 2012). In reality, most of the revenue often flows to external stakeholders, such as tour operators (Lapeyre 2010), or is subject to elite capture. Unfortunately, alternative income-generating activities often don't live up to expectations (Rosendo et al. 2011). This has been reported for efforts aimed at marine protection as well.

Community-based management

Community-based management is another option for achieving some level of biodiversity conservation outside of strict protected areas, thus avoiding the high costs of protection, while at the same time creating development opportunities. There has already been a substantial amount of investment in these kinds of initiatives throughout Africa, in the form of community-based natural resource management (CBNRM), sustainable forest management (SFM), and locally managed marine areas (LMMAs) and so forth. Community-managed areas can theoretically provide a range of benefits including biodiversity conservation, improved harvests, improved local governance, community organisation, resilience and adaptation, health, integrated resource management, cultural survival, improved social and human capital, and security of tenure for local traditional resources (Harding et al. 2012). However, the success of these ventures is highly variable, and dependent on the characteristics of the community (see Ostrom 2007) as well as the environmental and socio-economic context. These options are discussed under the section on sustainable use of resources.

3.6.2 Restoration

Restoration (or rehabilitation) efforts include the clean-up of pollution, removal of IAS, and the recovery of habitats and endangered species populations. Restoration efforts sometimes involve several or all of these actions. In South Africa, removal of alien species is the main element of restoration of many terrestrial and riparian habitats. In most cases, the degradation has come about because of differences in who bears the costs and benefits, and restoration costs are often prohibitive to private or communal land owners. Private and public benefits need to be weighed up against one another in determining who ultimately pays for rehabilitation and restoration actions.

Control of invasive alien species

The control of invasive alien species involves mechanical removal, biological control, chemical treatment, habitat management and construction of barriers (Turpie et al. 2011, based on Gherardi & Angiolini 2004). In some cases, mitigation measures and/or adaptation can be more sensible

(McNeely 2001). For priority species, control or eradication is desirable, as opposed to mitigation or containment (Turpie et al. 2012).

Restoration of degraded habitats

Habitat restoration may be desirable in order to restore productivity, the supply of ecosystem services, or as a means to conserve endangered species. Examples include the restoration of rangelands that have been overgrazed, the restoration of forests that have been overharvested or converted to agricultural land, and the restoration of mangrove forests that have been lost as a result of overharvesting or changes in hydrological regimes, the restoration of estuarine systems affected by water diversion, and the restoration of wetlands that have been drained and converted to agricultural land. The costs of restoration depend on habitat type and the degree of degradation.

Endangered species reintroduction, recovery and management actions

Reintroduction and recovery programmes are a last resort necessary for species that have declined to dangerously low levels either locally or for the species as a whole. There are several such programmes already operational in Africa. Many projects exist for a range of mammals, reptiles, amphibians, birds and plants. Many of these are linked to zoos, including local zoos such as the Johannesburg Zoo in South Africa. Most of these programmes are initiated and run by international organisations that partner with local institutions. For example:

- In **Tunisia, Chad, Senegal** and **Morocco**, NGOs (C2S2 and the Sahara Conservation Fund) are working to reintroduce the scimitar-horned oryx, which was exterminated from the wild in the early 1990s, as well as addax and addra gazelle, of which only a few hundred individuals remain (www.saharaconservation.org).
- In **Niger**, another Sahara Conservation Fund (SCF) project is working on reintroducing the North African ostrich, which is critically endangered may soon become extinct like the Arabian ostrich. The SCF launched an international fundraising appeal and involves partnering with a wildlife organization (CERNK) that will manage the breeding programme, with the aim of releasing ostriches into existing protected areas (www.saharaconservation.org).
- In the **Republic of Congo** and **Gabon**, the Aspinall Foundation works with local partners and national governments to stop the decline of the critically endangered western lowland gorilla, whose numbers have declined by 60% over the past 20-25 years. The "*Projet Protection des Gorilles*" (PPG), which also involves conservation and anti-poaching activities, has released 51 confiscated wild-born orphans and captive-bred individuals into the Batéké Plateau region which was first large wilderness area to see the extinction of gorillas in these countries (www.aspinallfoundation.org).

Reintroduction programmes are particularly important for small island states where extinction rates are particularly high due to introduction of alien species such as rats and cats. The case of the Aldabra white-throated rail, which was reintroduced to Picard island and has now reached its predicted carrying capacity (Šúr et al. 2013), suggests that these programmes can be highly successful when the original problem is removed.

3.6.3 Fire management

Certain ecosystems become more vulnerable to fires following human disturbance such as harvesting or infestation by invasive alien species. The change in fire frequency can have detrimental impacts on biodiversity, even in fire-dependent ecosystems. In these cases, interventions are required to reduce the risk of fire, and may include cutting fire breaks or convincing landowners and local communities to change their agricultural practices. Community based fire management in Caprivi, Namibia, yielded impressive livelihood and livestock gains within a few years, making it an attractive and viable option for communities (Hardcastle and Hagelberg 2012).

3.6.4 Ex-situ conservation

Ex situ protection of endangered species in botanical and zoological gardens, arboretums, gene banks and pollen banks is considered to play an important role in biodiversity conservation. There are at least 54 zoological gardens in Africa, of which 13 are in South Africa; Nigeria and Madagascar each have six, and Algeria, DRC and Egypt each have three. There are also a number of sanctuaries, such as the Chimpanzee sanctuary at Ol Pejeta, Nanyuki, Kenya, the Chipangali orphanage, Bulawayo, Zimbabwe, and Enkosini Eco Experience, Namibia.

There are about 89 botanical gardens in Africa. Of these, some 61 are in the Western Central and eastern African countries, with 20 in Nigeria, nine in Kenya, five in Ghana, five in Senegal, and four in Cameroon. In Nigeria, there is no central co-ordination of the botanical gardens (Borokini 2013). Most African countries have seed and field gene banks (FAO 2010). These tend to focus on agrobiodiversity, but some countries such as South Africa also include a significant effort on storage of biological diversity generally. Many countries report problems in using their facilities, however, due to problems such as lack of funds, equipment, staff and unreliability of electricity supply. For example, Guinea lost its entire ex situ collection as a result of failure in the electricity supply (FAO 2010). Only Benin, Cameroon, the Congo, Ghana, Kenya, Mali, Nigeria and Uganda have in vitro storage facilities.

Thus, while numerous facilities exist for *ex situ* conservation throughout Africa, these are not as effective as they should be: many facilities need to be upgraded, capacity building is required, and operations need to be more co-ordinated nationally, regionally and internationally.

3.6.5 Border protection

Border protection measures are required both for the prevention of introductions of potentially invasive alien species, as well as to prevent illegal trade in endangered species. Border protection involves not only the checking of freight by trained staff, but also the implementation of ballast water treatment measures. Several countries have now also developed 'rapid response' measures for situations where prevention measures are not sufficient and the invasive species is only identified once introduced or established (McEnnulty et al. 2001, NISC 2003, NEANS 2006, Locke & Hanson 2009, Turpie et al. 2012).

3.7 Sustainable use of land and resources

Achieving the sustainable use of land and natural resources[2] fulfils multiple objectives, one of which is reducing impacts on biodiversity. It is generally assumed that, under the right institutional settings, more productive production systems would reduce the growth in demand for virgin land (or coastal areas) as well as the demand for harvested natural resources. This, together with less damaging methods (less habitat damage, lower pollution outputs, less water wastage, less soil erosion, fewer genetic escapees etc.), will amount to more sustainable practices.

Achieving sustainable use of land and resources will require a revision of policy, legislation and institutions (or property rights) in order to change incentives and drive positive behaviour. These measures include:

- Allocation of clear property rights over land and resources;
- Removal of subsidies that encourage activities that cause environmental harm;
- Use of financial incentive measures (taxes or charges and subsidies or payments) to influence choices;
- Introduction of methods and technologies that improve productivity ("land sparing") and reduce harm;
- Setting standards for regulation and establishing certification systems to encourage achievement of higher standards;
- Performance bonds and offsets to ensure no net loss

Note however, that the actual choice of instruments and their combination is context specific and crucial to their successful outcome. For example, introducing methods to increase production in a situation without clear property rights would exacerbate rather than decrease the problem of biodiversity loss. Similarly the balance of measures to deal with industrial/commercial scale production on private land or concessions would be different from that used to deal with small scale production on communal land areas. The measures are described using examples, but it is not possible to describe the measures required for each subsector in detail. The detailed design of the policy measures to be implemented will be an important part of strategic planning.

Furthermore, while conservation efforts might be successful locally as a result of these measures, if the overall demand for resources such as fish or charcoal remains high, then the pressure will simply be displaced to areas where management is more lax (termed 'leakage' in policy impact studies). Thus, the above actions need to be complemented by interventions to address demand.

[2] Although the Aichi targets highlight fisheries and forestry, sustainable harvesting pertains to all renewable natural resources, including wildlife and water.

Land and resource-based activities (agriculture, aquaculture, silviculture, and the harvesting of fisheries[3], forest and wildlife resources) are all practiced on both a commercial/industrial scale as well as on a small scale (Box 10). Thus while they may provide important economic outputs, they also provide small-scale livelihoods for the majority of Africa's population and a fall-back option for people who have been marginalised and lack other options (e.g. Sandker et al. 2012). Allocation and management of these resources is thus a complex issue.

Box 11. Fisheries, forestry and wildlife use

Fisheries

In many African countries, the **industrial marine fisheries** have been overexploited through profitable relationships with foreign fishing fleets. South Africa is an exception to this, having excluded foreign fleets and having given priority to the management of these valuable resources. Industrial fisheries tend to be subsidised by governments in order to gain international advantage, encourage investment and generate employment. However, subsidisation of industrial fisheries is probably not as big a problem in Africa as it is in other parts of the world. One of the biggest problems in industrial fisheries is lack of information on stocks or reliable estimates of sustainable harvests, which arises because of the high resource requirements involved. Furthermore, because of the large capital investment in fisheries, there is also a political pressure to keep catch quotas relatively constant or above some minimum threshold, which can have negative consequences in years of low stocks.

Inshore coastal fisheries tend to be small-scale fisheries with simple technologies and easy access. These fisheries are of particular importance in terms of biodiversity and contribution to people's livelihoods. However, inshore coastal (and possibly some inshore lacustrine) fisheries are probably the most vulnerable because of the life history strategies of the species involved. Indeed, because of this and the open access nature of most inshore fisheries, these resources have been seriously overexploited throughout Africa. Inshore fisheries are not suitable for management as a social welfare system (i.e. managed for open access), and need to be better managed through property rights and regulation.

Inland river and floodplain fisheries also tend to be small-scale fisheries with simple technologies and easy access. Although heavily exploited, these are probably the most resilient of all the fisheries because of the fact that many of the targeted species are inherently adapted to extremely variable conditions. These fisheries are more suitable for management as a social welfare system, but measures need to be put in place to provide spatial or temporal refugia from fishing.

Africa's **lake fisheries** include industrial and small-scale fisheries on natural and man-made lakes. The fisheries of the larger lake systems have characteristics in common with inshore and pelagic marine fisheries. These fisheries have experienced problems from invasive alien plants and fish as well as from overfishing. The fisheries in the natural lake systems have been poorly managed and have had a very significant impact on biodiversity.

[3] In this report, fisheries are taken to include a wide range of aquatic resources including plants and invertebrates.

The highest priorities for intervention are probably the inshore coastal fisheries and certain industrial fisheries. Improved sustainability of fisheries in Africa will require:

- Expanding systems of no-take protected areas;
- Putting substantial effort into monitoring of fish stocks, determining sustainable yields developing management strategies that can cope with the underlying variability in fish stocks;
- Using buyouts to reduce effort in industrial fisheries;
- Limiting access and establishing LMMEs in coastal areas;
- Increasing regulation and enforcement; and
- Introducing certification systems.

Forestry

Forestry in Africa mainly comprises the commercial large- and small-scale exploitation of indigenous hardwoods, and the small-scale exploitation of indigenous trees for fuel and construction. As is the case with fisheries, these different activities require quite different interventions and management strategies. Plantation of exotic tree species for timber and pulp occurs on a much smaller scale.

Commercial timber harvesting generates important foreign income, but includes a large amount of exploitation by foreign companies, resulting in significant economic leakages. However, it also includes small-scale commercial producers. The commercial exploitation of forests in Africa is not well regulated and has been a disaster for biodiversity In certain areas where logging has opened up access to previously remote areas (Bennett et al. 2002). These problems are particularly severe in the tropical forest regions, but also extend to the dense woodland areas as far south as Zimbabwe and Mozambique. This area is one of the highest priorities for intervention.

The other main forestry activity is the **small-scale exploitation** of trees for fuel, most notably for charcoal production, as well for poles and timber for construction and crafts. This use is mostly for subsistence purposes and local markets, although there is considerable international trade in carvings (much of this informal). Unsustainable harvesting practices are rife through all the savanna woodland regions of Africa, and also coastal mangrove areas. While fuelwood harvesting is ubiquitous in rural areas and makes a significant impact, charcoal production is also fuelled by urban demands, and has much greater impacts. Most of this is by small scale producers who do not need major access routes to move their produce. Dealing with this problem is a major challenge and has received a lot of attention, particularly because of the impacts of deforestation on ecosystem services.

The main types of interventions required include:

- No-take protected areas;
- Better standards and regulation, monitoring and enforcement,
- Certification;
- Increasing processing efficiency;
- Addressing property rights and management capacity to achieve more sustainable use of forest resources through community forest management (CFM); and
- Introducing income-generating activities that require well-managed forests;
- Addressing urban and rural demands for fuel.

Wildlife

Sustainable use of wildlife is not explicitly mentioned in the Aichi targets but is integral to several of the targets. Wildlife resources have been badly depleted outside of protected area systems, especially in communal land areas. However, they are relatively easy to reintroduce where this has not involved excessive habitat destruction, which contributes to the success of simple interventions. Apart from the strict protection required for addressing the illegal trade in high value wildlife parts (ivory, rhino horn, lion bones etc.) and live animals, the main type of interventions used to encourage sustainable use of wildlife are:

- Devolving property rights over wildlife to local communities and landowners;
- Enabling the development of tourism ventures that make wildlife conservation profitable on communal lands; and
- Encouraging the conversion to game farming on private lands

3.7.1 Allocation of property rights

Lack of well-defined property rights (e.g. forestry, fisheries, pollution, grazing, water, wildlife, intellectual) is argued to be one of the most important drivers of overexploitation, land degradation and biodiversity loss. Property rights systems in Africa have undergone major changes through and following the colonial period, and continue to be a problem in the face of increasing populations and a large proportion of Africa's poor living in communal land areas where traditional systems of management have been weakened. Much effort is expended on rectifying this problem, through **community-based management programmes, the allocation of rights to resources such as fish, water, wildlife and grazing, and in the allocation of rights to pollute**.

It is widely asserted that devolving property rights to local communities can bring financial returns, social justice and environmental sustainability. These efforts often require substantial changes in policy and legislation, applied with extreme caution, given the high degree of sensitivity of these measures to their socio-economic and environmental context. This requires donors and investors to form innovative partnerships with local rights holders, with the donors bearing some of the set up costs. Numerous initiatives have been undertaken throughout Africa to address this issue in rangelands and wildlife areas, e.g. community-based natural resource management (CBNRM), in forests, e.g. sustainable forest management (SFM), and in coastal areas, e.g. locally managed marine areas (LMMAs).

These initiatives involve strengthening institutions and capacity for ecosystem and resource management. For example, evidence is growing that community-based management can have a major impact on the livelihoods of the poor, on the character of forest governance and on citizenship more generally (Brown et al. 2002). Implementation can be challenging, however, as there can be major disjunctures between the resident geographical community and those who claim ownership of the forest in question, which sometimes include urban elites of local origin. As a result, setting up community-based management projects can be an involved and costly process. Successful community-based management is highly dependent on a range of socio-economic contextual conditions, and p to now, there has been mixed success.

Reducing overexploitation in small-scale inshore fisheries will involve allocation of property rights such as fishing rights and/or territorial use rights in fisheries (TURFs) to eliminate open access problems, coupled with regulation and enforcement. The establishment of **locally managed marine areas** (LMMAs) is potentially an effective way of dealing with the problems of inshore fisheries (Box 12).

