UNEP-WCMC **technical report**

Review of GEF climate resilience

Report for the GEF Secretariat

UNEP WCMC

Prepared for

GEF Scientific and technical advisory panel (STAP)

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Executive Summary

Building resilience to climate risks is an important and urgent issue requiring a comprehensive and integrated approach. This review provides an updated, structured assessment of the impacts of climate change on GEF projects. In particular, the review focuses on the impact of climate change on ecosystems and species and its implications on **GEF-6 strategy** focal areas of biodiversity, land degradation, international waters and sustainable forest management. The review is intended primarily for the GEF Partnership and particularly the GEF Secretariat.

The report is based on the outcomes of a GEF-STAP workshop on the topic held in January 2014 and builds on pre-existing GEF work on the issue (Section 1). The **analysis framework considered the climate change impacts** on each of the four GEF focal areas in relation to a range of factors that are likely to be impacted by climate change: (A) physical/chemical properties and resources, (B) biological processes, (C) species and ecosystems, (D) provisioning ecosystem services, (E) regulating ecosystem services and (F) socio-economic systems and infrastructure (see section 2 for methods and analysis framework). The analysis involved identification, for each factor, of the aspects that might be altered by climate change, and how for different types of projects in each GEF focal area, these factors may influence the achievement of GEF goals. An assessment was then made of the ways GEF projects goals, objectives, and interventions may need to be adapted due to climate change, and new threats GEF projects may need to consider. Section 7 presents the detailed assessment tables and section 3 presents the synthesized results of the analysis.

Within the **GEF biodiversity focal** area climate change is likely to directly impact several of the main programs and objectives, in particular protected areas systems (program 1 and 2), invasive alien species (program 4), sustainable use of biodiversity (objective 3), coral reefs (program 6), mainstreaming biodiversity conservation and sustainable use (objective 4). A key issue is that climate change is likely to affect the distributions and relative abundances of species, and so cause changes in which species are most threatened and the locations most important for biodiversity.

Program 2 of the **GEF land degradation focal area** is already focused on sustainable land management for climate smart agriculture recognising that climate change is likely to have large impacts on issues related to land degradation. Including considerations of the issues highlighted in program 2 within the other programs could help support both climate resilience and integrated implementation of the GEF strategy.

The GEF strategy also recognises that climate change is a key challenge to the **international water focal area**. It can fundamentally alter the context in which water projects are carried out and that the GEF requirement that all new Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programs (SAPs) consider climate variability and change therefore needs to be implemented to support climate resilience. In marine waters including climate change in the assessments of the sustainability of fisheries, including models of sustainable yields, is essential for their continued sustainable use.

As GEF strategy recognises one of the main ways climate change is impact the **GEF sustainable forest management focal area** is through humans reactions to climate change, in particular climate change mitigation policies relating to reducing emissions from deforestation and forest degradation (REDD+). Climate change may also pose a risk in terms of causing forest die-back in some locations.

Increasing the climate resilience within all of the focal areas is closely linked to **climate change adaptation** (section 4). **Monitoring and evaluation** is important if the GEF wants to assess projects impact on climate resilience and monitoring is also likely to be increasingly important to enable adaptive management in the face of unpredictable climate change impacts (section 5).

Overall, this report constitutes an initial review of the potential impacts and also identifies potential response measures to enhance climate resilience (from managing risks to integrating climate resilience into multiple benefits planning). The impacts, and most suitable response measures, will vary between regions and the specific context of projects. This report highlights the general considerations useful for all projects to consider but more detailed and regionally specific guidance could also be developed, which considered all scientific evidence available relating to each of the program. The local context will also significantly impact on what is achievable and feasible in terms of incorporating information on climate change into project design and implementation. Challenges include the availability of information, tools and financial resources. Section 5 and the appendix to this report outline some of the tools and information which are available.

1 Introduction

Since 2010, the Global Environment Facility (GEF) Scientific and Technical Advisory Panel (STAP) has highlighted that many GEF focal area objectives and expected outputs are prone to risks associated with climate change through both direct and indirect effects on project interventions (Ravindranath et al., 2010). Building on the pre-existing GEF work on climate resilience (including GEF STAP 2010), this work provides an updated, structured assessment, for the GEF Partnership and particularly the GEF Secretariat, of the factors that the GEF Secretariat and GEF project proposers need to consider to help maximize the climate resilience[1] of the GEF 6 Strategy and related projects. The report focuses on the environmental impacts of climate change. It includes an assessment of the likely future impacts on the delivery of global environmental benefits expected from the implementation of the GEF Focal Area Strategies in the natural resource management sectors, specifically International Waters, Land Degradation, Biodiversity, and Sustainable Forest Management. The report is based on the outcomes of a GEF-STAP workshop on the topic held in January 2014.

As the latest report of the GEF STAP (Bierbaum et al 2014) highlights, building resilience to climate risks is an important and urgent issue requiring a comprehensive and integrated approach. It is a developing area for integration across the GEF and can be undertaken at three different levels: i) resilience as risk management; ii) resilience as a co-benefit; iii) resilience integrated into a Multiple Benefits framework (Bierbaum et al 2014). At the simplest level climate change resilience needs to be considered to ensure that GEF project objectives are not compromised by climate change impacts. Additional benefits for increasing wider climate resilience could be achieved if consideration of climate change is integrated into the framework for developing the multiple benefits of a project.

The GEF Secretariat has already proposed a framework for enhancing climate resilience in GEF projects based on focal area priorities and objectives which includes the need for (i) characterization of potential climate change risks and potential impacts relevant to the project; (ii). characterization of potential consequences of climate change on Global Environmental Benefits targeted by the project and project beneficiaries; (iii) Consideration of range of suitable adaptation measures and description of how the final project design will incorporate them. A review of the tools to assess the impact of climate change project results and sustainability, also highlighted that many funding agencies have implemented climate change risk assessment approaches but that for effective implementation of such tools "additional efforts will likely be required in order to ensure that there is sufficient knowledge and information on climate risks to global environmental benefits available" (GEF STAP 2011, GEF/C.41/Inf.16).

[1] Within the report, resilience is considered as the "the capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation" (Arctic Council, 2013 in IPclimate change, 2014). Climate change resilience is considered to be where such hazardous events or disturbances are climate change related. Climate adaptation is considered to be the decision-making processes and set of actions undertaken to adjust the system in response to actual, perceived or expected changes and impacts to reduce the overall impact of climate change on the system (Nelson et al., 2007).

It is likely that there will be at least a 1.5C increase in atmospheric temperatures by 2100 and even if CO_2 emissions are stopped most aspects of climate change will persist for many centuries (IPCC 2013) and climate change impacts on both terrestrial and marine ecosystems have already been observed (IPCC 2014), Climate change decreases ecosystems' stability and increases the magnitude and frequency of change in biological systems, human society, and the interactions between them (for example, habitat disturbances impact their ability to deliver ecosystem services). The objectives of GEF projects vary between the different focal areas, ranging from protecting specific biological systems or entities (for example, threatened bird species, coastal habitats, or large marine ecosystems (LMEs)) to conserving ecosystem services (for example, ensuring sustainability of fisheries), or improving governance of natural resources (for example, through protected area (PA) management, or transnational environmental cooperation agreements). For many of the focal areas and specific projects, the achievement of the objectives and the sustainability of those results could be impacted by climate change. In addition to the direct changes in physical conditions climate change is likely to induce changes in biological processes, species abundance and distribution, ecosystem services (provisioning and regulating), and socio-economic systems (blue arrows in figure 1). There may also be interactions between these changes (orange arrows). GEF project objectives, including protecting particular species, ecosystem services, or influencing socio-economic systems, can be related to several of the different components that may be altered by climate change (green arrows).

Therefore, climate change and its impacts may directly influence the achievement of the objectives of GEF projects such that the main activities and objectives within a project need to change. For example, through:

i. A shift in space (i.e. the location where the project is being held) may be required if, for example, the focus species of the project shifts its geographical range due to climate change.
ii. A shift in the focus of the project may be necessary if the problem being addressed is impacted. For example, a project addressing fire management in a forested area that will actually become exposed to more frequent precipitation due to climate change may need to change its focus if the efforts to manage fire occurrence become unnecessary due to more frequent rain events.
iii. A shift in the activities conducted to achieve the goals of the project. For example, a project focusing on land degradation and improving agricultural or forestry management might need to consider the changing the agricultural practises being developed if the area is likely to become more suited to different production methods.

Further, climate change may cause additional pressures which impact the effective implementation of projects (dark red arrows in Figure 1). Therefore, explicit consideration of climate-induced changes is likely to be essential for securing high returns on GEF Investments. Even where there is uncertainty in the specific way in which the climate will change, there may be actions that can be taken to improve the likelihood of GEF outcomes being resilient to the range of possible climate scenarios.

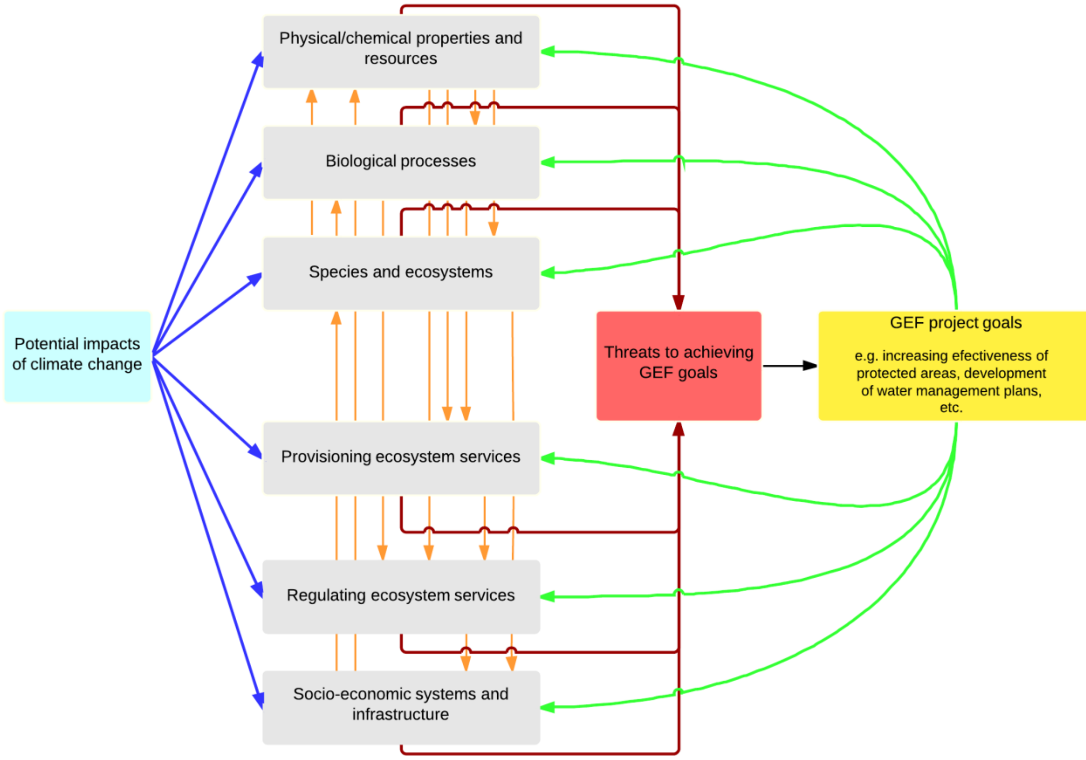

Figure 1: Factors that may be impacted by climate change (blue arrows), and also support the achievement of GEF project goals (green arrows). For example, a GEF project may be focused on conserving particular species or maintenance of provisioning ecosystem services, such as fish stocks. There are also complex interactions between these different factors (and the changes in them due to climate change) (orange arrows). Finally, changes in the different factors and the interactions between them may also impact the threats to achieving GEF goals (dark red arrows). For example, changes in species due to climate change may not only relate to project goals (such as conserving particular species of conservation concern), they may also threaten the achievement of GEF projects (such as due to changes in the distribution of invasive species). Similarly, changes in the supply of and demand for provisioning ecosystem services may threaten the establishment of an effective management plan.