Box 12. Locally managed marine areas (LMMAs)

Studies from outside Africa suggest that locally-managed areas can be more effective than state-imposed MPAs. McClanahan et al. (2006) explored biological and socio-economic measures at four national parks, four co-managed reserves, and three traditionally managed areas in Indonesia and Papua New Guinea. Average size and biomass of fishes were higher than unmanaged areas in all areas under traditional management and at one co-managed reserve, but there was no difference for the other co-managed areas or any of the national parks. Traditional systems were designed to meet utilitarian community goals rather than fulfil the western concepts of conservation. The effective sites were able to exclude ''outsiders'' at a relatively low cost because of placement of the managed areas were near the village. Management effectiveness was positively related to compliance, visibility of the reserve, and length of time the management had been in place but negatively related to market integration, wealth, and village population size.

Village-owned marine protected areas have emerged on their own in parts of the world such as south-east Asia, but have seldom been established spontaneously in Africa, where inshore marine resources are largely subject to open access. Indeed, areas under traditional management in southern **Kenya** have been found to be lower in biological diversity and coral cover compared to other fished or fully-protected marine park or reserve sites established by the national government (McClanahan et al. 1997). There is a successful example in **Zanzibar**, however (Lange and Jiddawi 2009), and this may be a useful model that could be scaled up to other villages and to a larger scale LMMA. Many of the traditional forms of management are potentially compatible with national policies, but confusion and conflict occur concerning enforcement and its benefits. Discussions are required between traditional and national fisheries leaders to develop mutually-acceptable policies that augment and share the power of management (McClanahan et al. 1997).

On the southwest coast of **Madagascar**, recognising the need to combat a persistent decline in fisheries catch, the community formed the approximately 1000km^2 Velondriake LMMA. Temporary closures of octopus fishing areas resulted in increased catches and income, and as a result this management technique has become common along the coast north of Toliara, South West Madagascar. The LMMA has also led to extensive environmental educational campaigns, scientific research, and community-based monitoring. A local Malagasy law governing resource use, called a *dina*, is now in effect in the LMMA, which is a remarkable achievement considering the long-held, deep community tradition of open access. The success of the intervention is attributed to strong relationships between fishers, fisheries collectors, and the NGO, as well as its having followed a gradual process of beginning with demonstrable biological effects (Oleson 2011).

In addition, property rights also pertain to **intellectual property**. Thus addressing property rights includes implementation of the Nagoya Protocol. This protocol sets out clear provisions on access to traditional knowledge associated with genetic resources, strengthening the ability of indigenous and local communities to benefit from the use of their knowledge, innovations and practices (Sharma et al. 2012). This encourages the advancement of research on genetic resources which could lead to new discoveries for the benefit of all, and creates incentives to conserve and sustainably use genetic resources (Sharma et al. 2012). Initiatives are required that make forest conservation more

attractive to communities, such as beekeeping, butterfly rearing, tourism, or through systems of "payments for ecosystem services" (including REDD). This would strengthen CFM or co-management arrangements.

3.7.2 Removal of harmful subsidies

Subsidies are often put in place in order to address employment and food security issues, and are common in the agricultural sector. For example, in **Botswana**, agricultural input subsidies increase the exploitation of natural resources and sometimes lead to unsustainable use of natural resources. For instance, the loan schemes supporting purchase of livestock for keeping in communal lands that are already overgrazed around settlements tend to exacerbate the problems of overgrazing and diminish the productive potential of those rangelands. Following lack of grazing and desertification, the poor might tend to adopt desperate means of survival and begin to overharvest fuel wood and other veld products to sell as a means to earn an income, with a negative impact on biodiversity (Yaron et al. 2012).

Subsidies that encourage activities that cause environmental harm need to be adjusted or removed. This is often difficult politically, as those subsidies have typically been put in place to increase production and food security, protect producers and encourage employment, and the beneficiaries of subsidies sometimes have a strong political voice. In **Malawi**, the Ministry of Agriculture and Food Security spends 85% of their budget, which amounts to about 10% of the national budget, on the Farm Input Subsidy Programme. This programme subsidizes improved inputs like hybrid (maize) seeds and fertilizers. The scale of the subsidy is reportedly hindering investment in other areas and there are also concerns over the impacts of the subsided fertilisers on local ecosystems. As yet there are no plans to tackle the issue of subsidy reform (UNDP-UNEP 2013).

The process of removal of subsidies will sometimes involve extensive negotiation, public and international pressure. While this may involve a costly process, their elimination will free up budgetary resources that can potentially be used for beneficial activities. Economic analysis is needed to demonstrate these potential benefits.

3.7.3 Introduction of financial incentives/measures

Many of the Aichi targets will require the use of incentive measures to bring about positive behaviour. These include taxes, charges and deposit-refund systems to increase the costs of damaging activities, subsidies, payments or even buyouts to reduce harmful activities and encourage conservation activities. Subsidies and payments require funds and are popular, but go against the polluter-pays principle and are not always effective. This includes "payments for ecosystem services". Taxes and charges are effective, but politically unpopular. Nevertheless they can be shown to be pro-poor. Buyouts are potentially effective, but costly.

Of the measures listed above, buyouts have not yet been attempted in Africa, and their effectiveness is not proven. For some types of fisheries, removal of some effort may not result in a proportional reduction in catches as it may allow other actors to increase their catches to an extent. Buyouts are likely to be required when capital investment in fisheries is high, making exit difficult.

The initial cost is high, but would lead to savings in management costs in the long run. The costs of would vary depending on the types of fisheries, and might also include retraining costs (Harding et al. 2012).

3.7.4 Improved organisation and marketing

Sustainable agriculture will require better governance and organization of production. According to (Hardcastle and Hagelberg 2012), access and benefit sharing arrangements will be expensive to secure and need to be linked with wider work on governance. Success with equitable revenue-capturing schemes would greatly strengthen enhanced governance, by for example raising community willingness to act against illegal activities (Hardcastle and Hagelberg 2012). Production can also be improved through access to reliable markets. Lack of access to markets is a key constraint facing rural smallholders in Sub-Saharan Africa (Lewis et al. 2011*a*).

- In **Burkina Faso, t**he producers of shea products formed a union (the NUNUNA Federation) and introduced informal measures to protect and conserve 3,345 hectares of shea-tree areas. Investments in technological improvements (shea butter processing factory) and certifications (Fair Trade) have helped the 4,000 members achieve a 95 per cent increase in income, while the position and workload of shea nut collectors has also improved. In addition, the NGO TreeAid has led to ongoing discussions with government over how to establish more secure commercial rights and so create a stronger incentive to enrich or restore forest areas with desirable trees like shea (MacQueen 2013).
- **In Zambia**, the Community Markets for Conservation (COMACO) model was developed in the Luangwa Valley, to promote and maintain sustainable agricultural and natural resource management practices among the communities surrounding national parks. The least food-secure households are identified and trained in sustainable agricultural practices that minimize threats to natural resources while meeting household needs. In addition, people responsible for severe natural resource depletion are identified and trained to generate alternative income. The project also provides extension support and transport of produce to a trading centre and ultimately to high-value markets. The project has brought about productivity levels that give COMACO access to stable, high-value markets and progress toward economic self-sufficiency and has also resulted in the stabilization of previously declining wildlife populations. In 6 years, the 60 extension staff have trained more than 40,000 farmers, 19,000 of whom are registered as having completed training and being compliant with Conservation Farming (CF) practices.

3.7.5 Improved methods and technologies

There is some debate about 'land sharing' systems, such as agroforestry, versus 'land sparing' systems, which involves sensitive intensification. Under the right conditions, agroforestry systems tend to be high in species richness and more similar to neighbouring forest reserves, and can thus play an important role in biodiversity conservation in human-dominated landscapes. Tscharntke et al. (2011) claim that although traditionally land sharing has been considered more biodiversity-friendly, land sparing is better as there is no loss of biological control, and it compliments small farm holdings more than land sharing does. Land sparing is considered to be a more promising strategy

for minimizing negative impacts of food production, at both current and anticipated future levels of production (Phalan et al. 2011).

Improving methods and technologies in **agriculture** includes the introduction of better seed varieties, encouraging reduced tillage, reducing reliance on external inputs, introducing more efficient cropping methods (e.g. polyculture), effective livestock management and efficient irrigation. For example:

- In **Ethiopia**, the seed industry is monopolised by state-run supplier focusing mainly on selling improved and hybrid varieties, and there is also no supply of local varieties (which also hampers the progress of achieving Target 13). Farmers therefore meet their needs through informal exchange systems (Atilaw and Korbu 2011, Fukuda 2011), as occurs in many parts of Africa (Kuyek 2002), but only to a limited degree because of the belief that everyone has the same crops and varieties. A community seed bank project has been successful at integrating the traditional styles of obtaining seed through exchange, but providing a greater choice of sources of seed, contributing to the management of agro-biodiversity, seed security and improved welfare for the farmers, and also ensuring in-situ conservation of genetic diversity (Atilaw and Korbu 2011, Fukuda 2011). This provides an example of a cost-effective intervention through supporting decentralised projects in order to circumvent central government inefficiency.
- In **Namibia**, the UNDP-GEF Conservation Tillage Project (CONTILL) advocates conservation tillage as a method for achieving resilience to climate change. The project encourages farmers to produce and apply compost-based fertilizer, to practice minimal soil disturbance using ripping and furrowing, to create in-field water harvesting, and to apply crop rotations, which enable farmers to secure their own food supply and to market surpluses. The project aims to reduce the negative effects of floods, drought and irregular rainfall patterns, rising temperatures, and soil degradation, and has already resulted in an increase in agricultural yields of up to 500% (UNDP 2011).

Improving the sustainability of **aquaculture** systems involves better site selection, management, culturing different species together (integrated multitrophic agriculture - IMTA), and the use of enclosed, and especially re-circulating, systems to avoid contamination of surrounding areas. IMTAs are cost-effective, generating revenues from the lower trophic level species that are farmed together with the main cultured species. Closed containment is only viable for high value species. These systems require further research and technological development to become more effective and affordable, as well as government incentives and regulation to help their implementation (Harding et al. 2012).

In plantation **forestry**, investments in new and more efficient technologies have been lagging behind, providing opportunities for major gains through technology transfer (Hardcastle and Hagelberg 2012). Among small-scale growers, impacts of plantation forestry can also be achieved by promoting indigenous species as an alternative to exotic species. For example:

- In **Uganda** farmers deliberately plant trees for wood and other uses. However, these planted trees are mainly exotic species, because farmers do not have access to diversity, quality and quantity of indigenous species. Investment in promoting commercial seed networks and better quality seed practices using indigenous species would have benefits for people

through reduced erosion and continued supply of forest products, and at the same time reduce landscape fragmentation and increase habitat for other species (Boffa et al. 2005).

- In **Zambia**, indigenous fruit trees play an important role in household livelihoods, and domesticating some of these species may be a good avenue for development (Kalaba et al. 2009).

Improved processing could be a way of reducing pressure on tropical forests by decreasing the number of trees felled to yield a similar volume of products (Hardcastle and Hagelberg 2012).

Even if new methods are shown to be more productive, investments by poor farmers may be expected to be slow (Mortimore 2005). Better conditions for private investment, such as local financial infrastructure and tenure security, would facilitate entry to niche markets and increase the profitability of sustainable forest management in general (Reichhuber and Requate 2012*a*).

3.7.6 Standards and regulation

Standards and regulations need to be addressed in many land- and natural resource based production systems. Most commercial production takes place on private land or concessions which provides the opportunity for improved management and regulation regarding methods and inputs. A priority in this regard is regulating timber harvesting methods and regulating the construction of forestry roads to minimise collateral damage through increased access to non-timber forest resources.

3.7.7 Certification

Certification systems are introduced at some cost to producers and consumers, but through increasing consumer awareness and access to markets, these measures can also provide an advantage to producers.

Investing in organic production and marketing may represent a cost-effective investment in livelihood improvement through access to lucrative organic markets. Many African production systems would be relatively easy to convert to recognised organic systems, and there is provision for a shorter conversion period for land that has a history of minimal agrochemical use (Thamaga-Chitja & Hendriks 2008). However, indigenous systems have been eroded with the advent of the Green Revolution (Juma 2007), and capacity-building would be critical for success. Government intervention, such as subsidized organic certification and facilitation of group certification among smallholder farmers would be vital to promote local organic production (Thamaga-Chitja & Hendriks 2008).

Opportunities for certification are also increasing with the growing demand for legally and sustainably sourced timber and fish. Forest certification has traditionally been applied to large-scale commercial ventures, but is also being applied in community-managed lands. For example, The Mpingo Conservation Project in Tanzania obtained the first FSC certificate for community-managed natural forest in Africa. The certification raised revenues by US$1,800 for the two communities involved, half of which was used to pay forest patrols and management activities (creating jobs and

boosting the local economy) and the other half to build new houses (Oldfield 2012). It is anticipated that FSC certification will enable communities to earn more than $19 per log compared to $0.08 they received before the start of the Project (Oldfield 2012). Communities with more than 7,000 hectares of forest are expected to earn more than US$100,000 per year from this scheme (Ball, 2010).

Certification can be strengthened by public procurement policies and voluntary partnership agreements. Public expenditure constitutes a strong market force which can bring about sustainable production. Such practices are now the norm in many northern countries, such as requiring SFM (Hardcastle & Hagelberg 2012), but have not been introduced in most African countries. Voluntary partnership agreements (VPAs) serve to broaden the number of countries within which for concern for legality is an important consideration. For example, this could apply to timber exporting countries meeting certain requirements in order to facilitate their access to markets. This does not necessarily eliminate unsustainable practices within producer countries but it does exclude it from international trade (Hardcastle & Hagelberg 2012).

It is important that investors require specific beneficial practices. For example, payment of a planting grant can be on condition that a certain proportion of the area is left untouched. For example:

- In **Uganda**, the Sawlog Promotion Grant Scheme supports plantation development only on degraded land, maintains standards through training and linking grant payments to achievement of defined standards confirmed by field inspection (Hardcastle & Hagelberg 2012)
- In **Ethiopia, f**ield research conducted in the coffee forest areas showed that forest coffee certification activities do not adequately promote conservation of the coffee forest ecosystem and its biodiversity. This is mainly because certification standards are designed to target agricultural coffee production systems and not biodiversity. In fact, the higher prices paid to producers for certified coffee provides an incentive for farmers to clear the forest areas more (Stellmacher et al 2010).

3.7.8 Managing demand for resources

In order to prevent 'leakages', or diverting resource use to other areas, interventions to achieve sustainable use need to include measures to reduce demand for those resources whose production or harvest is difficult to control on a wide scale. The most important examples are charcoal and fish. Reducing the demand for charcoal will entail introduction of alternative technologies, particularly in urban centres. Reducing the demand for certain fish involves consumer awareness campaigns.

3.7.9 Provision for implementing performance bond and offset systems

Many damaging activities such as infrastructure development and mining carry major environmental costs. Current requirements for mitigation and rehabilitation, as provided for under EIA regulations, are often weak and ineffective, especially where developers withdraw and declare bankruptcy at the end of a project. Performance bonds and offset systems ensure that residual damages are either rectified or offset by conservation actions elsewhere (Box 8**Error! Reference source not found.**). owever, in order for these systems to work effectively and not be misused, very strong policy,

legislation and sets of procedures need to be in place. These measures also apply to the protection of important flora, such as on private lands in the fynbos areas of South Africa.

Box 13. Performance bonds, banking and offset systems

Performance bonds are essential down payments made by developers to cover possible damage costs or to undertake rehabilitation at the end of a project.

Biodiversity offsets are conservation actions taken by developers to compensate for residual, unavoidable harm to biodiversity caused by development projects. However, there are risks involved in offsetting, including that the offset doesn't deliver the intended benefits, it may cause disputes around the process of placing value on biodiversity, and it can cause disagreements around conservation priorities (Kuntonen-van't Riet 2007). An example of a mining **biodiversity offset** project comes from South Africa, where a coal-mine committed to rehabilitate degraded wetland areas offsite to compensate for the unavoidable impacts on biodiversity onsite. This was a new offset design in South Africa and challenges included the bureaucracy of government processes; worries about the long term sustainability of the offsite rehabilitated land because it was not owned by the mine; inability to find "like" wetlands, and so rehabilitated wetlands were not identical to what was lost; and rehabilitation costs exceeding original estimates, partly because long term maintenance and monitoring costs were not originally considered (Kuntonen-van't Riet 2007).

Wetland banking, is a system where developers purchase enough wetland credits to offset their impacts, and these credit purchases are deposited with a regional wetland bank that uses the funds to restore wetlands in other areas that provide ecosystem services as least as great as those developed (Talberth and Gray 2012). The costs include: (a) the price of wetland credits paid by private entities seeking wetland development permits, and (b) the costs public agencies incur in managing the permitting process and otherwise providing oversight for the banking programs (Talberth and Gray 2012). Globally, credit prices range from $22,356 to $404,000, with an average of $33,721 per hectare (Madsen et al. 2010). This is equivalent to about **$3000 to $30 000** per hectare per year (Talberth and Gray 2012). In addition, costs of managing wetland banking programs amount to about **$150 to $1,500** per hectare per year (Talberth and Gray 2012).