This report therefore reviews key climate change risks and impacts for each of the GEF focal areas. A larger body of work could provide a more detailed review of all scientific evidence available on the most important risks and impacts. The report also identifies potential response measures to enhance climate resilience (from managing risks to integrating climate resilience into multiple benefits planning). The impacts of climate change, and most suitable response measures, are likely to vary between regions and the specific context of projects. This report highlights the general considerations that are likely to be useful for all projects to consider but more detailed and regionally specific guidance could also be developed, which also reviewed potential for implementing response measures in different settings.

2 Methodology and analysis framework

As figures 1 demonstrates, there are potentially complex interactions between climate change impacts and both GEF project goals and threats to the achievement of GEF projects. Systematically considering how climate change impacts on different components of the environment can help in understanding this range of interacting impacts in understanding of the climate resilience of the GEF 6 strategy. Therefore, an analysis framework was developed based on: the factors identified through the GEF STAP workshop held in January 2014; key categories of ecosystems and ecosystem services identified within the Millennium Ecosystem Assessment and UK National Ecosystem Assessment; and factors that were identified during a preliminary review of the focal areas. The core of the framework is the systematic assessment of potential project-relevant, climate-induced changes in the following factors:

A. Physical/chemical properties and resources
B. Biological processes
C. Species (that support the aim of the project or are a threat to the project) and ecosystems
D. Provisioning ecosystem services (including food/agriculture, timber, and non-timber forest products (NTFPs))
E. Regulating ecosystem services
F. Socio-economic systems and infrastructure

The list of factors corresponds to those listed in the middle column of figure 1. The analysis was then undertaken in two steps

i. identification, for each factor, of the aspects that might be altered by climate change, and how for different types of projects in each GEF focal area, these factors may influence the achievement of GEF goals;
ii. assessment, for each factor, of the ways GEF projects goals, objectives, and interventions may need to be adapted due to climate change, and new threats GEF projects may need to consider.

The review work involved carrying out an initial assessment of the main issues that need to be considered for each of the factors rather than reviewing all available scientific evidence on the different potential climate change impacts within different settings and regions or the financial and practical feasibility of adapting GEF goals, objectives, and intervention to climate change. The review identified issues that relate both to addressing climate change through managing risks and increasing potential multiple benefits. .

3 Summary of analysis results

Climate change may impact each of the assessment factors and focal areas in several different ways. The first section of this chapter summarises the main issues related to each of the assessment factors that are important across all focal areas. In the following sections the main issues relating to each of the GEF focal areas (across all of the different assessment factors) are highlighted. Full details of the review of each focal area are provided within section 7 of the report; including details on the programs within each focal area, and consideration of (i) the links between climate change induced changes and GEF projects, (ii) the ways GEF goals, objectives, and intervention may need to be adapted due to climate change and (iii) new threats GEF projects may need to consider. This section provides a summary of the main issues which need to be considered by the GEF secretariat and GEF project developers. The impacts of climate change on individual projects will depend on the location, specific focus and context of the projects. The response to potential impacts will also depend on the aims of the project, as well as the financial and practical considerations regarding feasibility of different options. Further work may need to be undertaken to understand potential regional differences in climate impacts, to collect all available scientific evidence on the different potential climate change impacts within different settings and to further evaluate the financial and practical feasibility of adapting GEF goals, objectives, and intervention to climate change.

3.1 General issues for each factor in the analysis framework

3.1.1 A. Physical and chemical properties and resources

Change in physical processes and resources caused by climate change (e.g. changes to temperature, salinity, acidity, rainfall, glacial melt, etc.) can directly impact the objective of GEF projects within all of the focal areas. Resources are very likely to change in a variety of ways, such as variability, and downward or upward trends at different scales. Changes in variability and the frequency of extreme events (such as in cyclones or droughts) can be particularly challenging to adapt to, but are therefore also particularly important to address in management plans in order to decrease negative climate impacts. Even when GEF projects are adapted to reduce the impact of climate change, residual risks can exist which need to be considered and potentially monitored for. Coral reefs, for example, cannot be fully protected against rising surface water temperatures that increase the risk of coral bleaching. Changes in physical and chemical properties and resources which impact GEF projects through other mediating processes (for example, changes in physical properties such as temperature impact biological processes, which in turn can have consequences for GEF projects) are discussed in the following sections.

3.1.2 B. Biological processes

Changes in the climate can cause changes in biological processes, such as changes in interactions between species, crop productivity and calcification (IPCC 2014). The most important changes depend on the system[2] being considered, and so vary between focal areas. One example is ocean acidification, which is likely impact calcification within marine species and so to pose large threats to reef conservation projects. Another is how rising CO_2 levels and changing rainfall and temperature patterns can affect ecosystem productivity and thus food yields in different locations, and therefore may impact landscape scale planning (see section D below). In general, changes in biological process can cause change in the overall dynamics of systems and how they respond to different pressures. As these changes can be unpredictable, monitoring programmes need to consider the potential need for information on changes in biological processes to enable adaptive management. Thus it is important to ensure adequate provision is made for both monitoring and adaptive management.

3.1.3 C. Species and ecosystems

Climate change can alter the relative abundances, distributions, behaviours of species and assemblages (at different scales) (IPCC 2014). Where species are predicted to move geographically (Burrows et al 2014), and in some cases temporally (such as altered phenology of plants, or changing behaviour patterns in animals), in response to climate change, then plans for their management and conservation are likely to need changing. Additionally, changes in species can pose a threat to achieving GEF project objectives, for

[2] In particular contexts, this may refer to biological systems (including ecosystems), socio-economic systems or combinations of the two; so-called 'social-ecological systems' (Folke, 2006).

example as invasive species that affect the target species or ecosystem services of these projects. Therefore, considering potential range expansions for relevant invasive species and pathogens (disease) can be important within project planning. As it is not possible to predict all changes in species that will occur due to climate change, as with biological processes, it is important to ensure adequate provision is made for monitoring and adaptive management. Shifting species can also interact with changing biological process (for example, altered food webs, increasing predation, or declining prey availability) and also impact provisioning and regulating ecosystem services (see sections D and E below).

3.1.4 D. Provisioning ecosystem services

Where climate change impacts species productivity, distributions, and interactions (see B and C above) it can cause changes in the supply of ecosystem services. In particular, changes in extreme events (such as floods and droughts) and more general climate variability (for example variability in daily, monthly, seasonal and annual precipitation rates) due to climate change can impact the resilience and supply of provisioning services. This can also interact with climate change impacts on regulatory ecosystem services such as flood control (see section E below).

The demands for provisioning ecosystem services, such as food and biofuel production, are also likely to change with climate change. For example, decreasing crop yields in one location can increase demand for food harvested from the wild, potentially increasing pressures on resources. Therefore, changes in the demand for resources (which may cause both legal and illegal use) need to be considered within planning efforts for each focal area along with potential future conflict in resource needs.

Adapting to changes in the supply of provisioning ecosystem services forms an important component of human adaptation to climate change and for which ecosystem-based adaptation is likely to be especially relevant. For example, managing changes in fisheries can be improved if impacts on the whole marine ecosystem are considered. Climate change is also likely to cause changes to food production on land. As agriculture takes place within wider landscape, managing this wider ecosystem can support production. For example, maintaining wetlands can support water regulation within downstream agricultural areas (see section E below).

3.1.5 E. Regulating ecosystem services

Climate change is likely to impact the availability and nature of natural resources such as potable water through physical processes (for example, changes to water availability, temperature, salinity, acidity, etc., as described in section A) and impacts on regulating ecosystem services (for example, changes to water purification services of wetland ecosystems or water storage capacity of upland forests). There can also be an increasing need for regulatory ecosystem services, such as wetlands contribution to flood control, to help reduce the impact of climate change. Ecosystem-based adaptation to climate change is being increasingly recognised as an adaptation option, and is likely to influence future landscape-scale management.

3.1.6 F. Changing socio-economic systems and infrastructure

Broad scale shifts in climate (for example temporal and spatial changes in precipitation patterns) will alter the feasibility of some infrastructure projects, with potential large scale impacts on biodiversity planning processes and a need for changes in management plans. Additionally, rapid moves towards less carbon-intensive/more renewable forms of energy may increase the need for integration of biodiversity protection into landscape-scale energy infrastructure (such as biofuel production, hydropower or solar farms). Climate change may also influence properties underpinning a particular governance initiative for example, a national park. Climate change could lead to alterations in the availability of resources for environmental management due to changing prioritisation, increased focus on the most pressing adaptation needs and potential impact of climate hazards on the economy. Furthermore, climate change may lead to scarcer and more limited resources, creating the potential for rivalries and conflicts that compromise environmental protection efforts.

Climate change is likely to cause migrations of people due to changes in availability of natural resources, rising sea levels, and increasing frequency and intensity of extreme events. In particular, impacts on coastal communities, coupled with the global concentration of people along coastlines, are likely to create large-scale shifts in population centres, with potential stresses on targets of GEF objectives.

Additionally, many countries have policies, strategies and projects in place to help mitigate and adapt to climate change. These can have knock-on impacts, including on GEF projects.

3.2 Biodiversity focal area

Climate change is likely to directly impact several of the main programs and objectives of the GEF biodiversity focal area, in particular protected areas systems (program 1 and 2), invasive alien species (program 4), sustainable use of biodiversity (objective 3), coral reefs (program 6), mainstreaming biodiversity conservation and sustainable use (objective 4). Details of the GEF focal area and potential climate change impacts are given within the detailed review results in section 7.1.

A key issue across these different programs and objectives is that climate change is likely to cause changes in which species are most threatened and the locations most important for biodiversity. As climate change increases it is likely to increasingly pose a threat to species, especially where climate change impacts are largest, potentially causing new species to become threatened. The locations of suitable climate for different species are also likely to change, increasing the importance of areas which will have favourable habitats in the future. Undertaking or accessing assessments and model projections on how relevant species will be impacted by and shifted due to climate change may help in understanding these potential impacts and can enable projects to adapt appropriately. There are potential challenges with availability of such information due to data availability issues and the resources required to undertake such analysis, however, some projections already exist (see section 6 and the appendix). The impact of climate change across different areas and parts of the environment make landscape-scale planning and scenario development, which consider climate change, especially important. As all of the changes due to climate change cannot be predicted, monitoring of what changes do occur in order to enable adaptive management will become increasingly important as our predictive capacity declines with increasing climate change (section 5).

The shift in species due to climate change means that enabling species movement can be very important for maintaining biodiversity in protected areas, production landscapes and coral reefs. Therefore, so called 'climate–smart' connectivity management in landscape-scale planning and within development of protected areas management is essential. Shifts in species ranges due to climate change will impact the distribution of invasive and pathogenic species as well as threatened and emblematic species. It is therefore important to assess what changes may occur and what new species pose a threat, compared to which are important to conserve and support in their movement to track the shifting climate. Lists of currently invasive species within a wider region and neighbouring environments can help in assessing what new species may be problematic.

If large changes are likely to occur, it can be important to focus on likely future priorities as much as current priorities. In coral reef environments it may be particularly important in the long-term to conserve those areas which have some resilience to climate change, rather than areas that are likely to experience unsustainable pressure within all possible climate futures. However, very threatened ecosystems can provide very important services (for example, coral reefs that may be under terminal decline may still provide important short-term protection against storm surges). Regardless of the degree of threat, focusing on actions that help maintain ecosystem functioning (protection of keystone species; removal of invasive species; managing the harvesting of key functional groups) can increase resilience. For example, within coral reefs protecting grazing herbivorous fish populations, that control algae growth, can increase coral's ability to recover from other threats by preventing algae becoming dominant.

Climate change can also have secondary impacts through socio-economic systems. Sea level rise, changes in flooding and droughts, impact crop yields in different locations, along with other impacts, can all affect communities' resilience. In times of hardship the importance of traditional uses of natural systems and resources can increase (for example, non-timber forest products and bush meat use can increase when crops fail, Misra and Dash 2000). Social-ecological systems around coastlines are particularly vulnerable to climate change and landscape-scale management, protected area management and reef protection should therefore include strong climate change consideration. Monitoring, land-use modelling, and economic analysis that assess the impact of changing supply and demand of commodities due to climate change can be used to support project planning.

Climate change mitigation and adaptation policy and strategies may have significant impacts on GEF projects, necessitating that these strategies are taken into account in project design and implementation. Ecosystems and biodiversity important for mitigation and adaptation are likely to be valued more highly, including in natural capital accounting. Mangroves are an example of an ecosystem with high value for both mitigation and adaptation. Not only does conservation of carbon stocks stored in mangroves contribute to mitigation, the flood and storm damage control services they provide can enhance adaptation to more frequent extreme weather events.

Mitigation policies, such as REDD+[3], could have a large role in conserving forests, although they may also displace pressures onto low-carbon ecosystems. Adaptation policies, such as using wetland conservation, restoration or sustainable management to protect against increase risk of flooding, or protecting coral reefs to protect against storm damage, may also have impacts on the creation and management of protected areas, coral reef conservation, and conservation within production landscapes.

3.3 Land Degradation focal area

There is already a focus on climate change within this focal area (see section 7.2 for an overview of the programs within the focal area and full assessment details). Program 2 is focused on climate-smart agriculture which directly recognises the importance of climate change in landscape-scale planning. Therefore, a key recommendation for the land degradation focal areas is that the principles of program 2 are also considered within program 1 on agro-ecological intensification and program 3 on forest landscapes. Climate change has multiple different potential impacts on productive landscapes including both direct and indirect impacts. Changes in temperature and rainfall patterns can cause change in the productivity of

[3] This term refers to reducing emissions from deforestation and forest degradation *plus* the conservation of forest carbon stocks, sustainable forest management, and enhancement of forest carbon stocks' in developing countries.

crops such that the most suitable area for growing a given crop shifts. Additionally, increased frequency of extreme events (floods, droughts, storms, etc.) can increase the risk of crop failure. Climate changes can also affect pest outbreaks, fires risk and nutritional value of crops. Therefore, sustainable land management for climate-smart agriculture (program 2) is fundamental to building climate resilience and the issues highlighted within this program should be considered when developing projects focusing on other programs including, but not limited to: undertaking agricultural land management systems that are resilient to climate shocks (drought, flood); diversifying crops and livestock production systems to enhance agro-ecosystem resilience and manage risks (for example, integration of tree-based practices into smallholder crop-livestock systems to increase resilience); and applying sustainable land management strategies and other ecosystem-based climate adaptation strategies for drought mitigation in drylands. Sustainable land management can also support provisioning and regulating ecosystem services and can reduce the impact of agriculture on other land areas.

Climate change can lead to increased competition for land. Changes in crop yields can mean that production of specific crops may need to move to new areas. Climate change policies, including large-scale energy production through hydropower, bioenergy, solar and wind, can require large areas of land. Such policies can potentially increase the scarcity of available resources for a variety of land-uses (including forestry, agriculture for food and biofuels, infrastructure, and urban areas) increase trade-offs between competing land-uses depending on the local context and potential for integrated land use. This can increase the pressure on biodiversity and increases the need to integrated landscape-scale planning (program 4), which can take account of climate change within scenario planning. Modelling tools can be useful for such planning by supporting the identification of potential future competition for resources.

Landscapes are not only important for crops, but also for other ecosystem services including traditional use of ecosystems and resources (such as non-timber forest products (NTFPs and bush meat), which can be increasingly important under climate change (for example, NTFPs and bushmeat are consumed more when supplies from agriculture are low, Misra and Dash 2000). Particular land-uses and land-cover types may increase landscape-scale social resilience to climate change by maintaining, protecting, or increasing supply of ecosystem services that are important for climate resilience (for example, maintaining forest cover can support regulation of water supply and erosion control and so support freshwater provision, Douglas et al., 2006). There can also be complex interactions between climate related threats and non-climate threats. For example, droughts and increased temperatures can increasing the likelihood of fires, which in turn can decrease the amount of living biomass and forest cover, increasing soil erosion, and changing microclimatic regulation, creating potential positive feedback loops. Overall, there is a risk that climate change will degrade ecosystem services that are important for climate resilience (for example, freshwater provision, soil erosion control, microclimatic regulation and fire prevention). These risks will interact with future increases in the intensification of agriculture in response to growing demand for food due to population growth. Therefore, GEF projects on sustainable landscape-scale management should take account of all of the different uses of the landscape and of landscape-scale climate planning (scenario planning) in order to ensure resilience to climate change can be maintained. The importance of ecosystem services also highlights why ecosystem based adaptation, using biodiversity and ecosystem services to support people to adapt to climate change, can be an important part of climate change adaptation plans.

Climate change mitigation policies can also have an impact, in particular REDD+ activities can affect forest landscapes and restoration (program 3 but also see sustainable forest management focal area). Policies for reducing deforestation can also have knock-on impacts in areas outside where they are directly implemented, if they displace pressures to non-forested landscapes. Ecosystem restoration can be a climate-smart tool (for example, wetland restoration and changing water flows) which can also support climate change mitigation as well as ecosystem based adaptation.

In undertaking sustainable landscape-scale management, empowering communities, women, and vulnerable groups, and utilising repositories of traditional knowledge can all support climate change adaptation and reduce the potential for negative impacts of climate change.

The impact of water management on agricultural landscapes, the fact that forests are often part of agricultural landscapes, and the importance of even productive and mosaic landscapes for biodiversity, highlights that many issues are cross-cutting across the different GEF focal areas, hence the issues within one focal areas can often be relevant to the others.

3.4 International Waters Focal Area

Climate change is likely to have many and varying impacts on all parts of the international waters focal area, including transboundary water systems (program 1 and 2) and marine and coastal areas (program 3) (see section 7.3 for details of the programs and the analysis results details for each program). Water systems will be both directly and indirectly impacted by climate change. The main impacts on terrestrial water systems include through changing rainfall patterns and more extreme events, glacial melt, changing temperatures affecting evaporation and transpiration rates and increasing risk of salinization (including from sea level rise)(IPCC 2014). Water systems are also likely to face changing demand and competition for water resources including from changing irrigation needs of agriculture and shifting populations. Marine and coastal systems face additional threats due to increases in ocean temperature and acidification.

The GEF strategy recognises that climate change is a key challenge to international waters. Climate change is particularly addressed within program 1.2 which is focused on resilience in the context of melting glaciers. The strategy already states (in program 2.1) that all new Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programs (SAPs) will be required to consider climate variability and change, TDAs and SAPs that have already been completed and that would benefit from latest science regarding climate impacts will be updated. Climate change has the potential to fundamentally alter the context in which water projects are carried out. Integrated watershed planning and increased emphasis on ecosystem-based water recharge and flood control programs can support increased socio-economic resilience to climate-change related threats. It is important that integrated planning takes account of all direct and indirect uses of freshwater (across water, food and ecosystem as recognised by program 2.2) and considers both climate change and non-climate change impacts. Therefore, although the glacial supply is of critical importance, and should be central to program 1.2, planning processes need to go beyond glacial water supply. As climate change is likely to cause rare events to become more frequent (such as increased frequency of droughts and storms), planning processes need to address the changes in these categories. Indirect impacts of climate change also need to be addressed. For example, changes to distribution of invasive species and pathogens due to climate change can be equally damaging as direct efforts of climate shocks. Climate-driven degradation of key regulating services that store and purify water can impact downstream stocks, as well as microclimatic regulation which can reduce evaporation rates. Climate change can also interact with other threats. Decreased flows of freshwater and runoff can cause pollution of water sources to be of higher concentration and thus more toxic.