3.8 Address pollution problems

The most important pollution-related threats to biodiversity in Africa are in freshwater and marine systems. Marine pollution problems include plastic pollution of sea and coastal areas, as well as oil pollution events. The pollution of freshwater systems poses a major threat not only to biodiversity, but to human health and production systems:

- Agricultural runoff results in the eutrophication of freshwater systems, in turn leading to clogging of water bodies and toxic algal blooms in dams that are used for domestic water supply;
- Mining activities are the cause of the most severe pollution in freshwater systems, particularly as a result of the abandonment of mines and informal mining activities that use toxic chemicals.
- In many areas, including South Africa, wastewater treatment infrastructure is out dated or has not been adequately maintained, resulting in badly polluted river systems.

Measures to reduce pollution outputs and the risks of oil spills are required on a large scale. These include:

- Upgrading and repair of wastewater treatment systems
- Stemming acid mine drainage and damaging commercial and informal mining activities
- Convincing governments to ban the sale of plastic carrier bags and restrict packaging

In addition, **certification** can be applied to discourage pollution in coastal areas. For example, in South Africa the uptake of the Blue Flag certification system for beaches has influenced public management to provide better controls over water pollution, and also to improve water quality monitoring and safety on beaches (Spenceley 2010).

3.9 Develop sustainable financing strategies

3.9.1 Devise sustainable financing mechanisms for protected area systems

Developing countries harbour most of the world's biodiversity, and its protection generates benefits at a global scale, including genetic resources and carbon sequestration. However, protected areas are far more costly for developing than for developed countries, often exceeding 1% of GDP. These costs can be offset to a degree through grant finance, but annual Global Environment Facility finance and co-finance averages only 8% of the opportunity costs faced by low-income countries, which is justifiable on the basis that the role of the GEF is only to finance global environmental public goods, not the local benefits that countries derive from their conservation efforts (Hamilton 2013).

UNDP has provided an excellent evaluation framework to assist countries in the development of sustainable financing strategies for parks. Such strategies include revising park pricing strategies, enabling voluntary payments and donation, and setting up endowment funds. While it is not particularly expensive to set such systems in place (apart from the endowment itself, which creates the incentive for a swift response), some further investment is required to ensure its success.

3.9.2 Payments for ecosystem services

Outside of protected areas, financing mechanisms to fund conservation efforts include setting up systems of payments for ecosystem services (PES). PES projects aim to pay landowners to take the necessary actions to ensure the delivery of ecosystem services. Usually this involves the reduction of damaging agricultural or deforestation activities. The most common applications are for water and carbon storage or sequestration. The latter include REDD projects (reduced emissions from deforestation and degradation). Africa has lagged behind the rest of the world in the implementation of these projects. A large number of projects have been initiated, but few have reached the operational stage. So far the REDD projects, which were initiated later, and which rely on international buyers, have fared better than the PES projects focused on hydrological services, in which the potential buyers are local.

3.9.3 Facilitate private sector investment in restoring and maintaining ecosystems

Three are opportunities for private sector investment in the restoration or maintenance of ecosystems in order to secure the supply ecosystem services. Such investments could include

funding sustainable use initiatives, ecosystem restoration/rehabilitation and improved ecosystem protection and management. While some commercial opportunities may exist, such as provision of water for breweries or bottling companies, it is likely that the bulk of such investment would be either in order to manage risks, in the case of the insurance industry, or in order to stimulate business through meeting the criteria for rating and accreditation systems, or simply through the marketing benefits of Corporate Social Responsibility investment. These types of investment are slowly gaining ground in Africa. Incentives for all these types of investments already exist to some extent. For example, in South Africa, the South African Breweries Limited (SAB) has formed a strategic alliance with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and WWF-SA to assess and reduce water risk in watersheds, and insurance companies such as Santam are starting to invest in ecosystem restoration in areas that are prone to natural disaster. However, most companies who are engaging in RI are focused on humanitarian goals. More advantage needs to be taken of the opportunity provided by investment in ecosystems, and this will require demonstrating the social benefits of doing so. The barriers need to be identified and the opportunities unlocked. Structures need to be put in place to develop and facilitate investment in bankable projects.

4 RESOURCE REQUIREMENTS

4.1 Key points

- Estimates of spending requirements are order-of-magnitude estimates at this stage as not enough evidence could be gathered in the time available to produced detailed costings that take geographical variation into account.
- Research and development expenditure could be in the order of $17.5 million. Investments in awareness and capacity probably need to be in the order of $7-8 million per country, and about $5-10 million needs to be spent on integrated land and resource use planning per country.
- Direct protection measures such as expanding protected area systems and restoring important natural habitats may require billions of dollars at the continental scale.
- Costs of achieving sustainable land and resource use are extremely variable, ranging up to $2000 per ha.
- A recent estimate is available of actual spending on conservation by country which suggests that at least US$480 million is currently being spent in Africa as a whole. This is probably a fraction of the investment required.
- All African countries are spending considerably less than 1% of their GDP on direct conservation activities, and the majority spend less than 0.1%. Spending is by far the highest in South Africa, but South Africa's spending represents among the lowest investments relative to GDP. The top six spenders are countries that have a high level of benefit from nature-based tourism.
- More research is required to establish what countries are spending on all the actions that contribute towards meeting the Aichi targets.

4.2 Costs of the actions required

4.2.1 Research and development

National assessments and accounting of biodiversity value

Preparing baseline valuation studies can be done at various levels to suit the needs of decision makers, but detailed planning generally requires fairly comprehensive assessments. The WAVES programme (s) has allocated an average of **$1.5 million** per country in order to develop natural resource accounts (Rayment 2012). This includes some capacity building.

Research and monitoring

A comprehensive desk-based **biodiversity inventory** could cost in the order of US$250 000 per country (African Development Fund 2013). Some countries, such as South Africa already have very comprehensive, spatial assessments of their biodiversity and its conservation status. However, in most African countries, there is a need for primary data collection on ecosystems and biodiversity.

Thus the financial resources required are likely to be more substantial, in the order of US$1 million per country.

Research and monitoring of ecological and socio-economic systems is hard to cost, since the returns to improved knowledge do not tend to decline. The African Development Fund (2013) estimated that baseline and ongoing monitoring of forested areas alone would require $1.5 million per country with annual costs of US$400,000 per country for collecting, verifying and reporting on the additional indicators. In South Africa, the government spent US$12.5 million on biodiversity-related research during 2012-13 (National Research Foundation annual report), and $1.5 million on biodiversity monitoring by a dedicated government institution (SAEON). In total African countries should be investing in at least $15 million per year in research relevant to the Aichi targets. Research funding needs for **technological and product development** are probably considerably larger.

4.2.2 Raising awareness and capacity

Awareness raising efforts do not require very big investments compared with many of the other actions required, but investment in doing them well is crucial to the effectiveness of what follows. They do, however, rely on investments in knowledge and research, which needs a considerably larger investment.

Baseline surveys help to focus awareness raising efforts. Based on assumption that national survey would need to be based on sample size of 1000 people, Conway (2012) suggested that such surveys could cost between US$50,000 and $100 000 depending on how difficult it is to reach the public. A study commissioned recently in South Africa is within this range. Following this, the development and execution of national communication and awareness strategies and campaigns could be expected to be in the region of $1-2 million per year (see Table 2). Improving awareness among decision makes will require the employment of one or two policy advisors to national government, which could cost in the order of $100 000 per country per year. In addition, policy advice can also be generated by consultancies and academic institutions, such as those affiliated with the EfD that have specific budgets aimed at the dissemination of policy advice (see Box 14). This suggests that additional allowance of at least $100 000 per country per year for other inputs to policy makers should be made, which includes production of policy briefs, workshops and events.

Box 14. The EfD Initiative

The Environment for Development initiative is a capacity building program in environmental economics focusing on research, policy advice, and teaching in Central America, Chile, China, Ethiopia, Kenya, South Africa, Tanzania and USA. The EfD centers in Africa are hosted by universities. It is initiated and managed by the Environmental Economics Unit, University of Gothenburg, Sweden. Financial support is provided by the Swedish International Development Cooperation Agency (Sida), and builds on Sida´s Environmental Economics Capacity Building Program. Core funding to support their activities excluding research amounts to about $100 000 per country centre.

Table 2. Some examples of awareness campaigns in Africa, and their costs. Source: (Conway 2012, ABCG 2004, Crump et al. 2000)

Name	Description	Cost (US $)
Cross River Gorilla Conservation in Nigeria and Cameroon: *"My Gorilla - My Community"*	The campaign targeted behaviour change to promote habitat conservation for the last remaining 250 Cross River gorillas that reside in Nigeria and Cameroon. The project involved engagement with local communities in dialogue and activities that promote the conservation of habitat and cessation of harmful activities. An Entertainment-Education drama (Linda's Joint) was also prepared for broadcast.	100 000 per year
Coastal Management in Ghana	Campaign involved developing a 52 episode radio soap opera (Biribireba), reaching up to 2.5 million people each week in six coastal districts of the Western Region of Ghana	150 000 per year
Sustainable Forestry in West Africa:	Programme spread over 4 countries and 3 transboundary hotspots. Campaign included a 52-episode radio drama in 5 languages.	500 000 per year
Sustainable Forestry & Ape Conservation in Gabon: *"The Sustainable and Thriving Environments for West Africa Regional Development (STEWARD)"*	Campaign sought to turn Gaguie the Gorilla, the official mascot of the African Cup of Nations football tournament, into an ambassador for conservation through editorials in newspapers; distribution of over t-shirts, hats and stickers with conservation messages to fans; ten conservation-themed discussions on Gabon's primetime morning TV show; and arranging for Gaguie and his dance troupe to parade a banner stating "We all win when we protect nature" around the stadium before the final game of the tournament	100 000 per year
Chimpanzee Conservation in Rwanda & Burundi: *"My Chimpanzee - My Community"*	Promoting the conservation of chimpanzees and their habitat in the Nyungwe-Kibira landscape in Rwanda and Burundi through the launch of a training workshop for program partners in March 2012 with broadcast set for January 2013	100 000 per year
Chimpanzee Conservation in Liberia & Sierra Leone: *"My Western Chimpanzee - My Community"*	Promoting the conservation of Western chimpanzees and their habitat in the Upper Guinea Forest Ecosystem in post- war Sierra Leone and Liberia	100 000 per year
Produce media materials	Produce 5000 posters and 3000 publications for Africa Biodiversity Collaborative Group (ABCG)	20 000
Hives of Hope event, South Africa	Developing two versions of Zulu beehive shaped huts, constructed of indigenous plants, to be created for COP 17. The Hive would be 10 metres high and designed as a place of rest and reflection, and to illustrate the intrinsic values of biodiversity.	240 000
"Yebo Gogga"	A week long arthropod exhibition that takes place annually at the Johannesburg Zoo. The show is based on demonstrator engagement and participatory experiments. The exhibition is aimed specifically at educating children and promoting interest in arthropods. The success of the exhibition has been demonstrated by increasing visitor numbers and visitor evaluation responses, as well as the level of media attention attracted.	16 500
Every River Has its People" (ERP)– Okavango,	This SIDA-funded project has served to raise awareness of the management issues of the Okavango River basin among local communities in Angola, Botswana and Nambia as well as building capacity and sharing information.	2 million over 3 years for Phase 2

Table 3. Costs of school education programmes (Source: 1, 3)

Country	Project	Annual Cost (US $)
Nigeria	Family Life and HIV education	560 000
Kenya	World starts with me (sexuality)	360 000
South Africa	Midlands Meander Education Project – aim to integrate environmental education into school curriculum through educator support and co-teaching	5000 for one school (112 children and 6 teachers)

Thus in all, investments in awareness and capacity are likely to be in the order of $7-8 million per country.

4.2.3 Developing plans and strategies

All of the actions need to be addressed together in integrated local level planning, catchment scale planning, in coastal zone management, and large marine ecosystem management. In this regard, care must be taken not to overestimate the costs of meeting the targets through double-counting, for example, if one were to include the costs of Integrated River Basin Management as well as the costs of implementing soil conservation measures in agriculture.

Developing plans for sustainable production and consumption is complex and requires time by governmental and/or a multidisciplinary team of consultants. Such planning could amount to something in the order of **$500 000 per country**. If this were done thoroughly for a few countries, other countries would be able to take these plans and adjust them to their own situations.

Integrated coastal management plans costs in the order of **$100 000 per 100 km** coastal area. There are economies of scale in some of the work, but it generally involves interaction at the local government (municipal) level. Given that Africa's coastline is 26,000 km, the total investment would need to be in the order of $26 million.

Integrated river basin management is often multinational and can be extremely costly. For example,

- In **Angola, Namibia and Botswana**, the Okavango Improved River Basin Management Project (IRBM), funded by USAID, cost US$5-6 million over 4 years (2004-2008; Tortell & Ayibotele (2006).
- In **South Africa**, integration of ecosystem considerations into water resource planning added about $150 - 300 000 to the process of water resource planning in the Berg River catchment. This process included consideration of environmental requirements in the design of the dam, the capital costs of which are discussed in a later section.
- In **Tanzania**, the Pangani River Basin Management Project (2002 to 2010) cost US$ 4.78 million (Cross and Förster 2011). Of this about US$200 000 was spent on quantifying changes in ecosystem services and the overall social and environmental tradeoffs (source: Author),

Given the fact that each country will have to plan for multiple river basins as well as coastal and ocean areas, a rough estimate of the total cost of implementing and/or upgrading planning

processes would be **$5-10 million per country**. These processes yield immense amounts of information, and are a very high priority.

4.2.4 Direct protection

Strengthen protected area systems

Establishing a new protected area may require the purchase of land at full market value, or it may simply require a change in land use on government, private or community-owned land (Ervin and Gidda 2012). As one increases the total area under protection, so the opportunity costs of protection increase, and hence also the acquisition costs. The costs of creating new protected areas are therefore highly variable and site specific. The most challenging areas for consolidating and expanding protection are likely to be where land pressure is high and demand for land is the primary driver of habitat loss (Hardcastle and Hagelberg 2012).

Globally, **acquisition** costs for terrestrial protected areas range from $460 to $10 189 per hectare and management costs range from $4.68 to $76 per hectare (Talberth and Gray 2012). In Ethiopia, (Reichhuber and Requate 2012*b*) estimated the acquisition and management costs of protecting a forest area US$79/ha US$3/ha respectively. The establishment cost of 76,000 km^2 of protected areas in the Niger Delta – Congo Basin Forest Region (Nigeria, Cameroon, Equatorial Guinea, Gabon, Central African Republic, Congo and the Democratic Republic of Congo) has been estimated to be in the order of $1 billion over ten years ($132 per ha).

Box 15. Cost of establishing protected areas in Madagascar

With donor funding, the Malagasy government has invested $75 million in the formation of a protected area network over a ten year period, resulting in a total of 41 protected areas covering approximately 1.5 million hectares. This investment protects approximately 3% of the country from deforestation. The protected areas are attracting increasing numbers of visitors and are making a significant contribution to tourism development in Madagascar (Carret and Loyer 2003).

Box 16. Conservation agreements with private landowners in South Africa

In South Africa, state protected areas have been augmented by management agreements with private landowners. In the Western Cape, areas of the globally important Cape Floral Kingdom (CFK) biome are protected by means of contractual agreements with farmers. The CAPE project embarked on a long term programme to achieve this, at an estimated cost of US$80 million (Stoll-Kleemann and O'Riordan 2002). Within this area, a conservation corridor now covers 37% of the biodiversity-rich Agulhas Plain and approximately 40% of the area of this corridor is conserved through private landowners, mostly in the form of stewardship agreements and conservation easements (Cadman et al., 2010).

Balmford et al. (2004) demonstrated that the size of the individual MPAs is the key determinant of cost. A more recent study shows that the costs of establishing vary with both size and the duration (in years) of the establishment phase (McCrea-Strub et al. 2011). The costs in are somewhat higher than those estimated in (Ervin and Gidda 2012;).

Table 4. Costs of establishing MPAs in Africa Source: (Gabrié et al. 2010).

		Total cost (US$)	Cost/km^2
Narou Heuleuk (4 MPAs), Senegal	102km^2	18 090 000	177 353
Seychelles MPA	182km^2	1 890 000	10 385
Mnazi Bay, Tanzania	250km^2	3 176 550	12 706
Quirimbas MPA in Mozambique	1522km^2	7 107 750	4 670

Table 5. Estimated costs per square kilometer for establishing new MPAs (Ervin and Gidda 2012).