Currently static solution-sets are still being designed for increasingly dynamic systems. Therefore, scenario planning under various climate scenarios, and designing capacity and use around climate-smart scenario assessments is critical. Uneven, unpredictable, increasingly uncertain freshwater futures increase the need for robust, integrated design, and the implementation of freshwater projects at all scales. Additionally, the combined impact of declining risk tolerance, increased system complexity, and increasing risk means that there is currently a projection capacity gap. The possibility of unexpected climate effects means that adaptive management strategies will become more important as our predictive capacity declines with increasing climate change. Additionally, a more frequent planning cycle may help to keep up with information flow and increasing understanding of change in climate variables.

Climate change is likely to have some of its largest impacts on coastal habitats. Climate change is causing rises in sea level, increasing storm frequency and intensity in some areas, leading to an increased risk of salinization (including through decreasing precipitation) and increased coastal erosion (IPCC, 2014). There are also significant risks from acidification impacts on calcification and temperature rises (leading to coral bleaching for example) (IPCC, 2014). Therefore, understanding and addressing climate change impacts is fundamental to coastal management. It is not possible to address many of the coastal impacts of climate change at the local scale (such as sea level rise). Therefore, it can be important to address other pressures to increase resilience, and it can also be important to adapt and plan for change, for example, managed coastal re-alignment is becoming increasingly relevant. As coastal systems will be heavily impacted by climate change, vulnerability assessments and ecosystem-based adaptation are increasingly needed as part of management planning.

Consideration of climate change is also needed for fisheries management and protection. One issue is that sustainable-use models need to take account of water temperature-driven change in fish maturation, growth rates, distributions and abundance. Changes in ocean biogeochemistry and phytoplankton community structure are also likely to be affecting fish distribution and productivity, and so should be considered within sustainable use models. The probability of system perturbation is greater with climate change, therefore in order to reduce the risk of irreversible thresholds in populations being crossed a more precautionary approach to setting sustainable limits may be needed. Additionally existing threats to sustainable fisheries, such as perverse subsidies, lack of alternative food and livelihood sources, pollution and regulation failures, will impact the climate change resilience of fisheries.

3.5 Sustainable Forest Management focal area

The GEF 6 Programme strategy already recognises forests are affected by climate change and also have an important role in efforts to slow climate change by maintaining and enhancing forest carbon. Policies for climate change mitigation in the forest sector through Reducing Emissions from Deforestation, forest Degradation, plus the conservation of forest carbon, sustainable management of forest carbon stocks and enhancement of forest carbon stocks (REDD+), are having significant impacts on global forest policy, and, in particular, regional and global cooperation on forest issues (objective 4), as well as, resources and deforestation (objective 1), forest management (objective 2), restoration of forest ecosystems (objective 3) (see section 7.4 – Analysis details - for more in depth information). Therefore, considering the impacts of climate change policies is, and needs to be, an integral part of project design within these programmes. It is also important for GEF projects in this focal area to consider the potential impact of other climate change policies, including adaptation policies, which are already mentioned in program 2.2., but can be relevant to other programs as well.

The direct impacts of climate change on forests have the potential to cause forest die-back in some locations (Allen et al 2014). This poses a potential long-term risk to payments for ecosystem services (PES) and restoration activities, and may threaten long-term investment in forestry activities. Understanding the thresholds and tipping points within ecosystems, and for the provision of ecosystems services, can be important for understanding, explaining and presenting the long-term risks to particular forests, and so investments. More research on this area is still needed and may be supported by monitoring of forest loss (program 1.3).

The impacts of climate change on the wider landscape can also impact forests. GEF recognises the importance of carrying out sustainable forest management within the context of integrated land use planning (program 1.1), which can help in considering the impacts of climate change on the wider landscape. In particular, including issues highlighted in the land degradation focal area program 2 on climate-smart agriculture within landscape planning as part of sustainable forest management can help support integrated climate resilient projects.

Restoration (objective 3) can be impacted by climate change in terms of the most appropriate locations for restoration and restoration methods. It is important to carry out restoration activities which are resilient to the predicted future climate and climate change related stresses in the location (including water stress, salinity and fire frequency). Therefore considering projections of future climate within areas of planned restoration is needed for designing climate resilient restoration. Additionally, recognising that restoration can have a role in societal climate change adaptation if restoration activities are strategically planned to enhance ecosystems services important to adaptation (such as to control water run-off and flood and soil erosion control), can support an integrated multiple benefits framework to climate resilience.

4 Relevance to, and relationship with, climate change adaptation

Increasing the resilience of programs and projects is a form of climate change adaptation and can support human adaptation to climate change. Despite climate change mitigation actions, climate change will have large impacts on people, and so climate change adaptation is important to reduce the negative impacts. Responding to climate-related risks involves continuing uncertainty about severity and timing of climate change impacts and with limits to the effectiveness of adaptation (IPCC, 2014). This makes an iterative risk management framework together with monitoring and learning important components of effective adaptation (IPCC, 2014). Analysing the likely future impacts of climate change on the delivery of global environmental benefits expected from the implementation of the GEF Focal Area Strategies in the natural resource management sectors, can support the wider consideration of the potential impacts of climate change on issues that the GEF is trying to address. Additionally, the issues that need to be considered in increasing the resilience of projects and adapting them to ensure they continue to meet their goals in the face of climate change, are likely to be closely linked to the issues that generally need to be considered in climate change adaptation within the system which the GEF is trying to support (for example sustainable agriculture, freshwater provision or protected areas).

Climate change adaptation can be approached through hard infrastructure development (such as sea walls) but the role that ecosystems can play in climate change adaptation has been increasingly recognised (Munroe et al., 2011). Intact ecosystems provide multiple services to humans, including provisioning and regulating services important for climate change adaptation, for example, flood plains and mangroves can provide natural protection against extreme weather events and rising sea levels. There can also be complex interactions in climate impacts for example, the microclimatic regulation of forests and trees can limit the effects of drought and fire, but is itself threatened by climate change. Additionally, climate change can affect institutional arrangements, governance capacity and incentives for environmental protection which can all affect ecosystems and then in turn, the ability of the ecosystem to provide ecosystem services which themselves are important for climate change adaptation.

Hence, systematically assessing the impacts of climate change through different components of the environment (as has been undertaken within this review) can support the development and assessment of appropriate adaptation measures. Carrying out a detailed review of adaptation measure which are currently used or suggested for use within in relation to the GEF focal areas and potential future projects could further strengthen the integration of adaptation considerations within projects. Building resilience to climate change within GEF programs not only improves the return on investments of GEF projects, but enables non-adaptation focused GEF projects to deliver adaptation returns.

5 Monitoring, evaluation and reporting, and climate resilience

The explicit consideration of the climate resilience of GEF projects can only be achieved if pragmatic and measurable indicators can be developed to assess the different facets of climate resilience, relevant to the GEF project in question. Additionally, as climate change increasingly causes systems to respond in unexpected ways, the necessity for adaptive management will grow. Ensuring that the design of monitoring takes account of potential changes can support the implementing adaptive management. Furthermore, gathering and dissemination information on the resilience of interventions will help develop the evidence-base for different approaches and support the generation of tools and information for future project development (see section 6).

Consideration of what factors to include in monitoring, evaluation and reporting will depend on the components of the social-ecological system being addressed, and which of these may be impacted by climate change (as is highlighted in section 3 and 7). It will also depend on the purpose of the monitoring. Monitoring to support adaptive management needs to track changes that may partly be due to climate change, but will also be due to other factors. For example, monitoring how fish stocks are changing, including shifts in species distributions and abundances, which may be influenced by climate change as well as other factors, is essential for ensuring the long-term stability of catches. Another example is that monitoring shifts in species, including the arrival of important threatened species and potential invasive species, can be important for protected area management in the face of climate change.

Assessing how projects have increased climate change resilience can be more challenging, as developing robust indicators of resilience and the impact of actions to increase resilience, is not easy. Monitoring can also be in terms of assessing vulnerability (often understood as the opposite to resilience). Vulnerability is often evaluated in terms of exposure to climate hazards, sensitivity to those hazards (together constituting the 'impact'), and adaptive capacity in the face of those hazards. Indications of ecosystems' adaptive capacity could be the response diversity in functional groups in the ecosystem in question, or extent of redundancy – the insurance conferred on the system by multiple species providing the same function.

In developing monitoring systems that are in themselves resilient to climate change, it is important that indicators will respond to both current conditions and projected future changes. This involves consideration of how the various aspects are likely to change given climate and non-climate related scenarios. The appendix provides tools to facilitate thinking on these issues.

6 Tools, capacity and information needs

As the resilience assessment highlights, there is a significant need for information to support planning in relation to climate change. A previous review of tools and methods to increase climate resilience of GEF projects and programs (ref) revealed that GEF agencies already use a range of tools to support consideration of climate risks. These range from general guidance documents to comprehensive risk assessment tools and operational screening tools. However, for climate resilient project planning and design at the project level, specific information on likely climate change within the location of projects and how this climate change will affect species and ecosystems is can be needed. The appendix to this report highlights the potential sources for information and tools for each of the focal areas.

Building resilience to climate risks can be undertaken at three different levels: i) resilience as risk management; ii) resilience as a co-benefit; iii) resilience integrated into a Multiple Benefits framework (Bierbaum et al 2014). If a risk management approach is being adopted a key question is what to do once potential risks due to climate change have been identified and how to identify, evaluated and then integrated risk management responses into projects. There can be information and analysis needs, as well as financing issues, associated with identifying and integrating management responses. Tools such as those outlined in the appendix can support such assessment. Developing more integrated multiple benefits frameworks involves including climate change resilience assessments as an integrated part of project design, tools to support such approaches are available including the Climate Resilience Framework (CRF) of ISET International (Bierbaum et al 2014) and can be supported by other tools and information sources (such as those listed in the appendix). The most appropriate approach will depend on the project, its location and context.

Models which can support planning range from modelled species distributions at regional scales (i.e. changes in the distribution of priority target species, and changes in the distribution of key resources for these species) to integrated demand, supply and suitability modeling under a range of climate scenarios. Policy development and assessment tools such as those used within protected area management, ecosystem-based adaptation and REDD+ policy development can also provide some guidance.

However, there are still gaps in our knowledge of climate change impacts and in keeping track of changing targets, threats and the actions needed to address them. In order to address this, it may be useful to develop more robust and comprehensive monitoring and evaluation of standardized indicators across projects, allowing broad-scale comparisons and the development of new information on the impacts of different interventions that can inform best practice and allow for adaptive management.

7 Detailed analysis results

The details of the analysis frame work for the Biodiversity (section 7.1), Land Degradation (section 7.2), International Waters (section 7.3) and Sustainable Forest Management 7.4) focal areas are presented within this section. The objectives and programs to meet these objectives of each focal area are described alongside the main outcomes expected programs. The results of the analysis of climate resilience are then presented for each program (or group of similar programs) in terms of the (i) the links between climate change changes and GEF projects, (ii) the ways GEF goals, objectives, and intervention may need to be adapted due to climate change and (iii) new threats GEF projects may need to cons

7.1 Biodiversity Focal area

7.1.1 BD 1 Improve sustainability of protected area systems

Program 1: Improving Financial Sustainability and Effective Management of the National Ecological Infrastructure
Program 2: Nature's Last Stand: Expanding the Reach of the Global Protected Area Estate

Outcome 2.1 Increase in area of terrestrial and marine ecosystems of global significance in new protected areas and increase in threatened species of global significance protected in new protected areas.

- *Indicator 2.1 Area of terrestrial and marine ecosystems and number of threatened species.*

Outcome 2.2: Improved management effectiveness of new protected areas.

- *Indicator 2.2: Protected area management effectiveness score.*

Links between climate change induced changes and GEF projects	Ways GEF goals, objectives, and intervention may need to be adapted due to climate change	New threats GEF projects m need to consider
A. Physical/chemical properties and resources		
Changes in the physical conditions within protected areas (PA) can threaten their resilience and management requirements e.g. changes in frequency and intensity of droughts, floods, fire, acidification, temperature extremes. Changes in physical conditions can also affect the best location for new PAs. e.g. • sea level rises will impact locations of coastal PAs • changes in flood regimes may impact the best location of wetland PAs (including so that they can contribute to climate change adaptation).	What constitutes effective management and the best location of future PAs is likely to change in the face of climate change. Therefore, development of management plans need to take account of changing physical conditions and the potential interactions with other threats (e.g. changing climate may make PAs less resilient to other human disturbance – temperature changes, drought and human disturbance may all contribute to, and interact with, changes in fire risk). Design of new PA systems should consider future climate change in planned locations of PAs.	Changes in flood regimes, drough temperature variability, oce acidification, etc. Interactions between changes physical conditions and other threa (e.g. fire risk).

B. Biological processes		
Changes in productivity and species interactions could impact the sustainable extraction levels within sustainable use protected areas (see D below). Changes in phenology may make species management more difficult and uncertain.	Management plans for sustainable use PAs could take account of changes in productivity and species interactions (and see D). The design of project monitoring should consider the need for adapting to changes in productivity and species interactions.	Unexpected and hard to pred changes in productivity.
C. Species and ecosystems		
Climate change can impact species climate envelopes (and so species distributions), mortality rates, reproduction, and other changes to species' life cycles, which in turn can increase the vulnerability of species to other threats.	Adaptive management is important so that management planning can keep up with the increased dynamics of the species and ecosystems caused by climate change. Many climate change affects will be hard to predict making flexibility within management approaches critical. Monitoring of changes is therefore essential to enable adaptive management.	Species loss due to climate chan and climate change interacting w other pressures on species.
Changing climate suitability envelopes for species will drive migration (often pole-wards or to higher elevations). Some species with limited ranges will not be able to adapt to rapidly changing climatic conditions and movement of species and components of ecosystems may be at different rates. As a result, protected areas may be inadequately able to protect species that they were designed to protect. However, new important and threatened species may move into protected areas as their area of suitable habitat changes. Movement of species also means that connectivity/permeability of the landscape between protected areas is a critical factor in the climate resilience of particular species.	Climate-smart protected area management will involve climate-smart connectivity management and a greater need for regional context to protected area management. It may be necessary to change management plans to accommodate new species that arrive in an area due to climate change and at the same time support those species that have remained. Monitoring of species change can therefore be needed. Communication and shared planning at the regional scale to plan wildlife corridors and, if necessary, move species artificially will be important. It will become important to take climate change into explicit consideration when planning the locations of new protected areas. Models can support such assessments (see appendix).	Species range shifting due to clima change.
Changing conception of 'globally significant biodiversity' – as climate change is likely to affect the relative abundances, scarcity, and extinctions of species, it may impact which are considered globally significant. Including changing which species are categorised as most threatened.	Needs to be a focus on what 'will' be important, aligned with predictions of what will be globally significant. Models and scenario development can help such assessments (see appendix).	Changes in what is consider 'globally significant biodiversity'

Climate change is likely to change the distribution and destructiveness of invasive species and of pests and pathogens.	Management plans will need to take account of the potential spread of new invasive species due to climate change, as well as the arrival of new threatened species whose range is shifting due to climate change and so to differentiate between the negative new arrivals and the ones to protect. As it is not possible to predict all species which may arrive, monitoring can support adaptive management and help track the arrival of new species and trends in pests and pathogens.	New invasive species, pests a pathogens
D. Provisioning ecosystem services		
Climate change is likely to have impacts on the vulnerability of people, which could increase people's reliance on natural resources (e.g. wild food sources) including within PA boundaries. The areas suitable for agricultural production may shift along with the demands of different products (including biofuels), resulting in changing pressures for conversion within protected areas. New areas may come under conversion pressures if old agricultural areas stop being suitable for production.	PA plans need to consider the potential increased pressure for provisioning ecosystem services within the protected area both in terms of potential increased conversion pressure and increased extractive pressures within reserves. Monitoring and the use of land-use change models can help assess changes which are occurring, and project likely future changes (see appendix for relevant resources) respectively. In developing plans, it is likely to be important to consider the local populations need for long term sustainable provision, including in the face of climate change. May need to focus on alternative livelihoods, increased enforcement unlikely to work on its own if surrounding communities have no alternatives.	Increased pressure on some protect areas due to local communiti reliance on natural resources fou within protected areas during times stress.
Within sustainable use protected areas there could be a change in sustainable use level (due to climate change impact individual species and species interactions).	Sustainable use PAs need to include changes due to climate change within their assessment of what is sustainable.	Hard to predict changes sustainable use levels due to clima change impact demand and supply.
Need for irrigation/inputs into agricultural production may increase.	This could impact sustainable production within sustainable use protected areas and increase the competition for water resources between protected areas and neighbouring agricultural areas.	Water resource demand becomi larger than sustainable supplies.
E. Regulating ecosystem services		
There can be increasing demand for regulating ecosystem services for climate change mitigation (e.g. carbon storage and the REDD+ process) or for climate change adaptation (e.g. flood control) which may impact the optimal location of protected areas.	Changing demands for regulating ecosystem services may need to be considered in developing protected areas plans (e.g. a country's REDD+ strategy or adaptation plan).	

F. Changing socio-economic systems and infrastructure		
Climate change may impact revenues of PAs through various pathways which affect the long-term financial stability of PAs. Policies for using ecosystems to support climate change adaptation and mitigation may provide financial support and stability. However, if climate change causes significant problems for a county it may require climate change funds to be diverted from PAs to other policies. Additionally, loss of flagship species or decline in ecosystem services that PA provides may reduce revenues.	Country's policies for climate change mitigation and adaptation should be considered when developing a protected area policy or specific management plan.	Increased pressure on financ resources due to problems caused climate change.
Vulnerable and poor households without access to viable agricultural land are more likely to exploit forest provisioning goods and services such as timber, fuel wood, medicinal products, and other sources of cash income, as well as converting intact natural systems for agriculture. This can increase the pressure on these ecosystems.	Consider climate change vulnerability of local populations and their changing needs for natural resources within protected area management plans.	Climate change disruption sustainable incomes of lo populations.
Climate change may increase the flow of inward migration into particular areas as migrants are forced to move as a result of a variety of climate impacts (such as sea-level rise, land degradation, and water scarcity) and their interactions with existing drivers (e.g. livelihood availability, viability of agricultural production). Shifting pressure on natural resources.	Include consideration of the impacts of shifting human populations and associated agricultural production within PA policies and management plans.	Large-scale shifts in population whi are hard to manage and plan for.

7.1.2 Objective 2: Reduce threats to globally significant biodiversity

Program 3: Reducing Poaching and Illegal Trafficking of Threatened Species
Program 4: Prevention, Control and Management of Invasive Alien Species
Program 5: Implementing the Cartagena Protocol on Biosafety (CPB)

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change.***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
B. Biological processes		
Program 4: Climate change may make ecosystems less resilient to invasive species, and change the competitive relationship between species.	Plans for managing and protecting against invasive alien species may need to consider changing species dynamics due to climate change, e.g. relative breading times of different species and other aspects of phenology.	Unexpected and new invasive spec emerging due to climate change.

C. Species and ecosystems		
Program 3: Climate change may cause range shifts in species which are subjected to poaching and illegal trafficking meaning that protection against such actions may need to shift location	Need to include monitoring programs to track range shifts and facilitate adaptive management.	Threatened species' range shift d to climate change.
Program 3: Pressure due to climate change can increase species' sensitivity to poaching so stricter protection may be needed.	Protection plans may need to include assessments and monitoring of species sensitivity to climate threats.	Climate change may make spec more sensitive to poaching and th less able to survive despite reductic in poaching.
Program 4: Climate change is likely to cause shifts in species distributions and so cause species to move into new areas – this is important for the classification of invasive species. Invasive species will also be impacted by changing climate envelopes, life cycles, and growth rates; it is possible that some invasive species will increase in the level of damage that they cause to other species and ecosystems (i.e. virulence). Climate change can reduce the resilience of systems to other pressures such as outbreaks of invasive species. Additionally, invasive species can exploit disturbances caused by climate change such as fire and storms increase in abundance.	Plans for managing and protecting against invasive alien species may need to consider changing species distributions and potential impact due to climate change. It will also be important to consider what constitutes an invasive species as all species shift their range due to climate change. Databases of current invasive species and consideration of the origin and impact of species can support this assessment (see appendix for potentially useful resources). Monitoring of changes in invasive species as climate changes increases the unpredictability of invasive species impacts and distribution. It can also allow adaptive management.	Unexpected and new invasive spec emerging due to climate change.
D. Provisioning ecosystem services		
Program 3: Climate change is likely to have impacts on the vulnerability of people which could increase their reliance on wild-caught species and therefore the instances of poaching, or alternatively lead to the migration of proportions of the local population reducing the threat to the wild-caught species.	Plans for preventing poaching should consider locals populations changing reliance on wild caught species. Including monitoring of the changing vulnerability of local people to ecosystem and non-ecosystem mediated climate impacts can support project planning.	Changes in poaching due to extrer events (such as droughts) which m be caused by climate change will particularly hard to manage against
Program 5: May be increased demand for use of GMO which are climate resilient	Where relevant projects may need to plan for changes in GMOs	
E. Regulating ecosystem services		
F. Changing socio-economic systems and infrastructure		
Program 3: Vulnerable and poor households without access to viable agricultural land are more likely to 'poach' rhinos and elephants other sources of cash income.	Plans for preventing poaching should consider local populations' changing reliance on wild-caught species. Monitoring changing vulnerability of local people may support adaptive management of projects.	climate change disruption sustainable incomes of lo populations

Program 3: Trafficking often takes place in states with reduced governance such as failed states, and is used to fund armed conflicts. In the longer term, climate change is likely to increase resource scarcity which may increase conflict and potentially lead to collapse of governance systems.		Climate change related social confli

7.1.3 Objective 3: Sustainably use biodiversity

Program 6: Ridge to Reef+: Maintaining Integrity and Function of Coral Reef Ecosystems

Outcome 6.1. Integrity and functioning of coral reef ecosystems maintained and area increased.