MPA size (km^2)	Cost of establishment/km2 (US$)
5	21 110
50	6990
500	2315
5000	766
50 000	254
500 000	84

Current expenditure on **management of protected areas** in lower-income countries reportedly only covers 31% of requirements (McCarthy et al. 2012). Based on a study of management effectiveness of nearly 7,000 protected areas worldwide, Leverington *et al*. (2010) found that management of 13% of protected areas was clearly inadequate, 27% had basic management with major deficiencies, 35% had basic management, and 25% had sound management in place (Ervin and Gidda 2012). Nevertheless, many countries in West and Central Africa were found to have reached the 60% target, possibly as a result of strong efforts of IUCN in that region through the PAPACO project (Coad et al. 2013).

Based on reserve sizes and economic indicators, Moore et al. (2004) estimated that US$630 million per year would be required to effectively manage reserve networks covering 10% of each of Africa's 118 ecoregions. Costs are likely to be correlated with levels of endemism and threat and that focussing exclusively on cheap areas is unlikely to achieve conservation goals. In the case of MPAs, management costs are inversely related to the distance to inhabited land (Balmford et al. 2004). Based on the model developed by Balmford et al. (2003), reported financial needs of terrestrial protected area systems in developing countries, and data on protected size, annual GDP per km^2, human development index and purchasing power parity, Bruner et al. estimated that annual management costs of existing protected areas in developing countries are in the order of $208/km^2 (Ervin & Gidda 2012).

The cost of **effective management** is a difficult to estimate, because protected area management can include tourism- and education-related activities as well as ecosystem management and enforcement. Hardcastle & Hagelberg (2012) considered law enforcement to be a crucial activity, and estimated that about **US$3 million** was required per country per year for law enforcement just for the management of forests. Butchart et al. (2012) estimate that median annual costs of *effectively* managing protected important bird areas in low income countries would be around **$272/km^2**. Ervin & Gidda (2012) estimate an average cost of **$119/km^2** to *improve* management effectiveness for both terrestrial and marine protected areas, ranging from $50/km^2 to $250/km^2. Estimated costs of effectively managing MPAs are given in Table 6.

Box 17. Costs of effective management of terrestrial protected areas

Conservation in **island hotspots** and **South African fynbos** costs $2500–12,500 per km^2 per year, compared with $500 per km^2 required for the Guinean forests of West Africa and for Madagascar (Moore et al. 2004).

In the **Niger Delta – Congo Basin** Forest Region mentioned above, estimates have also been made for the costs of effective management of the existing protected area system of about 135,000 km^2 plus the additional 76,000 km^2 to be acquired. This would require an estimated $87 million a year for management (about $4/ha) (Blom 2004).

The Lewa Wildlife Conservancy (LWC) occupies 62 000 acres of land in **Kenya**. The GEF awarded LWC a grant of US$0.75 million for the period 2000 to 2003, with co-financing amounting US$3.193 million. The three outcomes - long-term capacity of Lewa to provide global and local benefits from wildlife conservation strengthened, protection and management of endangered wildlife species in the wider ecosystem strengthened, and community-based conservation and natural resource initiatives strengthened – were all considered well to fully achieved (CDC 2007).

Blom (2004) estimated the costs of establishing an effective protected area system of 76,000 km^2 in the Niger Delta – Congo Basin Forest Region (**Nigeria, Cameroon, Equatorial Guinea, Gabon, Central African Republic, Congo and the Democratic Republic of Congo**) to be in the order of $1 billion over ten years ($132 per ha), much of this for improved management of existing protected areas.

Table 6. Estimated costs of effectively managing new MPAs (McCrae-Strub et al. (2011):

MPA size	Cost of establishment/km2 (US$)
5	47623
50	7723
500	1253
5000	203
50 000	33
500 000	5

4.2.5 Restoration

Restoration of degraded habitats, including the clearing of alien invasive species and reintroduction of populations, is considered to be one of the most expensive forms of direct conservation action. Nevertheless, restoration yields obvious benefits and numerous examples of projects exist throughout the continent (Box 18).

In the case of alien plant invasions, clearing costs for different genera across a range of densities vary significantly. The costs of restoration will also vary widely according to habitat as well as the level and degradation, and thus the extent of the restoration work. These costs are likely to be disproportionately high on islands, where they are often an integral part of species recovery programmes. At present, approximately US$60 million is spent annually on the control of IAS in Africa (UNEP 2006). The required expenditure is in the order of $2.74 billion (Turpie et al. 2012), not including control of agricultural pests and pathogens. A much more detailed assessment would be needed to estimate the funds required for other restoration and reintroduction programmes.

Box 18. Examples of restoration projects and costs

Range land restoration in South Africa. Ostrich production in the semiarid Little Karoo region of South Africa has had major impacts on rangelands in spite of specific legislation controlling stocking rates in order to avoid degradation. Herling et al. (2009) explored the restoration costs associated with shifting production focus from ostrich production to sheep production, a relatively conservation-compatible land use. Rehabilitation was not found to be financially feasible for private landholders because of the high costs of producing viable seedlings.

Forest restoration in east Africa. The Shinyanga region in central Tanzania had become severely degraded, with particularly negative impacts on forest resources. In 1986 the government started the HASHI project, which was instrumental in reviving the local people's traditional practices of conservation (called Ngitili), to create and restore forests in the region. By 2002 between 300 000 and 500 000 ha of Ngitili were restored. The economic value of a restored Ngitili is $14 per person per month, while national average rural consumption is $8.50 per person per month. The time needed to collect fuelwood, pole, thatch, water and fodder was reduced by several hours. Sukuma agropastoralists also pointed out that trees and catchment conservation improved water quality in the region, that restored woodlands provide fodder for oxen at the end of dry season - a critical time of the year. The HASHI program recognized the importance of the traditional practices of managing forests with enclosures, the Ngitili, and used the traditional knowledge of the Sukuma people as the basis for the restoration. This empowering approach was critical as it increased local people's ownership over, and capacity to manage their own natural resources. In order to protect and restore those goods and services, participatory planning including women's groups, youth, village government, and individual farmers, was essential in order to try to ensure equitable forest management and avoid elite capture. However, as the value of Ngitilis has risen, the powerful and rich have been trying to consolidate their own rights and benefits at the expense of the less powerful. The Ngitili case is an important example of trends which will become more common as REDD carbon schemes and other kinds of PES schemes come into existence: if resources acquire greater value, there will be greater competition for ownership of them. The response must be improved tenure and improved legal recourse for the poor, or we shall see much injustice and impoverishment as a result of these schemes (Barrow and Shah 2011).

Wetlands restoration in Cameroon. In Cameroon, the Waza Logone floodplain supports the livelihoods of some of the poorest people in the region but the ecosystem has become increasingly degraded due to adverse impacts of an upstream dam. Cost-benefit analyses shown that large-scale ecosystem restoration would have multiple long-term economic, social, and conservation benefits, but funding has been a challenge due to the tendency for donors to focus on forest-related projects in the country (Pauli et al. 2010). Flood release measures would cost between € 3-12 million to implement over a period of 5 years, and would thereafter generate incremental benefits of between € 1.4-2.7 million a year or € 3,050 per km^2 of land re-flooded. All of the re-inundation options identified had positive net present values over a 25 year period, of between € 6-8.4 million. The livelihoods of up to a third of the rural floodplain population, or 8,000 households, would be improved after re-inundation. On a per capita basis, this translated into up to € 53 added economic value per floodplain-dependent member of the population (Emerton 1948). Undertaking engineering works to reinstate the flooding regime could restore up to 90 % of the floodplain area, at a capital cost of approximately $11 million. The socio-economic effects of flood loss have been significant, entailing livelihood costs of almost $50 million over the years since the scheme was constructed. Local households have suffered direct economic losses of more than $2 million a year through reduction in dry season grazing, fishing, natural resource harvesting and surface water supplies. The economic value of floodplain restoration and return on investment will be significant. Adding just under $2.5 million a year to the regional economy—or $3,000 per square kilometre of flooded area—the benefits of reinundation will have equalled initial investment costs in less than five years. Investment in flood restoration measures shows an economic net present value of $7.76 million and a benefit-cost ratio of 6.5:1 (Emerton 1948).

Estuary restoration in South Africa. The St Lucia system is the largest and most important estuarine system in South Africa. and became the first World Heritage Site in South Africa in 2000. In spite of this, the system faces serious problems as a result of anthropogentic changes that have reduced the supply of freshwater and increased sediments loads flowing into the system. Of these, the artificial separation of the uMfolozi river from the St Lucia system in 1952 has arguably had the greatest impact on the diversity and abundance of the system's biota. Concerns about the deteriorating ecological status of the St Lucia and uMfolozi systems prompted the iSimangaliso Wetland Park Authority (iSimangaliso WPA), the statutory body responsible for the park and protection of its world heritage values, to make an application to the Global Environment Facility (GEF) for the necessary funds to investigate and evaluate potential solutions to the problems facing Lake St Lucia. This application was successful and iSimangaliso WPA was awarded a US$9 million grant to design and implement the most feasible option for improving the ecological functioning of the St Lucia estuarine system, among other development activities (Anchor Environmental Consultants 2013).

Watershed restoration. A study by Blignaut and Mander (2010), looking at five past watershed restoration and reforestation projects in South Africa, estimates that conservation in these areas has provided a monetary annual return equivalent to R116 to R220 per hectare per year over periods of about 30 years compared to equivalent estimated costs of watershed restoration totaling between R21 to R88 per hectare per year. These positive returns have been calculated by assigning assumed values to the ecological services provided by conserved watersheds, mainly the ability to regulate the local hydrological cycle, increase the base flow of rivers, reduce levels of soil erosion, sequester carbon, and prevent the loss of rainfall through non-productive run-off.

Eradication of alien invasive species for conservation of threatened species. In the Seychelles, costs were estimated with the aim of **restoring different islands** to a state where globally threatened birds could be safely translocated **(synergy with Target 12)**, which would open the way for natural colonisation of other native biodiversity. A number of elements were costed, but the activities most likely to be applicable elsewhere were restoration planning and habitat conversion. Restoration planning was estimated to cost US$73 to 372/ha, with an average of US$155/ha across all islands. The habitat conversion process is basically vegetation management with the longer-term objective of restoring a biotic community of existing species, density and composition, to one more suitable for supporting globally threatened birds. For habitat conversion, a clear priority is to select native woodland habitat because of the low treatment cost, ranging from about US$100 to just over 500 per ha. On the other hand, where islands have a dominance of habitat stocked mainly with coconut and other exotic species, the conversion costs will be extremely high, in the order of US$7500–8400 per ha (Henri et al. 2004).

Reintroduction of elephants in Central Africa

An investment operation for biodiversity conservation through savannah elephant protection in Central Africa is estimated at US$6 million. On the ground, the programme will focus its activities on the last savannah elephant populations found in Northern Cameroon and Southern Chad. Programme interventions will cover the Sena, Chari-Baguirmi and the Mayo Kebbi national parks in Chad, and Northern Cameroon. The key programme beneficiaries will be: (i) the wildlife conservation services of the Cameroon - Chad trans-border complex, whose response capabilities in the field will be strengthened, and trained personnel; (ii) national actors and all conservation stakeholders at the local level who will be sensitized in view of their involvement in fighting trans-border poaching in the programme area (population, opinion and traditional leaders, local and national elected officials, community radio network, civil society, etc.); (iii) central level wildlife conservation services in CAR and other services in charge of fighting wildlife crime; and (iv) Governments and ECCAS whose structures will be strengthened (African Development Fund 2013).

Border protection

The required expenditure on border protection measures is likely to be related to the numbers of points of entry, and the volumes or values of freight or the numbers of passengers passing though these points (Turpie et al. 2012). The above estimate of costs to control IAS include border protection costs. Additional systems would need to be put in place to extend this to trade in endangered species.

4.2.6 Sustainable land and resource use

Measures to achieve sustainable land and resource use usually involve a suite of actions that are carried out together. These vary depending on the type of production system and its socio-economic context, as well as the degree to which intervention is required. Examples of the costs of projects are as follows:

- The **East Africa** Cross Borders Biodiversity Project (CBBP) was a full-size GEF/ UNDP project that was operational between 1998 and 2003. Its objective was "to reduce the rate of loss of forest and wetland biodiversity in specific cross-border sites of national and global significance in East Africa". The idea was to promote and achieve sustainable use of biodiversity, and to bring demands on natural resources into balance with the sustainable supply at key forest and wetland sites. In order to achieve this, the project attempted to establish an enabling environment (policy, legislation, awareness) that allowed sectoral and development agencies as well as local communities, providing support at four levels - regional, national, district and community - and ensuring strong linkages between these levels. Site-based conservation interventions took place at four paired cross-border sites which were important from a biodiversity conservation perspective. The development of an enabling environment with supports the sustainable use of biodiversity was considered to be achieved at the most successful site, while bringing resource demands in line with supply was partially achieved at the same site. The GEF funding for the project amounted to US$12.9 million with additional co-financing of US$5.5 million. Source: Conservation Development Centre (2007).
- **In Ethiopia**, some US$538,900 was spent on a suite of actions including formation of small group trade associations, business and financial capacity for production, and certification systems, all in order to increase markets for medicinal plant-based products through expansion of value chains and national and international markets[4]
- **In Zambia**, the Community Markets for Conservation (COMACO) project involved considerable investment, including construction of a trading facility, building of local depots, etc, amounting to some US$740,000 (Lewis et al. 2011*b*), but was not yet financially self-sustaining in 2010.

[4] Ethiopia: Capacity Building for Access and Benefit Sharing and Sustainable use of Medicinal Plants. GEF Grant Funding Report.

- The costs of LMMAs reportedly range from $42 to $2000 per km^2 of managed fishing ground (Harding et al. 2012).
- Moye & Carr-Dirick (2002) reported that some $30 million in donor funding had been spent on sustainable management of central African forests over a ten-year period. They also recorded $5 million in funding for Institutional Strengthening and Policy Development at the sub-regional level and $10 million at the national level (but only for a few countries). In addition, $6 million per year had been committed to Community-based Natural Resources Management.
- In Tanzania, the Ministry of Natural Resources and Tourism (MNRT) and the UNDP, through the UN-REDD National Programme, recently investigated the costs of REDD projects. Four kinds of costs were distinguished: opportunity costs, implementation costs, transaction costs and institutional costs. Results showed that all cost elements have wide variations depending on the location of a project, the surrounding land-uses and the general economic conditions. Project-specific opportunity costs range from US$-7.8 to 28.8 per tonne of CO2. Combined implementation, transaction and institutional costs range from US$3.9 to 8.9 per ha and per year with up to 95% of this being implementation costs (Merger et al. 2012).

Making these revisions is a major process involving stakeholder consultation, and can be especially lengthy and complex when it involves the definition or reallocation of property rights. In South Africa, revision of fishing rights alone has been a process without a quick fix. Initial allocations failed, and a longer process that involves checks and balances along the way has been far more successful. However, in Namibia, the revision of property rights conditions for incentivising stewardship of wildlife was a relatively straightforward process that yielded a high level of success. Realistically, the amount to invest in these enabling actions might be in the order of $4 million per year.

4.2.7 Sustainable financing strategies

Based on GEF funding proposals, Ervin & Gidda (2012) estimated that the costs of improving sustainable finance for protected areas globally ranges from **$1.19 million to $60.45 million** (average of $13.33 million) per country.

Box 19. Establishing a trust fund for financing protected areas

In **Uganda**, the Bwindi Impenetrable National Park (BINP) and Mgahinga Gorilla National Park (MGNP) cover 321km^2 and 33.7km^2 respectively, representing highly biodiverse afro-montane forest ecosystems in one of the most densely populated parts of Africa. A GEF/World Bank project was started in 1995 to establish a **trust fund** as a mechanism to support long-term biodiversity conservation in the parks, through provision of support to community development activities, research and monitoring, and park management activities. The GEF initially endowed the fund with US$4.3 million, after which USAID provided US$890 000 between 1995 and 1997, and Government of the Netherlands provided financing of US$2.86 million between 1997 and February 2003. At the end of the project the trust had therefore been successfully established and was operating effectively in working towards it conservation goals, however, the ability of the Trust to have long-term impacts on conservation in the ecosystem was undermined by the limited progress on developing the Trust's asset and fund-raising base (Conservation Development Centre 2007*b*).