- *Indicator 6.1 Area of coral reef ecosystems that maintain or increase integrity and function as measured by number of coral species and abundance both outside and inside MPAs.*

Program 7: Securing Agriculture's Future: Sustainable Use of Plant and Animal Genetic Resources

Outcome 7.1 Increased genetic diversity of globally significant cultivated plants and domesticated animals that are sustainably used within production systems.

- *Indicator 7. 1. Diversity status of target species.*

Program 8: Implement the Nagoya Protocol on ABS

Outcome 8.1: Legal and regulatory frameworks, and administrative procedures established that enable access to genetic resources and benefit sharing in accordance with the provisions of the Nagoya Protocol

- *Indicator 8.1: National ABS frameworks operational score.*

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Program 6: Particular threats to reefs include increased temperature (leading to coral bleaching), flooding and droughts (impacting on sediment loads from river discharge), ocean acidification, more extreme storms and rising sea levels. These threats, stressors and disturbances are likely to be regionally and locally differentiated.	It will be important to consider potential climate change impacts when creating policies to protect coral reefs. Projects may need to focus on reefs which are less impacted by climate change rather than those which are predicted to reach tipping points under all climate change scenarios. The most important areas for protection may change depending on the time-frame considered (e.g. importance of reefs for immediate-term protection of communities compared with which reefs may have longer-term survival), and over time given the dynamic nature of the threats expected with climate change. Monitoring of changes is likely to be important for adaptive management of projects	Include increased temperatu (leading to coral bleaching), floodi and droughts (impacting on sedime loads from river discharge), oce acidification, more extreme stor and rising sea levels in threat analys Some coral reefs may disappear und all climate scenarios

B. Biological processes		
Program 6: Increased ocean acidification is projected to have large-scale effects on calcification processes within corals and other marine organisms.	Maintain herbivore communities and functional diversity of species within the reef ecosystem as a key contributor to reef resilience, and stopping the conversion from coral to algal dominated communities.	Increasing risk of large-scale oce acidification
C. Species and ecosystems		
Program 6: There can be shifts in species distributions due to changing temperature, acidification and sea level rise.	Ensuring well managed climate-smart connectivity between reefs can increase resilience	Shifting species distributions
Programs 6 and 7: Climate change is likely to change the distribution and destructiveness of invasive species and pathogens which are a key threat	The design of project monitoring systems should consider that monitoring can help identify new invasive species or pathogens if they arrive.	Emergence of new invasive spec and pathogens
Program 7: Many species of globally significant cultivated and domesticated plants and their wild relatives may be impacted by climate change. Program 7 and 8: The movement of species as a result of changing climate envelopes is likely to cause increased intermixing of genetically-diverse populations of wild relatives of cultivated plant and livestock where such movements are possible, and cause losses of genetic diversity in such organisms where movement is not possible. In both cases, genetic diversity is likely to decrease.	Consideration of genetic differentiation explicitly across climate gradients may be important to improve understanding of what aspects of genetic diversity are under threat from climate-related impacts, as well as which aspects of genetic diversity appear to be responding well with climate change and can thus be used sustainably in climate change adaptation measures. Genetic banking and husbandry (e.g. selective breeding) may be important for safeguarding genetic diversity	
D. Provisioning ecosystem services		
Program 7: Concept of 'globally significant' cultivated plants and domesticated animals may change. For example, crops that grow well or animals that adapt well to future climate scenarios are likely to become more globally significant whilst crops that do not respond well to future climate are likely to decline in significance.	The diversity of crops is particularly important in the face of climate change. Consideration of genetic differentiation explicitly across climate gradients may be important to improve understanding of what aspects of genetic diversity are under threat from climate-related impacts, as well as which aspects of genetic diversity appear to be responding well with climate change and can thus be used sustainably in climate change adaptation measures.	Genetic diversity may be lost befo its importance for climate chan adaptation is realised.
Climate change may impact what constitutes sustainable use (due to changes in species populations). What previously constituted a sustainable level of use might with climate change come to be overexploitation of the resource.	Climate change impacts should be considered within the development of sustainable use plans. The potential for climate change to change what constitutes sustainable use increases the importance of monitoring and adaptive management which can identify and respond to changes which occur.	Unexpected or unpredictable chang in sustainable use levels

E. Regulating ecosystem services		
Program 6: the importance for climate change adaptation and risk reduction of different reefs may change, potentially impacting on which reefs are considered most important overall. .	When deciding which coral reefs to protect using MPAs, it may be important to consider climate adaptation-related regulating services such as storm protection and coastal erosion control. Additionally, it may be important to consider that even degraded reefs or reefs impacted by climate change still have a key role in protection against storms and coastal erosion.	
F. Changing socio-economic systems and infrastructure		

7.1.4 Objective 4: Mainstream biodiversity conservation and sustainable use into production landscapes and seascapes and production sectors

Program 9: Managing the Human-Biodiversity Interface

Outcome 9.1 Increased area of production landscapes and seascapes that integrate conservation and sustainable use of biodiversity into management.

- *Indicator 9.1 Production landscapes and seascapes that integrate biodiversity conservation and sustainable use into their management preferably demonstrated by meeting national or international third-party certification that incorporates biodiversity considerations (e.g. FSC, MSC) or supported by other objective data.*

Outcome 9.2 Sector policies and regulatory frameworks incorporate biodiversity considerations.

- Indicator 9.2 The degree to which sector policies and regulatory frameworks incorporate biodiversity considerations and implement the regulations.

Program 10: Integration of Biodiversity and Ecosystem Services into Development & Finance Planning

Outcome 10.1 Biodiversity values and ecosystem service values integrated into accounting systems and internalized in development and finance policy and land-use planning and decision-making.

- *Indicator 10. 1 The degree to which biodiversity values and ecosystem service values are internalized in development, finance policy and land-use planning and decision making.*

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Changing temperature ranges and extremes, rainfall patterns (including flooding and droughts), sea level rise etc. can change the importance and value of different areas including for production, sustainable use and conservation. This could be a result of degradation of biodiversity and ecosystem service assets, as well as other services becoming of greater importance due to their role in climate change adaptation (such as flood control).	Changes due to climate change need to be considered within integrated management and planning.	If biodiversity and ecosystem servic are projected to decline or disappe a higher discount rate may be appli to these assets.

B. Biological processes		
Climate change may cause changes to photosynthetic rates, carbon uptake and productivity. In some areas, increased productivity changes community composition towards faster growing species, with slower growing species declining. However, there may be instances where conservation of biodiversity directly benefits from increased primary productivity, carbon uptake and changes to photosynthetic rates.	Developing the understanding of the relationship between carbon dioxide fertilisation and the impact on biodiversity in different ecosystems, and developing modelling tools that can predict changes at scales relevant to GEF project management is a potentially important area of future research that GEF may consider funding.	Changes in biological processes (su as productivity) may impa sustainable use and sustainal landscape management plans
C. Species and ecosystems		
D. Provisioning ecosystem services		
Provisioning services may be directly impacted by climate change as the ecosystems responsible for the supply of these services are affected by climate change (including due to direct impacts on constituent species, impacts on key ecological interactions, as well as changes to physical/chemical properties and resources). These impacts may cause decreases and increased fluctuations in ecosystem services.	What previously constituted a sustainable level of exploitation might with climate change come to be overexploitation of the resource. Thus, forecasting of the abundances of key species and the impacts of climate change will be important to estimate the sustainable levels of use. Considering the potential changes in the variability and extremes due to climate change can be particularly important as the extremes can cause thresholds to be crossed and disrupt previously linear relationships which sustainability estimates may be based on.	Risk of overexploitation if clima change changes sustainable use leve especially difficult to predict chang such as through changing frequer and intensity of extreme events, disrupting the relationship whi sustainable use models are based on.
Climate change can impact crop productivity and the relative suitability of different crops in different areas can affect the competition for resources including land, water, and other ecosystem services. Demand for water may increase due to increased need for irrigation, and changing water availability. Areas that are, or become, suitable for agricultural production may face increased demand for intensification of production due to decreases in productivity elsewhere.	Planning of integrated landscapes should aim to consider potential changes in competition for land and water resources due to climate change, including changes in variability and extremes. (See appendix for potential tools which can help)	Increased demand and competition resources may decrease politi willingness for biodivers conservation.
Rising CO_2 levels in the atmosphere are likely to change primary productivity in some areas, but are also predicted to decrease the nutritional value of major staple food crops (particularly the supply of micronutrients) in some areas. The threat of malnourishment for subsistence agriculturalists and those that cannot access alternative sources of micronutrients, may impact the ability of agriculturalists to engage in the sustainable use of biodiversity.	In some areas it may be important to include research and forecasting of where these effects are likely to be significant. Projects may also consider nutrient supplements as a component of GEF projects in areas of climate-induced malnourishment in order to increase effectiveness of GEF project outcomes and as an adaptation measure.	Changing nutritional value of fo crops

E. **Regulating ecosystem services**		
The variables that are included in natural capital accounting may change as adaptation and mitigation values of ecosystems are considered in the context of climate change. For example there may be increased emphasis on regulating ecosystem services such as for adaptation (e.g. storm protection, water purification) and mitigation (carbon storage, carbon sequestration). Additionally, valuation of ecosystem services may take into account the potential risks of climate-related degradation, thus lowering their perceived value within national accounting. If ecosystem services are projected to decline or disappear, a higher discount rate may be applied to these assets.	GEF project planners may also consider building climate change into alternative measures of growth/progress (beyond GDP, GDP+), and more generally into accounting systems. Climate change adaptation and mitigation may increase political willingness to integrate biodiversity considerations into sector policies (e.g. agriculture, forests, and fisheries). Risk assessment systems should be encouraged to include adaptation projects as risk reduction measures, and link this work to insurance rates. Cost-benefit and cost-effectiveness analysis methodologies should be adapted for analyses of climate change adaptation interventions, and include consideration of the multiple benefits of ecosystem-based approaches. Ecological restoration using climate-resilient species in strategically located areas can be considered a climate-smart tool (e.g. wetland restoration and changing water flows) in order to safeguard important regulating services which would otherwise have increased vulnerability to climate change. It may be important for GEF to be involved in developing the evidence-base for the hypothesis that consideration of natural capital in national accounting will be more important with climate change. For example, the more intense the environmental stresses are, the more important it becomes to increase ecosystem-based adaptation / solutions to increasing resilience.	Key biodiversity and ecosyste services may change due to clim change which may alter the valu placed on them.