4.3 Current spending on conservation

A recent estimate is available of actual spending on conservation by country (Figure 3, Table 7) which suggests that at least US$480 million is currently being spent in Africa. The study suggests that all African countries are spending considerably less than 1% of their GDP on conservation, and the majority spend less than 0.1%.

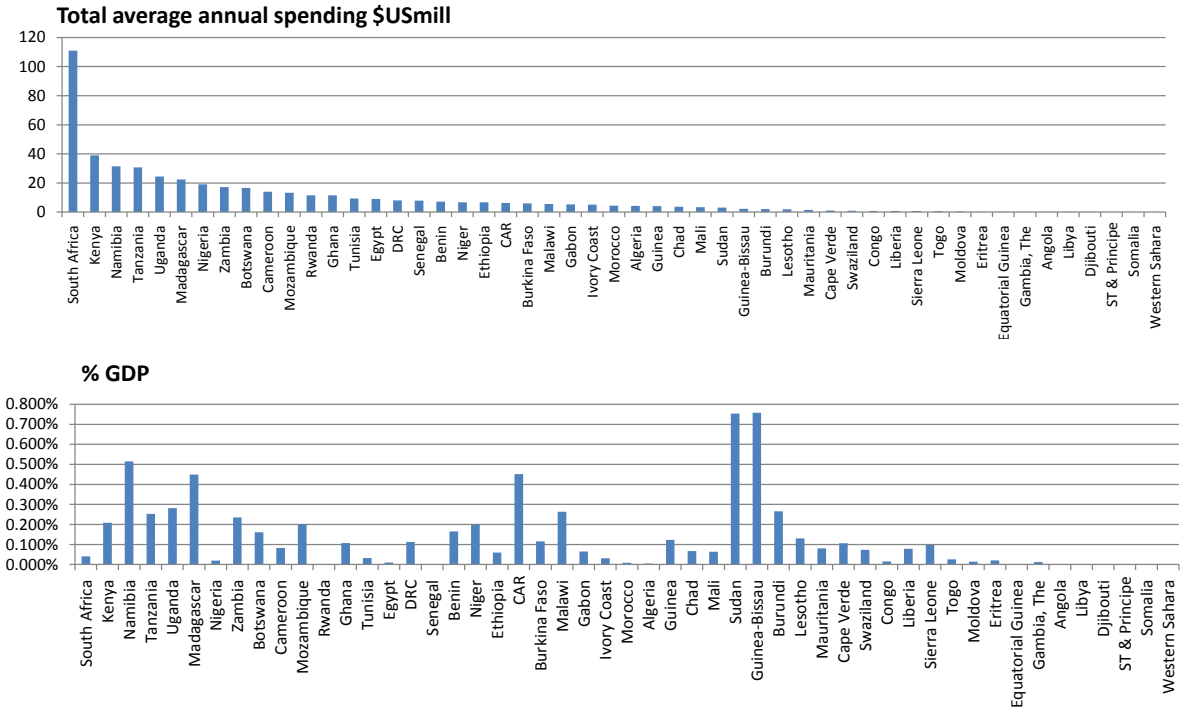

Figure 3. Total average annual spending on conservation by African countries, and that amount as a percentage of GDP. Data: Waldron et al. 2013.

Spending is by far the highest in South Africa, but South Africa's spending represents among the lowest investments relative to GDP. It is interesting to note that the top six spenders are countries that have a high level of benefit from nature-based tourism.

he expenditure was defined as "country-level conservation funding flows from multiple sources including government, donors, trust funds, and self-funding via user payments", but the nature of the expenditure was not described and is assumed to be fairly narrow, involving direct biodiversity protection measures such as protected areas and restoration. Further research should investigate the total expenditure on all the types of actions required to meet the Aichi targets in order to better estimates the financing gaps.

Table 7. Percentage area in protected areas, GDP and total average annual spending on conservation by African countries. Source: Waldron et al. 2013.

COUNTRY	% pa	GDP $bn	Total average annual spending $USmill	% GDP
Algeria	6.24	102.3	4.22	0.004%
Angola	12.06	32.8	0.061	0.000%
Benin	23.27	4.3	7.098	0.165%
Botswana	30.93	10.3	16.598	0.161%
Burkina Faso	13.85	5.2	5.989	0.115%
Burundi	4.85	0.8	2.127	0.266%
Cameroon	9	16.9	13.98	0.083%
Cape Verde	0.16	1	1.056	0.106%
Central African Republic	17.74	1.4	6.316	0.451%
Chad	9.39	5.5	3.687	0.067%
Congo	9.6	5.1	0.761	0.015%
Djibouti	0.05	0.7	0.002	0.000%
DRC	9.99	7.1	7.981	0.112%
Egypt	4.38	89.4	9.083	0.010%
Equatorial Guinea	14.02	3.2	0.081	0.003%
Eritrea	3.69	1	0.209	0.021%
Ethiopia	17.71	11.2	6.639	0.059%
Gabon	5.33	8.1	5.285	0.065%
Gambia, The	1.27	0.5	0.062	0.012%
Ghana	13.96	10.7	11.485	0.107%
Guinea	6.42	3.3	4.069	0.123%
Guinea-Bissau	26.93	0.3	2.273	0.758%
Ivory Coast	21.82	16.3	5.05	0.031%
Kenya	11.73	18.7	39.036	0.209%
Lesotho	0.49	1.5	1.95	0.130%
Liberia	1.44	0.8778	0.686	0.078%
Libya	0.11	38.8	0.027	0.000%
Madagascar	2.54	5	22.466	0.449%
Malawi	15.02	2.1	5.52	0.263%
Mali	2.34	5.3	3.367	0.064%
Mauritania	1.13	1.9	1.531	0.081%
Moldova	1.35	2.9	0.406	0.014%
Morocco	1.53	51.6	4.333	0.008%
Mozambique	13.76	6.6	13.287	0.201%
Namibia	13.92	6.1	31.367	0.514%
Niger	7.07	3.4	6.767	0.199%
Nigeria	12.59	99	19.12	0.019%
Rwanda	9.89	763.7	11.486	0.002%
Sao Tome and Principe	0	0.9	0	0.000%
Senegal	23.1	309.8	7.813	0.003%
Sierra Leone	4.3	0.7	0.684	0.098%
Somalia	0.53	0.3	0	0.000%
South Africa	6.7	277.2	111.036	0.040%
Sudan	4.18	0.4	3.014	0.754%
Swaziland	3.02	1.3	0.947	0.073%
Tanzania	26.36	12.1	30.641	0.253%
Togo	11.04	2.2	0.558	0.025%
Tunisia	1.27	28.7	9.295	0.032%
Uganda	8.51	8.7	24.477	0.281%
Western Sahara	6.49	-999	0	0.000%
Zambia	36.04	7.3	17.146	0.235%
Zimbabwe	7.01	2.00E+06	No data	No data

4.4 Funding gaps

It was not possible to find enough evidence to make a reliable estimate of the funding required to meet the Aichi targets, let alone the funding gap taking existing expenditure into account. This is even difficult at a regional level. For example, Moye & Carr-Dirick (2002) could not find accurate statistics on the level of government spending for protected areas management in the Central African forests sub-region (Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon and the Republic of Congo; 137). However, a couple of examples illustrate that the funding gap is likely to be very large. In South Africa, where biodiversity conservation probably receives more attention than most other African countries, the annual management expenditure of protected areas in the Cape Floristic Region (CFR) was found to be only 48% of what was considered adequate for effective management, and needed to be increased from $6.7 million to $13 million per annum (Frazee et al. 2003). In addition, South Africa has a major problem caused by acid mine drainage from mines that are abandoned after they become unviable. The cost of cleaning up the water pollution was estimated to be $3 billion, but in the 2013 national budget, only $15 million was allocated to this.

5 ALIGNMENT WITH OTHER POLICY AND DEVELOPMENT AGENDAS

5.1 Key points

- There are strong synergies between biodiversity and global development agendas.
- There is a significant overlap between the Aichi targets (especially targets 4, 6 and 7) and the Millennium Development Goal (MDG7) to ensure environmental sustainability.
- In addition, the Aichi targets as a whole will make important contributions to Millennium Development Goals 1 and 6, though gains in natural capital and the flow of ecosystem services that impact on human health and livelihoods, as well as supporting economic development.
- The above synergies are not fully appreciated and the Aichi targets (particularly target 1) will guard against development agendas focusing on economic output as a means of reducing poverty without considering the role of biodiversity.
- In turn, the pre- and post-2015 development goals will facilitate meeting the Aichi Targets and will be critical to maintaining the achievements in the longer term.
- There are also very strong synergies between the Aichi targets and the UN conventions on addressing climate change and combating desertification, since both of these require addressing and reversing ecosystem degradation.

5.2 Synergies with other development agendas

The period for meeting the Aichi Targets straddles that for the Millennium Development Goals, and the Post-2015 Development Agenda, which will build on these. The global development agenda is currently driven by the Millennium Development Goals that were adopted in 2000 and set for the period 2000-2015. The eight MDG goals are:

1. To eradicate extreme poverty and hunger
2. To achieve universal primary education
3. To promote gender equality and empowering women
4. To reduce child mortality rates
5. To improve maternal health
6. To combat HIV/AIDS, malaria, and other diseases
7. To ensure environmental sustainability
8. To develop a global partnership for development

The UN member states are now looking towards setting the post-2015 development agenda. This process was initiated at the UN Conference on Sustainable Development in Rio in 2012 (Rio+20 summit), where it was agreed to develop global sustainable development goals to be integrated into the post-2015 development agenda. Initial ideas were put forward in a document called “The future we want”. The specific goals will be developed by Open Working Groups during 2013-14. The themes of these discussions are: addressing inequalities, conflict, violence and disaster, education, energy, environmental sustainability, governance, growth and employment, health, hunger, food security and nutrition, population dynamics and water. The goals are likely to address sustainable

agriculture, land degradation, water, energy, sustainable consumption and production, and oceans, forests and biodiversity.

While the post-2014 development agenda has not yet been articulated in detail, the development agenda for Africa will no doubt continue to be focussed on economic growth and poverty reduction (MDG1), and there will continue to be global pressure on African states to address education (MDG2), gender (MDG3), health (MDG 4, 5 and 6), and environmental (MDG7) issues.

There are important synergies between the Aichi targets and the current MDG goals (Table 8). In particular, the Aichi targets will make important contributions to Goal 7, and indirectly to Goal 1 and Goal 6.

Table 8. Synergies between the Aichi targets and the Millennium Development Goals.

Millennium Development Goals	Synergies with Aichi targets
1. To eradicate extreme poverty and hunger	The Aichi targets reduce the rate of loss of biodiversity and resources, upon which many people depend for their livelihoods. These losses would be counter to achieving MDG 1. In addition, restoration efforts and some of the measures taken to bring about sustainable production (both industrial and agricultural), will create opportunities for the poor. An excellent example of this is the WfW programme.
2. To achieve universal primary education	In the long run, this will help to maintain the achievements under the Aichi targets in a number of ways, and is fundamentally critical.
3. To promote gender equality and empowering women	The development activities such as agricultural intensification and community forest management will provide many opportunities for the empowerment of women.
4. To reduce child mortality rates	Indirectly, households that can meet their needs and healthier environments will contribute to reducing child mortality.
5. To improve maternal health	As above.
6. To combat HIV/AIDS, malaria, and other diseases	Maintaining ecosystem services help to address water quantity and quality, which will help provide rural and urban populations with access to clean water.
7. To ensure environmental sustainability	This MDG goal has direct overlap with the Aichi Targets, especially targets 4, 6 and 7, which aim to plan towards sustainable development in general, and achieve sustainable practices in the land- and resource-based sectors. The MDG goal was to achieve the latter by 2010. This was not achieved, but the Aichi target continues to work on this. MDG7 also aims to halve the population without access to safe water and sanitation (mentioned above).

Some examples of how actions to meet Aichi targets will address development goals are as follows:

- Expanding subsistence agriculture and need for fuel are driving deforestation and forest degradation in Africa. There are opportunities to invest in both agroforestry projects and forest restoration, both of which will benefit biodiversity both through expansion of habitat and reduction of pressure on remaining natural habitat. There are opportunities for local livelihood benefits both through carbon credit sales as well as shifts to sustainable forest management after restoration to ensure continued supply of forest products.

- Labour-intensive environmental restoration programmes not only restore the flow of ecosystem services to society but also provide signficant opportunities to address unemployment. In South Africa, the government-funded Working for Water (WfW) programme clears mountain catchments and riparian zones of invasive alien plants to restore natural fire regimes, the productive potential of land, biodiversity, and hydrological functioning. The programme was established in 1995 as a poverty-relief initiative which aimed to provide employment and training opportunities for the unemployed. Because of this focus, it has received far more government support that it would have if developed as an environmental initiative. The WfW programme has an annual budget of more than half of the countries conservation agencies and has created thousands of jobs. Its success has spawned the development of several other initiatives, including Working for Wetlands, Working on Fire and CoastCare (Turpie et al. 2008).
- Achieving the Aichi Targets will also address the intra-and inter- generational distribution of benefits derived from biodiversity. The benefits are highly skewed at this point, with resources being rapidly depleted by this generation, with elite-capture of the benefits in many cases.

At the same time the development goals will facilitate the Aichi Targets. In Africa, much of the pressure on biodiversity is by the rural poor, and reduction in poverty will help to address this. Achieving universal primary education will not help to achieve the Aichi targets, but will be critical in maintaining and improving upon the achievements made, as well as being the key tool towards the ability of future generations to adapt to change.

5.3 Synergies with other conventions and plans

There have been a number of conventions that have been signed by African governments, dating back to the 1900 London Convention for the Protection of Wild Animals, Birds and Fish in Africa 1900. The African Convention on the Conservation of Nature and Natural Resources (Algiers Convention) was adopted in 1968, with the aim of ensuring the conservation, use and development of resources in accordance with scientific principals and with due regard to the best interests of people. Similar principles were embodied in Agenda 21, adopted at the UN Conference on Environment and Development in 1992. Implementation of the Algiers Convention was limited by lack of financial resources. The convention was revised and agreed at the 9th session of AMCEN[5] in 2002. In addition, the Nairobi Convention and Abidjan Convention make provision for protection of the marine and coastal environments in East and West Africa, respectively.

[5] The African Ministerial Conference on the Environment (AMCEN) is a permanent forum where African ministers of the environment discuss mainly matters of relevance to the environment of the continent.

Environment has been identified as one of the core priority initiatives of the New Partnership for Africa's Development (NEPAD), the planning and coordinating agency of the African Union, which was established to address the development challenges facing the African continent. NEPAD's Action Plan includes improving environmental conditions in Africa in order to contribute to the achievement of economic growth and poverty eradication. It will also build Africa's capacity to implement regional and international environmental agreements and to effectively address African environmental challenges. Nepad's action plan for the first decade of the century included programmes on (1) combating land degradation, drought and desertification, (2) conserving Africa's wetlands, (3) prevention, control and management of invasive alien species, (4) conservation and sustainable use of marine, coastal and freshwater resources,(5) combating climate change and (6) transboundary conservation and management of natural resources.

Subregional and regional bodies, such as the African Union, the Southern African Development Community (SADC), the Economic Commission of West African States (ECOWAS), the East African Community, the Economic Commission for Africa (ECA), the Economic Community of Central African States (ECCAS) and the Intergovernmental Authority on Development (IGAD) have environmental programmes or considerations in their development agendas. For example, SADC has protocols on wildlife conservation (1999), shared watercourses (2000), fisheries (2001), Forestry (2002), and, with the help of IUCN, has recently developed a Regional Biodiversity Strategy and Action Plan. In addition, international River Basin Organisations also encourage cooperative actions within and among African states.

Most African countries have also ratified a number of international agreements, including the Basel Convention (on hazardous wastes), the Stockholm Convention (on persistent organic pollutants), the Rotterdam Convention (on chemicals and pesticides), the Ramsar convention, CITES, the Convention on the Conservation of Migratory Species of Wild Animals, the World Heritage Convention, the United Nations Convention to Combat Desertification, the Convention on Biological Diversity and the UN Framework Convention on Climate Change (UNFCCC).

The Aichi targets overlap entirely with many of the objectives of all of the above conventions and agreements, many of which were signed well before the Aichi targets were adopted. For example, developing plans to achieve sustainable production and consumption (Target 4) will be aligned with the goals of the UNFCCC, and reducing the loss of natural habitats (Target 5), achieving sustainable agriculture and forestry (Target 6), and restoring degraded systems (Target 14) will be aligned with some of the goals of the UNFCCC as well as the goals of the UNCCD. Many of the other targets also contribute to the goals of these conventions either directly or indirectly. Actions relevant to the Aichi targets have also been incorporated into several of the more recently developed plans. Thus most countries should already have started implementing actions that would help to achieve these targets. A more thorough analysis of existing NBSAPs with regard to their ability to meet the Aichi targets is needed.

5.4 Potential trade-offs

The above synergies suggest that there are opportunities for investment that lead to co-benefits. For example, investment in improved agricultural practices will provide opportunities to improve food security, as well as improving the supply of clean water to people living downstream. However, the synergies between the Aichi targets and the development agenda are far from adequately appreciated in Africa. National development agendas are strongly focused on economic growth and the Aichi targets may be perceived to be in conflict with this, especially where its actions require reductions in outputs of certain sectors. Areas of potential conflict include the various areas of development such as mining and energy, transport and communications. In this regard, Aichi Target 1 will be critical in leveraging government investment in natural capital in order to achieve development goals.

6 ACHIEVING COST-EFFECTIVE DELIVERY OF AICHI TARGETS

6.1 Key points

- There is a high level of synergy between the different Aichi Targets. This means that the costs of delivering all the Aichi targets will be considerably less than the sum of the costs of delivering each in isolation.
- There is evidence that some actions will be more cost-effective than others, both at the broad level (e.g. strict protection versus incentive measures), and at the detailed level (e.g. radio broadcasts versus print media).
- Activities with the highest returns to cost are likely to be raising awareness of biodiversity values and tradeoffs, removal of harmful subsidies, strengthening protected area systems, and sustainable agriculture.
- Cost effectiveness of different actions will vary depending on geographical context and is likely to be lower in poverty-stricken, populous areas.
- Spending time on research will inform strategy and thereby increase cost-effectiveness of the next steps, but there are also trade-offs between the knowledge gained and the costs of delaying actions. Incentive measures should not be delayed where they can be adapted following further research. Protection measures should not be delayed by exhaustive planning.
- Sequencing of actions will be important in for achieving individual targets, but sequencing of addressing the Targets will not be critical in determining overall cost effectiveness, because benefits may be outweighed by the costs of delay.
- Improved governance and a better institutional and policy framework will be very important in achieving the delivery of the Aichi Targets in Africa in a cost effective manner

6.2 Synergies that will increase cost-effectiveness

There is considerably synergy between the actions required for meeting the different targets, mainly because of the common goal of biodiversity conservation. This means that the costs of delivering all the Aichi targets will be considerably less than the sum of the costs of delivering each in isolation. Some of these synergies are as follows:

- **Target 1** (awareness of biodiversity value) is fundamental to its integration into development planning (**Target 2**). It is also an important strategy to achieving many of the other targets which require public and government support in order to achieve.
- **Target 2** (integration of biodiversity into planning), in turn links to many of the other Aichi Targets by helping to establish a favourable policy and institutional environment for the delivery of the targets.
- **Target 3** (elimination of harmful incentives) will play an important role in the delivery of many targets, most notably Target 4 (sustainable production & consumption), and the Targets related to reducing direct pressures on land and resources (Targets 6 to 10).
- **Target 4** (plans for sustainable production and consumption) also plays an important role in the success of Targets 5 – 10 over the longer term.

- **Target 5** (halve rate of habitat loss) will contribute to Target 8 (reducing pollution), for example through adopting green infrastructure over conventional grey solutions, as well as to Target 14 (restoring and safeguarding ecosystems).
- **Target 6** (harvest sustainably) contributes to achievement of Target 5 (halving habitat loss), Target 10 (sensitive habitats) and Target 11 (Marine Protected Areas). There are also synergies between different elements of this target (see Box).
- **Target 7** (Sustainable agri/aqua/silviculture) will contribute to Target 5 (halving habitat loss), Target 8 (reducing pollution) and Target 13 (minimizing genetic erosion), and may benefit from Targets 5, 11 and 14 though the ecosystem services provided by natural to agricultural systems. It will also help to achieve Target 6 (sustainable harvesting) by reducing the demand for wild foods and raw materials[6].
- **Target 8 (**reducing pollution) contributes to meeting Target 10 (coral reefs and sensitive ecosystems), Target 11 (conservation of terrestrial and marine systems), Target 12 (prevent extinction of threatened species) and Target 14 (restoring and safeguarding ecosystems). It also directly addresses one of the MDG goals, "halving the proportion of the population without sustainable access to safe drinking water and basic sanitation".
- **Target 9** (reduce alien invasives) contributes to meeting Target 5 (habitat loss), is particularly important for Target 12 (prevent extinction of threatened species), and is one of the main actions required for Target 14 (ecosystem restoration). It may also be important for Target 10 (coral reefs and sensitive ecosystems).
- **Target 10** (reduce threats to coral reefs and sensitive ecosystems) is dependent on several other targets, such as Target 6 (sustainable fisheries management), Target 8 (reducing pollution), and Target 11 (Marine Protected Areas), and will contribute to Target 14 insofar as people rely on the ecosystem services provided by coral reefs.
- **Target 11** (conservation of terrestrial and marine areas) is one of the actions required for Target 5 (halving rate of habitat loss), Target 6 (sustainable harvesting), Target 10 (protection of coral reefs), Target 12 (protection of threatened species), Target 14 (restoring and safeguarding ecosystems), Target 15 (ecosystem resilience). It also has the potential to contribute to Target 18 (participation and respect of indigenous and local communities) and Target 20 (sustainable finance).
- Actions required for **Target 15** (enhancing ecosystem resilience) overlap with those of many of the preceding targets, particularly Target 5, 6, 7, 8, 9, 10, and 11.
- **Targets 17 to 20** (implementing NBSAPs, using traditional knowledge, improving overall knowledge & technology, mobilising financial resources) have the potential to contribute to all the preceding targets.

[6] Note that harvesting of indigenous forests is taken to be part of Target 6, and only plantation forestry is included in this interpretation of Target 7.

6.3 Relative cost-effectiveness of different investments

Different types of investments are likely to have different levels of return in terms of contribution to the Targets relative to cost. A list of the main types of investments needed for the Aichi targets and their expected levels of benefits relative to costs is given in Table 9 based on a combination of evidence and rationale. Of these, the communication of the value of achieving the targets is tantamount to successfully motivating the necessary investments in many of the others such that they are addressed in a way that takes biodiversity impacts into account, and not just development impacts, as drives many of these initiatives at the moment. Other actions that are likely to have very high returns are the removal of harmful subsidies, such as those supporting the extractive industries, including mining as well as fishing and forestry, and those affecting the demand for water and energy. Changes in these activities will have enormous ramifications.

The returns to activities that improve knowledge and awareness are expected to be high, provided that these activities are well designed and focused on how to gain benefits rather than moral suasion. There is also evidence many rural programmes aimed at achieving conservation and development objectives require ongoing extension and support services in order to succeed.

In general, the cost effectiveness of improving protected area systems is expected to be higher than the cost effectiveness of restoration. Similarly, actions to prevent pollution are expected to be more cost effective than attempts at cleaning up. In general, it is logical that prevention is better than cure. An exception to this may be dealing with alien invasive species: many studies have shown that their removal is well worthwhile in terrestrial and freshwater habitats, and that swift action also pays off.

Cost effectiveness of different actions will vary depending on their geographical context. For example, measures to reduce pressures through more sustainable practices are likely to be less cost-effective than strengthening protected area systems in areas of high population density and poverty (where damaging behaviour is a survival issue) or where the rewards from damaging behaviour are very high (e.g. high value species). For example, restrictions on fishing gear are largely ignored in coastal fishing areas of Tanzania, in spite of considerable management effort (Albers and Robinson 2012).

To a large extent, cost effectiveness of particular actions is also determined by how they are carried out. For example, a study on an awareness raising campaign in Kenya on the use of indigenous vegetables demonstrated that family and social networks are stronger forms of communication than mass media in influencing attitudes and behaviour change. While mass media may be successful in increasing awareness, it is less effective in changing behaviour than interpersonal communication. Broadcast media channels were slightly more effective than print media. Lessons learnt included that the message source must be credible and of high quality, should be consistent and have repeated exposure, and that informal sources of communication are important in complementing mass media. The study also concluded that campaigns should run nationally over long periods, and that characteristics of different segments of the audience should be understood for appropriate behaviour change interventions to be made (Obel-Lawson 2006).

Table 9. Expected levels of cost-effectiveness of different types of investments required to meet the Aichi targets

Types of investments	Expected level of B:C	Evidence or rationale
National assessments and accounting of biodiversity values	Very high	South Africa put more resources into coastal management after a simple assessment of coastal value. Also in South Africa, the Durban municipality started to invest more in natural capital after a very broad-brush valuation of its ecosystems using benefit transfer methods (Boon 2010). In Namibia, a relatively simple assessment of the value of investing in the protected area system led to a capital injection of $100 million (Turpie et al. 2012).
Research on biodiversity and socio-ecological systems and their response to policy measures	High	Research is important for guiding priorities and strategy. For example, research has suggested that incentive programmes in rangeland areas may be a wasted investment compared to strict protection of lions (Packer et al. 2013).
Research traditional knowledge	Low	Evidence is lacking. However obtaining traditional knowledge can be difficult, the knowledge will pertain to a small number of species, when the knowledge is required, researchers will go for it. Ie the research would have better payoffs if demand-driven
Raise awareness among policy makers and public	Very high	This is similar to the first example, but broader, and includes raising awareness on the need for specific strategies, and to change preferences. In **Tanzania**, efforts to mainstream environment through effective communication helped bring about an increase of 800% in the budget for the Division of Environment. This was done by gathering evidence on the links between poverty and the environment, then using the media through TV, print and radio, and by targeting events where there was ministerial involvement. In **Rwanda**, the result of a similar effort has been an increased awareness across government sectors, as well as highlighting the underfunding of the environment in the government budget, which led to an increase in budget for the environment by 40% in 2007/08 (UNEP PEI 2008). In **Burkina Faso**, a valuation study of the Sourou Valley wetlands has been used to make an economic case improve their conservation, by showing that they were worth more than the region's agricultural outputs. The study also raised awareness of the usefulness of economic valuation tools in development planning (Somda and Nianogo 2010). In **Malawi**, a study on the value of sustainable resource use (Yaron et aol 2011) had an important impact on policy makers. The report was powerful in that it was written in a way that civil servants could relate to. The report contributed to the inclusion of natural resource management as one of the nine priority areas in the new Malawi Growth and Development Strategy II for 2011 – 2016) and an allocation of approximately US$ 50 million to environmental programmes over the next 5 years (UNDP-UNEP 2013).
Education campaigns	Low	A study in Madagascar showed that including environmental programs in the school curriculum had a large impact on environmental awareness among children. In rural Africa access to media is often limited, so school plays an important role. Environmental education appeared to be most efficient when it offered hands-on experience, such as tree planting, together with classroom theory (Korhonen and Lappalainen 2004). The implications are that, despite the lack of definite link between awareness

Types of investments	Expected level of B:C	Evidence or rationale
		and action, investment in school level environmental education is a crucial investment, particularly at a time when the audience is guaranteed. While crucial for their long term success, this will not have direct bearing on achieving Aichi Targets by 2020.
Capacity building	Medium	Building capacity is essential, but efforts can be ineffective, especially where this is taking place from a weak base. To be more effective, this needs to take the form of major training initiatives and mentorship programmes, rather than workshops, for example.
Extension services for agri-, aqua- and silviculture	High	Support programmes for CBNRM have succeeded in Namibia thanks to ongoing support, whereas have not been very successful in Botswana where there has been less support. The same logic would apply to introducing any new way of doing things.
Integrate biodiversity into development planning	Medium	Important in theory, but efficiency is untested. In Tanzania, extensive efforts to do this in the water sector have not yet resulted in significant action. In Egypt a US$80,000 study of the values of ecosystem services and trade-offs associated with a transfer of water from the Nile river to the agricultural West Delta desert area provided strong arguments for decision makers to significantly reduce the scale of the project in an early stage of the planning process (Slootweg 2010).
Removal of harmful subsidies	Very high	The response to subsidies is often widespread, so the scale of the action can be large relative to the investment required to revise the legislation.
Provision for implementing the Nagoya Protocol	Low	While this meets social objectives, the impact on biodiversity may be small. Nevertheless, the investment is small.
Strengthen protected area systems (expansion and management)	High	Relatively high costs, but potentially high returns.
ICDPs	Low	Integrated conservation and development projects (ICDPs) have had limited success in addressing the often conflicting objectives of conservation and development. A study in Cameroon showed that contributing to poverty alleviation while maintain current animal population sizes will be extremely difficult and require long-term external financial support for anti-poaching, and that additional investment is needed in improving local environmental governance and controlling corruption (Sandker et al. 2012*b*).
Restoration (not including IAS removal)	Low	This is generally very costly compared with returns. Examples are St Lucia, restoration of wetlands, restoration of veld, restoration of thicket, restoration of forests. Can be worthwhile in conjunction with development objectives (employment). There is evidence that successful establishment of indigenous vegetation can suppress alien recruitment (Pretorius et al. 2008), and in cases where the costs of restoration are lower than the costs of follow-up IAS management then restoration is a cost-effective investment (Synergy with Target 14).
IAS control	High	Eradication of IAS from islands has proven an effective conservation tool, resulting in remarkable recoveries of endangered species and threatened island ecosystems. Over 1,100 successful IAV eradications have been implemented on islands worldwide (Turpie et al. 2012). For mainland infestations, control will only be achieved if enough resources are devoted to the problem (van Wilgen et al. 2012), and will be more cost-effective if treated early (Marais et al. 2008).

Types of investments	Expected level of B:C	Evidence or rationale
Ex-situ conservation	Low	This is always the last resort. There are already several effective institutions dealing with this.
Border protection	Medium	Current investments are badly ineffective. A very large investment needs to be made for this to be effective, but given what is at stake, this could yield good returns. In South Africa, the capture and sale of consignments of poached abalone destined for Asian markets
Sustainable harvesting of fisheries, forestry and wildlife	Medium	This is difficult to achieve especially in areas where poverty is high and institutions are weak, and requires considerable investment in stock assessment, property rights, management and enforcement systems. Efforts will need to be focussed where unsustainable harvesting activities pose the most threat. These actions include community-based management projects that focus on property rights. Privatization of control over use of wildlife has perhaps had more success in promoting biodiversity in the southern African region than any other policy measure (Muir-Leresche & Nelson 2000).
Sustainable agriculture, aquaculture and silviculture	High	Investments in methods and technologies are likely to meet development goals, but impact on biodiversity still debateable and likely to be successful in specific circumstances. Nevertheless, widespread nature of problem means successful interventions could have huge pay-offs. In Africa the focus should be on agriculture.
Clean up and reduce pollution	Low	These problems are localised, and cleaning up some of the main threats, like acid-mine drainage is prohibitively costly. Investment should be primarily in prevention.
Integrated management of areas and resources	Medium	Like integrated planning, this is very important in theory but remains largely untested.
Sustainable financing of protected area systems	High	This is a relatively small investment that can potentially yield high returns. In Namibia, revenues from animal sales and fines are being put in a trust fund that will fund certain park activities; In Zambia, park management has been outsourced to the private sector and this is proving very cost-effective.
Payments for ecosystem services and REDD+	Low	Up to now, numerous projects have been initiated in Africa. PES has been seen as a major opportunity for achieving conservation goals. For example, in an analysis of a conservation intervention in southeastern Madagascar indicated that, Ferraro et al. (2005) suggested that were the nearly $4 million of available conservation funds invested in annual payments conditional on the protection of forest, about 80% of the original forest could have been protected into perpetuity, whereas only 12-22% could have been protected through support of indirect incentives such as subsidizing capital acquisition in eco-friendly commercial activities. However, a more recent analysis of PES projects in Africa by Ferraro et al suggests that few of these initiatives had ever got off the ground and none had yet achieved their goals.

This also applies to many of the incentive measures used to achieve sustainable land and resource use. For example, strategies such as PES have become very popular because of a few successful examples, but fail under many circumstances. If these strategies are to be used they need to be very carefully targeted to areas where all the ecological and socio-economic conditions are suitable. It should also be noted that PES goes against the polluter pays principle and potentially encourages illegal activities for resource users to claim payments (Pirard et al. 2010).

Cost effectiveness of actions can also be increased through combined strategies, taking advantage of the synergies mentioned above. For example, Wilson et al. (2007) developed a framework that combines geographic priorities with the allocation of funds among alternate conservation actions that address specific threats. This framework offers an improvement over approaches that only focus on land purchase or species richness and do not account for threats. Their study showed that it was possible to protect many more plant and vertebrate species by investing in a sequence of conservation actions targeted towards specific threats, such as invasive species control, land acquisition, and off-reserve management, than by relying solely on acquiring land for protected areas.