Pollination services are likely to be severely affected by climate change. These changes will be both direct (i.e. impacts of climate change on the geographic distribution, timing of life cycles) and indirect (impacts of changing interactions between species, effects of climate-intensified natural disturbances) Soil regulating services are also likely to be affected by climate change. For example, a wide variety of fauna responsible for decomposition and other nutrient cycling processes important for agricultural production are likely to be affected directly and indirectly by climate change.	Potential changes due to climate change increase the need for monitoring to enable adaptive management.	Changes in pollination and s regulation can threaten t sustainability of producti landscapes
F. Changing socio-economic systems and infrastructure		
REDD+ and other climate change policies including renewable energy schemes are likely to have secondary impacts on biodiversity within production systems. They may change the level of protection given to different areas, but also cause increased pressure for agricultural intensification, exploitation of biological resources and land in others due to displacement from protected areas.	Landscape level planning should take account of climate change-related policies including REDD+.	
Climate change may impact communities' access to viable agricultural lands. Vulnerable and poor households without access to viable agricultural land are more likely to exploit forest provisioning goods and services such as timber, fuel wood, medicinal products, and other sources of cash income, as well as converting intact natural systems for agriculture. This can increase the pressure on these ecosystems, potentially pushing exploitation levels for these resources past sustainable limits	The impact of climate change on local population's requirements needs to be included within planning for sustainable use of landscapes.	Changes in demands due to clima change induced changes in frequen of extreme events that affect access viable agricultural lands.

7.2 Land Degradation focal area

7.2.1 *LD 1: Agriculture and Rangeland Systems: Maintain or improve flow of agro-ecosystem services to sustain food production and livelihoods*

PROGRAM 1: Agro-ecological Intensification

Priority actions: (a) Agro-ecological methods and approaches including conservation agriculture, agroforestry, etc.; (b) Improving rangeland management and sustainable pastoralism — regulating livestock grazing pressure through sustainable intensification and rotational grazing systems, increasing diversity of animal and grass species, and managing fire disturbance; (c) Strengthening community-based agricultural management, including participatory decision-making by smallholder farmers and diversification of farms and practices at scale; (d) Integrated watershed management where sustainable land management (SLM) interventions can improve hydrological functions and services for agro-ecosystem productivity; (e) Implementing integrated approaches to soil fertility and water management.

PROGRAM 2: SLM for Climate Smart Agriculture

Outcome 1.1: Improved agricultural, rangeland and pastoral management.

- *Indicator 1.1 Land area under effective agricultural, rangeland and pastoral management practices and/or supporting climate-smart agriculture*

Outcome 1.2: Functionality and cover of agro-ecosystems maintained.

- *Indicator 1.2 Land area under effective management in production systems with improved vegetative cover*

Outcome 1.3: Increased investments in SLM.

- *Indicator 1.3: Value of resources flowing to SLM from diverse sources (including climate change adaptation and mitigation)*

Priority actions: Agricultural land management systems that are resilient to climate shocks (drought, flood); (b) Improving management of impacts of climate change on agricultural lands (including water availability) to enhance agro-ecosystem resilience and manage risks; (c) Diversification of crops and livestock production systems through SLM to enhance agro-ecosystem resilience and manage risks; e.g. Integration of tree-based practices into smallholder crop-livestock systems to increase resilience; (d) Mitigating impacts of climate change on agricultural lands using SLM (e.g. water management practices) to enhance agro-ecosystem resilience and manage risks; (e) Applying SLM strategies and other ecosystem-based climate adaptation strategies for drought mitigation in drylands; (f) Applying innovative financial and market instruments (e.g. carbon finance with public and private sector partners) to implement SLM practices that reduce GHG emissions and increase sequestration of carbon on smallholder farms; (g) Rangeland management and sustainable pastoralism, focusing on SLM options for climate change adaptation and grazing management to reduce GHG emissions.

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
The GEF strategy already recognises the importance of changing rainfall patterns which can increase soil erosion through increased run-off. Extreme rainfall events can also damage crops (e.g. heavy rain, hail). Furthermore, changes in the amount and intensity of rainfall, its distribution through the season and across years, can all have serious impacts on agricultural production, including arable and pastoral agriculture.	Although program 2 already directly relates to climate change, it is important that the issues identified within program 2 are also considered within the development of program 1 projects. The GEF strategy already recognises the importance of soil and water conservation schemes in order to maintain or enhance productivity. Recognising that water stress can be linked to a range of factors including, but not limited to climate change can be important for developing sustainable plans	Changes to provisioning services su as water may interact with existi threats such as pollution. Pollutar are likely to be more toxic in are experiencing increased water stress.

The GEF strategy also recognises that climate change is also likely to increase soil erosion through dust blown during dry periods and droughts.	Additionally, assessing the climate-resilience of planned sustainable technologies to predicted climate scenarios can be important. Some sustainable technologies might have to be adapted to changing environmental conditions or require new designs (for example new irrigation systems).	
Climate change is likely to increase temperatures in some areas, which can reduce productivity through increasing evaporation rates (and thus reduced soil moisture), direct physical damage to crops, as well as increasing risk of fires (which is a threat exaggerated also by increasing water stress and droughts). Increased temperature variability can also affect high-yielding varieties more than traditional varieties (i.e. traditional varieties are more resilient).	The GEF strategy considers the impact of temperature changes in agriculture, in relation to climate smart agriculture. However, even in cases where climate-smart agriculture is not the aim of the project, the impact of changes in temperature and temperature variability should be considered. GEF project planners may wish to consider the utility of 'climate analogues' and 'participatory scenario planning'. As climate change can have unpredictable impacts, monitoring can be increasingly important to allow adaptive management.	
Increased temperatures and droughts are linked to increased fire frequency. This is important for projects aimed at 'managing fire disturbance', and that seek to 'reduce GHG emissions and increase sequestration of carbon on smallholder farms.'	It will be important to increase awareness of the risk of fire, and potentially introduce monitoring of appropriate burning conditions (if these are part of current agricultural practices), as well as regulation and enforcement of climate-sensitive fire regimes.	Increased risk of fire.
Climate change is predicted to increase sea level, which is likely to increase coastal flooding, particularly when combined with the threat of increased extreme events (such as storms). There is also likely to be an increase in coastal erosion with potential direct loss of agricultural land. The societal response to coastal erosion may also increase the loss of agricultural land in coastal areas relative to other land-use types, as coastal protection infrastructure in urban areas can displace storm impacts to agricultural areas.	It may be important to consider the impact of coastal erosion and the potential loss of agricultural land within the wider land-use planning process.	Increased risk of extreme (stor events in some areas.
Salinization is also predicted to become a major threat to agriculture in coastal areas, with potential knock-on effects for inland areas if yields are significantly impacted. Salinization of both soil and water resources can increase due to sea level rise. Additionally, increased groundwater use (which may occur where climate change decreases available surface water) can lower the freshwater table in coastal areas and facilitate drawing of seawater into the groundwater resource, thus increasing salinization.	It is likely to be important for coastal projects to assess the potential for salinization. Where salinization may be a problem, there is a need to consider innovations and technologies that can mitigate the effects. This may involve the use or development of saline-tolerant crop varieties, or increased water conservation technologies to reduce the use of (salinized) groundwater.	Increased risk of salinization.

B. Biological processes		
Climate change is likely to affect biological processes that play a key part in agricultural production. Increasing CO_2 levels may increase yields (particularly where CO_2 is the limiting growth factor). However, in some areas the effects of 'CO_2 fertilisation' will be offset by changes to temperature and water availability. Furthermore, increased growth rates may not be conducive to acceptable commodity quality in some crops, and there is evidence that increased CO_2 levels in the atmosphere lead to decreased nutritional values (micronutrients) in staple crops, which has serious socio-economic consequences where alternative micronutrients are not available.	As part of climate smart agriculture advocated by the GEF strategy, changes in crop productivity and nutritional value need to be considered within agricultural planning.	Decreases in nutritional content some crops in certain areas due climate change.
C. Species and ecosystems		
Climate change is likely to impact species used within agricultural settings and their wild relatives in terms of climate envelopes (and impact yields and distributions of wild relatives), mortality rates, reproduction, and other changes to life cycles.	When increasing diversity of animal and grass species in GEF projects it will be important to take account of the effects of climate change on the species suggested as alternatives to current varieties. This can be done by conducting field trials in locations analogous to future climate predictions for the area in question. It can also be important to recognise the role that indigenous and local knowledge can play in building resilience through awareness of traditional varieties, as well as innovative practices such as climate-resilient cropping cycles. Additionally, species can be assisted to adapt to climate change through selective breeding (and potentially genetic modification), husbandry, and developing new climate resistant crop varieties, as well as undertaking field trials of wild relatives of stable crops to test for climate suitability.	Changing areas which are suitable different crops. Increased mortality of some crops wild relatives.
Climate change is likely to change the distribution of pest species and pathogens. In some cases this might have negative impacts for agriculture if, for example, pests/pathogens expand to areas that were previously too cold, or are able to survive in greater numbers.	GEF project planners might wish to consider improving biosecurity to reduce the mobility of crop pests and pathogens, reducing the speed of damaging species into new areas. Maintaining agricultural diversity is likely to improve landscape resilience to invasive species, pests and pathogens.	Emergence of new pests a pathogens.