6.4 Investment in preparatory actions

Investment of time in preparatory actions can be important. Spending time on research will inform strategy and thereby increase cost-effectiveness of the next steps, but there are also trade-offs between the knowledge gained and the costs of delaying actions, and these trade-offs can be reduced if adaptive management is possible. The example of plastic bag legislation in southern Africa (see Box 20) provides a good illustration. The policy would have been better implemented with more research, but could just as easily be adjusted to correct the problem, for example by following examples from other countries (e.g. Monaco) where plastic bag purchases are not even possible and people have changed their behaviour accordingly. Protection measures should not be delayed by research. Investment in investigation will pay off for the actions whose outcomes are uncertain or variable (such as implementing incentive measures).

Box 20. Impacts of plastic bag legislation in southern Africa

The implementation of similar **plastic bag legislation** in South Africa and Botswana has had mixed results (Dikgang and Visser 2012). Until 2003 most retailers in the country supplied free thin disposable bags at checkouts. Widespread pollution was the inevitable consequence. To combat the problem, two key regulations were introduced in 2007: that shoppers should pay for packets, and increasing the minimum allowable thickness of the plastic used. These interventions aimed at curbing consumption and encouraging reuse by providing more durable bags. However, these policies had mixed impacts. In South Africa, consumption of these bags dropped initially but then recovered to original levels within four years, but now more plastic is entering the system because of the heavier gauge! This did not happen in Botswana, possibly because better pricing. This illustrates how well-intentioned policies can occasionally have unanticipated negative consequences, and that a total ban on plastic shopping bags is required.

In other cases, there is less opportunity for adaptive management, such as the gazetting of new protected areas. The planning of these areas needs to be done carefully in order to meet targets and maximise their success, and will involve time consuming stakeholder processes. Nevertheless, the expansion of protected area systems is urgent given pressures on land and marine systems, and planning efforts should not delay implementation longer than necessary. This means that waiting for a high level of consensus might be unproductive.

6.5 Sequencing of actions

Sequencing of actions will be important for achieving individual targets, but sequencing of addressing the Targets themselves will not be critical in determining overall cost effectiveness, because benefits may be outweighed by the costs of delay. There is enough information to begin work on all of the targets, and there will still be enough opportunity in most cases to capitalise on the synergies with other targets during the process of implementation.

6.6 Role of governance in achieving cost-effective delivery

Improved governance and a better institutional and policy framework will be very important in achieving the delivery of the Aichi Targets in Africa in a cost effective manner. Currently there are major inefficiencies associated with weak policies, governance and institutions. Even where policies are good, they are often ineffective as a result of weak or ineffective law enforcement. This stems from a major lack of capacity, and from widespread corruption. Systems to improve accountability will be important in ensuring that funds are well invested. This might be encouraged by socially responsible investment practices on the part of international investors.

7 THE OVERALL COSTS AND BENEFITS

7.1 Key points

- There is little evidence as to the relative scale of the benefits and costs of investments required to meet the Targets for different initiatives, or at different geographical scales.
- The best evidence comes from the literature on restoration, in which costs of clearing invasive alien species or replanting vegetation is compared with the delivery of hydrological and carbon sequestration services.
- The net benefits of implementing sustainable use practices and expanding terrestrial and marine protected areas are generally reported to be positive.
- Because many benefits cannot really be measured in monetary terms, such as awareness of the value of biodiversity, cost-effectiveness analysis is going to be more relevant than cost-benefit analysis in many cases.

7.2 Protected areas

In **Madagascar**, deforestation in mountain areas is thought to be the reason for losses in production in downstream areas due to siltation, of between $40 (Maroantsetra region) and $80 (Alaotra region) per hectare. Based on management costs and estimated revenues that could be derived from farming and fuel wood and plant harvesting, the opportunity costs of the protected areas was estimated to amount to $1.8 per hectare, but would be expected to escalate. The benefits of protection were estimated to amount to an annual $10 per hectare. Protection of the area was estimated to have a highly attractive economic rate of return of 54% (Carret and Loyer 2003).

7.3 Restoration

Cost-benefit analysis is likely to favour projects where they offset the need for the implementation of significant engineering options in order to continue the supply of certain services upon which local communities are heavily reliant. For example, Van Wilgen *et al.* (1996) assessed the costs and benefits of removing alien trees from fynbos mountain catchments in the Western Cape of **South Africa**, which supply about two-thirds of the Western Cape's water requirements. Fynbos is particularly well-adapted to the dry Mediterranean climate of the Cape, where the plants' low biomass ensures conservative water use. This services has been described as playing a crucial role in the region's economy and contributed a gross domestic product of US$ 15.3 billion in 1992 (Bridgeman *et al.* 1992, cited in van Wilgen *et al.* 1995). However, fynbos is particularly susceptible to invasion from alien trees and shrubs, which have the potential to dramatically increase biomass and reduce run-off in catchments, significantly impacting water supplies within the catchments. Projected increases in alien invasives in the upper catchments of the Cape had the potential to result in the loss of more than 30% of the water supply to the City of Cape Town. Whilst the clearing of alien invasives and management of upper catchments would by no means be a cheap operation, the alternatives to optimally managed catchments would be far from attractive, and would include the implementation of sewage effluent exchange and desalinization plants. Van Wilgen *et al.* (1996)

found that these alternatives would deliver water at a cost between 1.8 and 6.7 times more than optimal catchment management.

Marais and Wannenburgh (2008) carried out a more recent assessment of the benefits of river restoration through alien clearing. They calculated the water benefits associated with clearing based on the assumption that the increased yield per condensed hectare cleared was 2250 m^3/ha/annum along perennial rivers, and 750 m^3/ha/annum for non-perennial rivers, multiplied by the local water tariff. They estimated yield would increase by some 34.4 million m^3/year, equivalent to about 42% of the yield of the new Berg River Scheme (81 million m^3/year) in the Western Cape, which was developed at a cost of around R1.6 billion. Marais and Wannenburgh (2008) concluded that the investment in clearing species known for excessive water use from riparian areas at a cost of R116 million would be a good investment.

7.4 Sustainable resource use

In **Madagascar**, a state/fishing industry partnership was set up to overcome over-fishing problems in the shrimp fishery, following widespread concerns about the state of the fishery. A new set of long-term, tradable licences was established in 2000. The shrimping industry has benefited, and there are signs that sound sustainable management regimes are in place. An approximate evaluation of the scheme suggests a very acceptable benefit-cost ratio of 1.5 (Rojat et al. 2004).

In **Mozambique**, as in most other African countries, renewable natural resources make a significant contribution to peoples' livelihoods and the economy, but this is not all captured in official statistics. Estimates suggest that their contribution is in the order of 47-50% of GDP. As a rapidly developing country, Mozambique's natural systems have suffered from soil loss, deforestation, water pollution and the overexploitation of natural resources. These losses, as well as the inefficient use of resources, material and energy, have been estimated to cost the equivalent of 17% of GDP annually. Excluding inefficiencies, environmental degradation costs Mozambican economy between 6 and 11% of GDP (Bandeira et al. 2012). This includes agricultural soil degradation worth some US$108 million. Based on the estimated costs of required investments in environmental protection, the overall benefit/cost ratio of preventing these losses was estimated to be 1.8. The analysis indicated that investments to reduce soil degradation, deforestation and to enhance coastal protection would bring the highest returns of all the actions considered. Investments in improved access to clean water and reduction of water pollution, air pollution and waste management also had positive benefit-cost ratios (Bandeira et al. 2012).

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9 REFERENCES

African Development Fund. 2013. Central Africa Biodiversity Conservation Programme protecting Central Africa's elephants.

Allebone-Webb, S., R. Jimenez-Aybar, A. Matthews, and D. Stevens. 2013. The GLOBE Natural Capital Legislation Study: A Review of Efforts towards Natural Capital Legislation in Eight Countries. London, United Kingdom.

Atilaw, A., and L. Korbu. 2011. Recent development in seed systems of Ethiopia. Pages 1–93 *in* D. Alemu, S. Kiyoshi, and A. Kirub, editors. Empowering Farmers' Innovation - Improving Farmers' Access to Seed. Volume Series No. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Attuquayefio, D. K., and J. N. Fobil. 2005. An overview of biodiversity conservation in Ghana-Challenges and prospects. West African Journal of Applied Ecology 7:1–18.

Barbier, B. Y. E. B., M. Acreman, and D. Knowler. 1997. Economic valuation of wetlands: a guide for policy makers and planners. Wetlands. IUCN - The World Conservation Union.

Barrow, A. E., and A. Shah. 2011. Restoring woodlands, sequestering carbon and benefiting livelihoods in Shinyanga, Tanzania.

Bennett, B. E., H. Eves, and J. Robinson. 2002. Why is eating bushmeat a biodiversity crisis? Conservation Biology In Practice 3:3–4.

Blom, A. 2004. An estimate of the costs of an effective system of protected areas in the Niger Delta – Congo Basin Forest Region. Biodiversity and Conservation 13:2661–2678.

Boffa, J.-M., L. Turyomurugyendo, J.-P. Barnekow-Lillesø, and R. Kindt. 2005. Enhancing farm tree diversity as a means of conserving landscape-based biodiversity. Mountain Research and Development 25:212–217.

Boon, R. 2010. Spatial planning in the eThekwini Municipality (Durban), South Africa.

Borokini, T. I. 2013. The state of ex-situ conservation in Nigeria. International Journal of Conservation Science 4:197–212.

Boucher, D., P. Elias, K. Lininger, C. May-Tobin, S. Roquemore, and E. Saxton. 2011. The Root of the Problem: What's driving tropical deforestation today?

Braat, L., P. ten Brink, J. Bakkes, K. Bolt, I. Braeuer, A. Chiabai, H. Ding, H. Gerdes, M. Jeuken, M. Kettunen, U. Kirchholtes, C. Klok, A. Markandya, P. Nunes, M. van Oorschot, N. Peralta-Bezerra, M. Rayment, C. Travisi, and M. Walpole. 2008. The cost of policy inaction: The case of not meeting the 2010 biodiversity target. Wageningen, Brussels.

Brashares, J. S., P. Arcese, M. K. Sam, P. B. Coppolillo, a R. E. Sinclair, and A. Balmford. 2004. Bushmeat hunting, wildlife declines, and fish supply in West Africa. Science 306:1180–1183.

Carret, J., and D. Loyer. 2003. Madagascar protected area network sustainable financing Economic analysis Perspective. Pages 1–12 *in*. Workshop Building comprehensive protected areas systems. World Parks Congress, Durban, South Africa.

Coad, L., F. Leverington, N. D. Burgess, I. C. Cuadros, J. Geldmann, T. R. Marthews, J. Mee, C. Nolte, S. Stoll-Kleemann, N. Vansteelant, C. Zamora, M. Zimsky, and M. Hockings. 2013. Progress towards the CBD protected area management effectiveness targets. Parks 19:1–12.

Conservation Development Centre. 2007*a*. GEF impact evaluation. Case Study: Reducing biodiversity loss at cross - border sites in East Africa Project.

Conservation Development Centre. 2007*b*. GEF impact evaluation. Case Study: Bwindi Impenetrable National Park and Mgahinga Gorilla National Park Conservation Project.

Conservation International. 2011. Ankeniheny-Zahamena Corridor, a field demonstration model.

Conway, M. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets - Target 1: Awareness Raising.

Coria, J., and E. Calfucura. 2012. Ecotourism and the development of indigenous communities: The good, the bad, and the ugly. Ecological Economics 73:47–55.

Crafford, J., R. Strohmaier, P. Munoz, T. De Oliveira, C. Lambrechts, M. Wilkinson, A. Burger, and J. Bosch. 2012. The role and contribution of montane forests and related ecosystem services to the Kenyan economy. G.-M. Lange, J.-L. Weber, N. Hagelberg, and S. Muriithi, editors. UNON Publishing Services Section, Nairobi.

Cross, K., and J. Förster. 2011. Environmental flow assessment taking into account the value of ecosystem services, Pangani River Basin, Tanzania.

Crump, C. M., M. J. Byrne, and W. Croucamp. 2000. A South African interactive arthropod exhibition. Journal of Biological Education 35:12–16.

Cullis, J. D. S., A. H. M. Gorgens, and C. Marais. 2007. A strategic study of the impact of invasive alien plants in the high rainfall catchments and riparian zones of South Africa on total surface water yield. Water SA 33:35–42.

Daly-Hassen, H. 2013. Economic valuation of forest goods and services, Tunisia.

Daya, Y., and N. Vink. 2006. Protecting traditional ethno-botanical knowledge in South Africa through the intellectual property regime. Agrekon 45:319–338.

Decher, J. 1997. Conservation, small mammals, and the future of sacred groves in West Africa. Biodiversity and Conservation 6:1007–1026.

Department of Environmental Affairs. 2012. Baseline valuation report on biodiversity and ecosystem services.

Dovie, D. B. K., C. M. Shackleton, and E. T. F. Witkowski. 2007. Conceptualizing the human use of wild edible herbs for conservation in South African communal areas. Journal of environmental management 84:146–156.

Emerton, L., L. Iyango, P. Luwum, and A. Malinga. 1999. The Present Economic Value of Nkivubo Urban Wetland, Uganda. Economics and Biodiversity Programme, IUCN Eastern Africa Programme/ National Wetlands Conservation and Management Programme.

Emerton, L. 1948. Economic justification of additional floodplain re-inundation. Pages 105–121 *in* P. Loth, editor. The return of the water: Restoring the Waza Logone floodplain in Cameroon. Volume 44. IUCN Publications Services Unit, Cambridge, United Kingdom.

Emerton, L. 1997. Seychelles biodiversity: Economic assessment.

Enwelu, I. A., C. F. Izuakor, and M. U. Dimelu. 2012. Upscaling Indigenous Knowledge (IK) of forestry resources in Anambra State, Nigeria. Pages 198–210 *in* M. C. Madukwe, E. M. Igbokwe, C. J. Garforth, and M. A. Dube, editors. Proceedings for the 17th Annual National Conference of the Agricultural Extension Strategies for Climate Change Adaption. Agricultural Extension Society of Nigeria (AESON), Nigeria.

Ervin, J., and S. Gidda. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets - Targets 11: Protected areas. Volume 2020.

FAO. 2010. Chapter 3 The state of ex situ conservation. Pages 54–90 *in*. The second report on the state of the world's plant genetic resources.

Frazee, S. R., R. M. Cowling, R. L. Pressey, J. K. Turpie, and N. Lindenberg. 2003. Estimating the costs of conserving a biodiversity hotspot : a case-study of the Cape Floristic Region , South Africa. Biological Conservation 112:275–290.

Fukuda, S. 2011. Agro-biodiversity in Ethiopia : a Case study of Community Seed Bank and Seed Producing Farmers. Pages 1–41 *in*. Empowering Farmers' Innovation - Improving Farmers' Access to Seed.

Gabrié, C., T. Clément, J. R. Mercier, and H. You. 2010. Marine Protected Areas - Review of FGEF's cofinanced project experiences.

Gachanja, A., P. Mastrangelo, K. McGuigan, P. Naicker, and F. Zewge. 2010. Africa's Water Quality.

GEF Evaluation Office. 2008. GEF impact evaluation. GEF protected area projects in East Africa.

Hamilton, K. 2013. Biodiversity and National Accounting.

Hardcastle, P., and N. Hagelberg. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets. Volume 2020.

Harding, S., M. Vierros, W. Cheung, I. Craigie, and P. Gravestock. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets 6, 7, 10, 11: Marine cluster.

Heck, S., C. Béné, and R. Reyes-Gaskin. 2007. Investing in African fisheries: building links to the Millennium Development Goals. Fish and Fisheries 8:211–226.

Henri, K., G. R. Milne, and N. J. Shah. 2004. Costs of ecosystem restoration on islands in Seychelles. Ocean & Coastal Management 47:409–428.

Hoberg, J. 2011. Economic Analysis of Mangrove Forests : A case study in Gazi Bay, Kenya. UNEP.

Kalaba, F. K., P. W. Chirwa, and H. Prozesky. 2009. The contribution of indigenous fruit trees in sustaining rural livelihoods and conservation of natural resources. Journal of Horticulture and Forestry 1:1–6.

Kamukuru, A. T., Y. D. Mgaya, and M. C. Öhman. 2004. Evaluating a marine protected area in a developing country: Mafia Island Marine Park, Tanzania. Ocean & Coastal Management 47:321–337.

Kasthala, G., A. Hepelwa, H. Hamiss, E. Kwayu, L. Emerton, O. Springate-Baginski, D. Allen, and W. Darwall. 2008. An integrated assessment of the biodiversity, livelihood and economic value of wetlands in Mtanza-Msona Village, Tanzania. Dar es Salaam, Tanzania.

Kipkoech, A., H. Mogaka, J. Cheboiywo, and D. Kimaro. 2011. The total economic value of Maasai Mau, Trans Mara and Eastern Mau forest blocks of the Mau Forest, Kenya. Environmental Research and Policy Analysis, Nairobi.

Kiss, A. 2004. Is community-based ecotourism a good use of biodiversity conservation funds? Trends in Ecology & Evolution 19:232–237.

Korhonen, K., and A. Lappalainen. 2004. Examining the environmental awareness of children and adolescents in the Ranomafana region, Madagascar. Environmental Education Research 10:195–216.

Kuntonen-van't Riet, J. 2007. Strategic review of the status of biodiversity management in the South African mining industry.

Kuyek, D. 2002. Intellectual property rights in African agriculture: Implications for small farmers. GRAIN, Spain.

Lambooy, T., and Y. Levashova. 2011. Opportunities and challenges for private sector entrepreneurship and investment in biodiversity, ecosystem services and nature conservation. International Journal of Biodiversity Science, Ecosystem Services & Management 7:301–318.

Lange, G.-M., and N. Jiddawi. 2009. Economic value of marine ecosystem services in Zanzibar: Implications for marine conservation and sustainable development. Ocean & Coastal Management 52:521–532.

Lapeyre, R. 2010. Community-based tourism as a sustainable solution to maximise impacts locally? The Tsiseb Conservancy case, Namibia. Development Southern Africa 27.

Lee, J., G. Ledec, C. Sobrevila, and M. Lovei. 2012. Toward Africa's green future. Washington, DC.

Lemma, H. 2012. Domestic animal biodiversity in Ethiopia and its threats and opportunities with emphasis to changing climate: An overview. Advances in Life Science and Technology 6:33–39.

Lewis, D., S. D. Bell, J. Fay, K. L. Bothi, L. Gatere, M. Kabila, M. Mukamba, E. Matokwani, M. Mushimbalume, C. I. Moraru, J. Lehmann, J. Lassoie, D. Wolfe, D. R. Lee, L. Buck, and A. J. Travis. 2011*a*. Community Markets for Conservation (COMACO) links biodiversity conservation

with sustainable improvements in livelihoods and food production. Proceedings of the National Academy of Sciences of the United States of America 108:13957–13962.

Lewis, D., S. D. Bell, J. Fay, K. L. Bothi, L. Gatere, M. Kabila, M. Mukamba, E. Matokwani, M. Mushimbalume, C. I. Moraru, J. Lehmann, J. Lassoie, D. Wolfe, D. R. Lee, L. Buck, and A. J. Travis. 2011*b*. Community Markets for Conservation (COMACO) links biodiversity conservation with sustainable improvements in livelihoods and food production. Proceedings of the National Academy of Sciences of the United States of America 108:13957–13962.

Le Manach, F., C. Andrianaivojaona, K. Oleson, A. Clausen, and G.-M. Lange. 2013. Natural capital accounting and management of the Malagasy Fisheries Sector: A technical case study for the WAVES Global Partnership in Madagascar.

Marais, C., and A. M. Wannenburgh. 2008. Restoration of water resources (natural capital) through the clearing of invasive alien plants from riparian areas in South Africa — Costs and water benefits. South African Journal of Botany 74:526–537.

McCarthy, D., S. Butchart, A. Symes, L. Bennun, L. Fishpool, G. Buchanan, P. Donald, P. Morling, A. Balmford, J. Green, N. Burgess, M. Schaefer, J. Scharlemann, S. Garnett, D. Wiedenfeld, R. Maloney, and D. Leonard. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets - Targets 11 and 12: Protected areas and species.

McClanahan, T. R., H. Glaesel, J. Rubens, and R. Kiambo. 1997. The effects of traditional fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya. Environmental Conservation 24:105–120.

McClanahan, T. R., N. a J. Graham, J. M. Calnan, and M. A. MacNeil. 2007. Toward pristine biomass: reef fish recovery in coral reef marine protected areas in Kenya. Ecological Applications 17:1055–1067.

McClanahan, T. R., M. J. Marnane, J. E. Cinner, and W. E. Kiene. 2006. A comparison of marine protected areas and alternative approaches to coral-reef management. Current Biology 16:1408–1413.

McCrea-Strub, A., D. Zeller, U. Rashid Sumaila, J. Nelson, A. Balmford, and D. Pauly. 2011. Understanding the cost of establishing marine protected areas. Marine Policy 35:1–9. Elsevier.

De Merode, E., K. Homewood, and G. Cowlishaw. 2003. Wild resources and livelihoods of poor households in Democratic Republic of Congo.

Moore, J., A. Balmford, T. Allnutt, and N. Burgess. 2004. Integrating costs into conservation planning across Africa. Biological Conservation 117:343–350.

Moran, D., C. Leggett, and S. Hussain. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets - Target 7: Agriculture component.

Mortimore, M. J. 2005. Dryland development: success stories from West Africa. Environment 47.

Oladele, O. I. 2011. Contribution of indigenous vegetables and fruits to poverty alleviation in Oyo State, Nigeria. Journal of Human Ecology 34:1–6.

Oldfield, S. 2012. FSC Certification for maintaining ecosystem services, Tanzania.

Oleson, K. 2011. Taking an ecosystem service perspective in Velondriake locally managed marine area.

Pauli, N., C. Stephens, A. Litovsky, A. Grover, B. Gardiner-Smith, E. Clark, and S. Reading. 2010. GLOBE natural capital case studies. London, United Kingdom.

Pretorius, M. R., K. J. Esler, P. M. Holmes, and N. Prins. 2008. The effectiveness of active restoration following alien clearance in fynbos riparian zones and resilience of treatments to fire. South African Journal of Botany 74:517–525.

Rayment, M. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets. Resource requirements for Aichi Targets 2-4 – the "Macro-economics" cluster. Volume 2020. Plymouth, UK.

Reichhuber, A., and T. Requate. 2012*a*. Alternative use systems for the remaining Ethiopian cloud forest and the role of Arabica coffee — A cost-benefit analysis. Ecological Economics 75:102–113.

Reichhuber, A., and T. Requate. 2012*b*. Alternative use systems for the remaining Ethiopian cloud forest and the role of Arabica coffee — A cost-benefit analysis. Ecological Economics 75:102–113.

Rosendo, S., K. Brown, A. Joubert, N. Jiddawi, and M. Mechisso. 2011. A clash of values and approaches: A case study of marine protected area planning in Mozambique. Ocean & Coastal Management 54:55–65.

SANBI. 2012. Dialogue on ecological infrastructure. SANBI.

Sandker, M., M. Ruiz-Perez, and B. M. Campbell. 2012*a*. Trade-offs between biodiversity conservation and economic development in five tropical forest landscapes. Environmental Management 50:633–644.

Sandker, M., M. Ruiz-Perez, and B. M. Campbell. 2012*b*. Trade-offs between biodiversity conservation and economic development in five tropical forest landscapes. Environmental Management 50:633–644.

Sanford, C., and M. Vijge. 2008. IIED user guide to effective tools for environmental mainstreaming Kenya case study.

Schmidt-Soltau, K. 2003. Conservation-related resettlement in Central Africa: Environmental and social risks. Development and Change 34:525–551.

Secretariat of the Conservation on Biological Diversity. 2011. Incentive measures for the conservation and sustainable use of biological diversity: Case studies and lessons learned. Montreal, Canada.

Sharma, R., M. Lehmann, V. Normand, J. Scott, D. Duthie, E. Seyoum-Edjigu, B. Gomez, and D. Cooper. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets - Target 16 - Enabling activities.

Slootweg, R. 2010. West Delta water conservation and irrigation rehabilitation programme, Egypt.

Smith, E. 2012. Resource requirements for Aichi Target 13 – the “Genetic diversity” cluster.

Solh, M., A. Amri, T. Ngaido, and J. Valkoun. 2003. Policy and education reform needs for conservation of dryland biodiversity. Journal of Arid Environments 54:5–13.

Somda, J., and A. J. Nianogo. 2010. Wetland valuation changes development policy perspectives in Burkina Faso.

Spenceley, A. 2010. Tourism certification, national standards and biodiversity conservation, South Africa.

Stoll-Kleemann, S., and T. O’Riordan. 2002. From participation to partnership in biodiversity protection: Experience from Germany and South Africa. Society & Natural Resources 15:161–177.

Šúr, M., J. Van De Crommenacker, and N. Bunbury. 2013. Assessing effectiveness of reintroduction of the flightless Aldabra rail on Picard Island , Aldabra Atoll , Seychelles. Conservation Evidence 10:80–84.

Swiderska, K. 2002. Mainstreaming biodiversity in development policy and planning: A review of country experience.

Talberth, J., and E. Gray. 2012. Global Costs of Achieving the Aichi Biodiversity Targets. United Kingdom.

Turpie, J., J. I. Barnes, J. Arntzen, B. Nherera, G. Lange, and B. Buzwani. 2006. Okavango Okavango Delta, Delta, Botswana, Botswana,. Earth. Anchor Environmental Consultants.

Turpie, J., C. Jurk, B. Keitt, and N. Holmes. 2012. Cluster report on resource requirements for the Aichi Biodiversity Targets - Target 9: Invasive alien species. Volume 2020.

Turpie, J., C. Marais, and J. Blignaut. 2008. The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. Ecological Economics 65:788–798. <http://linkinghub.elsevier.com/retrieve/pii/S0921800907006167>. Accessed 27 Jul 2011.

Turpie, J. 2010. Water quality amelioration value of Fynbos Biome wetlands, South Africa.

UNDP. 2011. Community-based adaptation in Namibia - a tool to enhance conservation tillage practices.

UNEP. 2011. Creating the “New Normal” - Enabling the financial sector to work for sustainable development. Switzerland.

UNEP. 2013. The state of responsible investment in South Africa. South Africa.

Vantomme, P., D. Göhler, and F. N’Deckere-Ziangba. 2004. Contribution of forest insects to food security and forest conservation: The example of caterpillars in Central Africa.

WAVES. 2012. Moving beyond GDP: How to factor natural capital into economic decision making.

Wells, S., N. Burgess, and a Ngusaru. 2007. Towards the 2012 marine protected area targets in Eastern Africa. Ocean & Coastal Management 50:67–83. <http://linkinghub.elsevier.com/retrieve/pii/S0964569106001499>.

Wilhelm-Rechmann, A., and R. M. Cowling. 2011. Framing biodiversity conservation for decision makers: insights from four South African municipalities. Conservation Letters 4:73–80.

Yaron, G., R. Mangani, J. Mlava, P. Kambewa, S. Makungwa, A. Mtethiwa, S. Munthali, W. Mgoola, and J. Kazembe. 2011. Economic analysis of sustainable natural resource use in Malawi.

Zander, K. K., and A. G. Drucker. 2008. Conserving what's important: Using choice model scenarios to value local cattle breeds in East Africa. Ecological Economics 68:34–45.

10 Appendix 1. Summary of the actions required to meet Aichi targets

Actions for each target were derived from the global assessments of individual targets made in 2012.

Target	Actions
1. Aware of the values of biodiversity	Research awareness and develop strategy
	Awareness raising activities – schools, public, policy makers
2. Integration of biodiversity into planning	National assessments of biodiversity values
	Raise awareness
	Develop procedures to integrate into policies, strategies and plans
	Implement in - national accounting - land-use and development planning - resource allocation (water, fisheries etc)
3. Elimination of incentives harmful to biodiversity	Studies on incentives, develop action plans
	Raise awareness
	Remove/adjust harmful subsidies
4. Plans for sustainable production and consumption	Studies on production & consumption externalities
	Develop strategies and formulate national action plans
	Awareness raising
	Implement strategies such as new legislation, ecolabelling, effluent charges/taxes
5. Halving the rate of loss of all natural habitats	Review/research causes and develop strategies, with a focus on important/valuable habitat areas
	Awareness raising, training and education of conservation, agricultural and forestry extension officers and EIA practitioners
	Implement incentives to encourage off-reserve conservation measures Property rights, ecolabelling, payments
	Implement offset systems to ensure no net loss of development
6. Fish, invertebrates and aquatic plants are managed and harvested sustainably (including indigenous forestry)*	Research on ecological and economic aspects of resource harvesting, and effectiveness of management measures, and develop strategies
	Allocation and/or buyout of rights
	Monitoring and enforcement
7. Areas under agriculture, aquaculture and (plantation)* forestry are managed sustainably	Research on the negative internal and external impacts of cultivation/culture practices, research and develop strategy to minimise
	Awareness and extension
	Adapt policy, legislation and institutions (property rights)
	Implement conservation measures & incentives - removal of perverse incentives - minimum standards and measures to treat effluent/return flows - closed containment, multi-trophic aquaculture - minimum tillage & soil conservation measures - buffer zones around sensitive habitats - fire management
8. Reducing pollution**	Research on better production and clean-up technologies
	Raise awareness
	Marine debris clean-up
	Introduce improved technologies/upgrade facilities - change to biodegradable plastic production - improve wastewater treatment capacity and stormwater systems - reduce agricultural runoff - install best available technologies for stationary and mobile sources of pollution
	Introduce incentive measures - deposit-refund systems or taxes for packaging - tradeable rights for effluent and emissions
9. Invasive alien species and pathways are identified and prioritized	Research and prioritisation of IAS and pathways
	Awareness and extension
	Control and eradication measures
	Prevention measures
10. Minimize the anthropogenic pressures	Integrated coastal zone management with marine protected areas
	Sustainable harvesting practices (Target 6)

Target	Actions
on coral reefs and other vulnerable ecosystems	Integrated watershed and wastewater management
11. Conservation of terrestrial and marine areas	Integrated conservation planning and develop economically defensible strategy for protected areas, buffer zones and connectivity corridors
	Expand protected area system and set up systems for conservation of buffer and connectivity areas [overlap with Target 5] - acquisition of land - conservation easements/contractual arrangements/stewardship agreements/fiscal incentives
	Improve PA management effectiveness, monitoring and enforcement
	Implement measures to gain co-operation of communities around parks - shared benefits/compensation - development/opportunities
12. Prevent extinction of known threatened species	Research and prioritisation of actions
	Education and awareness raising
	Protection and restoration of critical habitats and sites for threatened species (Targets 11 and 14)
	Control/eradication of invasive alien species (Target 9)
	Species reintroduction, recovery and management actions, including ex-situ conservation
	Measures to reduce illegal harvesting and trade - appropriate legislation & penalties - physical protection - increased vigilance at borders - international solutions to address demand
13. Minimizing genetic erosion and safeguarding genetic diversity	Identify socio-economically and culturally valuable species and develop conservation strategy [overlap with Target 11]
	Raise awareness and capacity
	Ex-situ maintenance and expansion of existing collections [overlap with Target 12]
	Encourage in-situ conservation by farmers
14. Restoring and safeguarding ecosystems	Research and prioritise ecosystem areas for restoration and safeguarding
	Removal of subsidies and public support for harmful infrastructure [Target 3]
	Establishment of protected areas and conservation initiatives [Targets 5, 7, 11]
	Removal of alien invasive species [Target 9]
	Restoration of degraded terrestrial vegetation, drainage systems and soils
	Restoration and reestablishment of coastal and marine systems (e.g. dune systems, mangroves and coral reefs)
15. Enhanced ecosystem resilience	Overlap with many of the preceding targets [particularly Target 5, 6, 7, 8, 9, 10, 11]
16. Implementation of nagoya protocol on access to genetic resources	Deposit the instrument of ratification, acceptance or approval
	Revise legislative, administrative or policy measures already in place or develop new measures
	Put in place institutional structures required for implementing the protocol
17. Implementation of national biodiversity strategy and action plan	Developing, updating and implementing NBSAPs – this will cover all the targets.
18. Traditional knowledge, innovations and practices of indigenous and local communities respected	National and regional level strategies
	Capacity building to foster participation of indigenous local communities
	Capacity building for implementation
19. Knowledge, the science base and technologies relating to biodiversity improved	Research [overlaps with most of the above targets]
	Implementation of monitoring and information systems [overlaps]
20. Mobilisation of financial resources	Develop and implement resource mobilization strategies

* Author's adjustment to the Aichi targets to streamline lists of actions.

**Air pollution and carbon emissions not dealt with here.