D. Provisioning ecosystem services		
Climate change is likely to drive processes that could increase water scarcity in agro-ecological systems, including through decreased rainfall and ecosystem degradation. Furthermore, climate change may change the water requirements of different crops, as well as transpiration and evaporation rates from crops in agricultural systems, and change the supply and demand of freshwater to other sectors (e.g. industry, households). They will also likely be relevant to program 1 activities (d) Integrated watershed management where SLM interventions can improve hydrological functions and services for agro-ecosystem productivity; and (e) Implementing integrated approaches to soil fertility and water management.	The activities stated under project priority 1 can be both affected by water scarcity and influence water scarcity. Many of the principles that form the foundation for 'climate-smart agriculture' in project priority area 2 also apply to project priority 1. GEF projects that fall under project priority area 1 and do not take water resources and other climate impacts into account will potentially increase the vulnerability of the landscape to climate change. GEF projects need to consider the whole range of factors that impact water scarcity including both climate change and social factors such as water usage, both within program 2 as well as program 1. See the 'International Waters' Section for more details.	Increased water scarcity.
Climate change is likely to affect the competition for resources including land, water, and other ecosystem services through effects on supply and demand of key provisioning services including agricultural commodities. Demand for agricultural commodities is likely to change due to changes in productivity in different areas, rising food prices, and climate change induced migration, leading to agricultural intensification in some areas and putting pressure on activities that seek to make agricultural production more sustainable.	As part of the climate smart planning in program 2 as well as within program 1 activities it may be important for GEF project planners to consider the effects of shifting climate envelopes for target crops (import and export) at the national level, and how production of key commodities may be displaced into/away from the landscapes in focus. Furthermore, it may be important to consider potential trade-offs between intensification and resilience (especially if some varieties are more high yielding but not as climate resilient as others).	Changing competition for resources
E. Regulating ecosystem services		
Climate change mitigation and adaptation policies may cause changes in the demand for land for adaptation (e.g. storm protection, water purification) and mitigation (carbon storage, carbon sequestration). This may place increasing demands and completion on the land.	It is likely to be important for GEF projects to take account of the impact of climate change adaptation and mitigation projects on production landscapes.	Changing competition for resources
Climate change is likely to impact key regulating services such as decomposition (for nutrient cycling), pollination and invertebrate activity (for soil structure). Decreasing productivity and yields could lead to pressure to intensify production in the landscape (leading to declines in biodiversity within production areas), as well as pressure to convert intact natural systems.	Although it is not directly mentioned in the GEF strategy, project planners may wish to improve sustainability of agriculture production, and increase climate resilience, by improving the statuses of pollinator populations or by providing refuges of natural habitat in and around agricultural areas.	Loss or reduction in key regulati services such as pollination, especia if management plans do not consic them.

F. Changing socio-economic systems and infrastructure		
Climate change is likely to affect many livelihoods based on natural systems, such as agriculture, forestry, and fisheries.	Program 2 priorities activities that diversify income and improve livelihoods of farmers and pastoralists through climate smart agriculture. However it might also be important to consider the climate change impacts on livelihoods within program 1 projects.	Impact of change in frequency a intensity of extreme events livelihoods.
Societal response to coastal erosion and coastal flooding caused by climate change may increase the loss of agricultural land relative to other land-use types, as coastal protection infrastructure in urban areas can displace storm impacts to agricultural areas.	GEF project planners may wish to use landscape approaches that consider hard infrastructure options in relation to the food production ecosystem services of the landscape.	Unintended impacts of ha engineered climate change adaptati strategies.
Increased numbers of people migrating from areas affected by climate change into other areas can create additional demands on resources and reduce the amount of land available for agriculture (through urbanisation, declining food security)	The impact of climate change on changing resource needs should be included within planning for sustainable use of landscapes.	Changing demand for resources d to migration.
REDD+ and other climate policies including landscape scale energy infrastructure (wind and solar in particular) are likely to have secondary impacts on biodiversity within production systems. They may change the level of protection given to different areas but also cause increased pressure for agricultural intensification, exploitation of biological resources and land in others due to displacement from protected areas.	Consideration of climate change policies needs to be included in planning for sustainable use of landscapes	Unintended impacts of clima change policies.

7.2.2 LD-2: Forest Landscapes: Generate sustainable flows of forest ecosystem services, including sustaining livelihoods of forest dependent people

Program Priority 3: Landscape Management and Restoration

Outcome 1.1: Improved agricultural, rangeland and pastoral management

- *Indicator 1.1 Land area under effective agricultural, rangeland and pastoral management practices and/or supporting climate-smart agriculture.*

Outcome 1.2: Functionality and cover of agro-ecosystems maintained

- *Indicator 1.2 Land area under effective management in production systems with improved vegetative cover.*

Outcome 1.3: Increased investments in SLM

- *Indicator 1.3: Value of resources flowing to SLM from diverse sources (including climate change adaptation and mitigation)*

Activities may include

(a) Sustainable management of forests and agroforestry for increased ecosystem services (e.g. food resources, reduced land and soil degradation, diversification) in agriculture; (b) Landscape regeneration through use of locally adaptive species, including agroforestry and farmer-managed natural regeneration; (c) SLM approaches to avoid deforestation and forest degradation in production landscapes; including practices for sustainable supply of wood and biomass energy; (d) Good practices in community and small-holder land management, including local knowledge.

Links between climate change-induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Changes to physical/chemical properties can influence forests and forest landscapes by directly impacting both the forests and the wider landscape (including agriculture). For example, changes in natural hazard regimes, rainfall and in temperature patterns can in turn reduce forest resilience, and cause changes to forest composition. Increased fires may be associated with conversion to grasslands. Additionally, in some areas climate change is likely to decrease moisture availability, increasing competition between land-uses. Agroforestry plantations and restoration activities can impact the hydrological regimes of the areas in which they are conducted, and in areas of water stress, new plantations and trees may contribute to water scarcity due to higher uptake and transpiration rates. Trees, depending on which species is planted where, can also draw water to the top layers of soil, and increase micro-climatic regulation.	The GEF strategy directly recognises the importance of climate smart agriculture in relation to landscape management. GEF project planners may wish to investigate how interventions such as plantations and agro-ecosystems will be impacted by climate change and also the effect of the project on the hydrological system under different climate scenarios. Planting tree species that are locally-adapted (for example to drought). Species tolerance to future climate also needs to be considered. Species, found in present day climate 'analogues' areas may need to be considered (e.g. more drought-tolerant species from drought-prone regions). As climate change can have unpredictable impacts, monitoring can be increasingly important to allow adaptive management.	Viability of restoration activities

Climate change is likely to increase temperatures in some areas, which can reduce productivity through increasing evaporation rates (and thus available soil moisture), direct physical damage to crops, as well as increasing risk of fires (a threat exaggerated also by increasing water stress).	Increasing awareness of risk of fires. Potentially consider tree species that are resistant to fire, or species that do not cause increased risk of fire (and thus increase risk of fire to settlements, agriculture, and existing forests). Monitoring litter buildup that increases the risk of intense fire may also be important.	Increased risk of fires in some areas.
B. Biological processes		
Climate change is likely to affect biological processes that play a key part in agricultural production, including the interactions between species. For example, if a pest species emerges earlier due to climate change, but its natural predator does not.	As part of the climate smart agriculture advocated within this program, there is a need to consider the potential impact of climate change on biological processes, including within the design of monitoring systems to allow for adaptive management.	Disruption to biological process such as natural pest control.
C. Species and ecosystems		
Climate change is likely to change species' growth characteristics, climate envelopes, life cycle characteristics, and mortality rates. There is already some evidence that increased drought leads to increased mortality rates, and thus to forest dieback. However, in some cases species specific responses to climate change may be positive, for example with increasing growth rates and improving survival of seedlings. Climate change may cause some planted species to grow in unexpected ways, which in the extreme could cause them to become invasive (particularly if non-native species are used).	GEF project planners should be aware that species introduced as a result of GEF-funded interventions could also be affected by the changes in climate-driven invasive species distributions, or could themselves become invasive under certain climatic conditions.	New invasive species.
Climate change is likely to change the distribution of pest species and pathogens, in some cases with negative effects for tree species if they expand to areas that were previously too cold, or they survive in greater numbers during colder seasons. Climate change can reduce the resilience of systems to other pressures such as outbreaks of invasive species. Additionally, invasive species can exploit (for example by increasing in abundance) disturbances caused by climate change such as fire and storms.	Improving biosecurity to reduce the mobility of crop pests and pathogens, reducing the speed of damaging species into new areas. Could also involve careful monitoring of trees to check for pests and pathogens, with corresponding action to reduce risk of pests and pathogen outbreaks.	New pests or pathogens.

D. Provisioning ecosystem services		
Climate change may cause changes to flows of provisioning ecosystem services both through direct impact of climate change on the ecosystem and through indirect impacts. For example, if food from agriculture declines due to climate change, bush meat hunting (food) may increase as a result, thus creating a threat of overexploitation. Migration from other areas due to climate change may also exacerbate these effects.	There is a need for planners to recognise how the sustainability of the resource use will change, and thus adjust practices to reflect this. Increasing adaptive capacity could build the resilience to theses change. Project effectiveness may dependent on how much provision is given to addressing the demand versus the supply available and how this relationship changes with climate change climate change.	Unexpected changes in t sustainability of resource use.
E. Regulating ecosystem services		
Climate change can impact the supply (and demand) of regulating ecosystem services (e.g. soil erosion control, water purification, pollination, microclimatic control). Storms and other natural hazards may be more damaging if climate change affects the capacity of the forest to control soil erosion. Pollution may be increasingly toxic if climate change affects the water purification regulating services of the forest.	GEF project planners may wish to consider how climate change may affect ecosystem services and how that may affect the impact of future climate change events. Project planners may prioritise management actions to maintain ecosystems that supply key ecosystem service functions in the landscape.	If climate change affects the capac of the forest to control soil erosi impacts from natural hazards will more damaging.
F. Changing socio-economic systems and infrastructure		
Interventions (including GEF interventions) designed to protect existing forest cover through carbon sequestration and storage may have the unintentional effect of displacing demand for forest resources (such as timber and fuel wood) to tree species outside of protected forests, thus creating unforeseen pressures.	Consider potential displacement effects of GEF projects aiming at forest protection or sustainable use.	Displacement of pressures due to t impact of climate change policies.
Traditional Ecological Knowledge can be threatened by a variety of socio-economic processes that are related to climate change, including migration, increasing vulnerability, increased competition for resources including potential land-tenure issues as part of ecosystem-based mitigation activities)	Local knowledge can form a key part of the landscape's adaptive capacity in the face of climate change. Local people can have important knowledge of past climatic change and culturally-appropriate adaptation measures. Specifically addressing local ecological knowledge can support project implementation.	

7.2.3 LD-3: Integrated Landscapes: Reduce pressures on natural resources from competing land uses in the wider landscape

Program Priority 4: Scaling-up sustainable land management through the Landscape Approach

Outcome 3.1: Support mechanisms for SLM in wider landscapes established

- *Indicator 3.1: Demonstration results strengthening cross-sector integration of SLM*

Outcome 3.2: Integrated landscape management practices adopted by local communities

- *Indicator 3.2: Application of integrated natural resource management (INRM) practices in wider landscapes*

Outcome 3.3: Increased investments in integrated landscape management

- *Indicator 3.3: Increased resources flowing to INRM and other land uses from diverse sources*

Links between climate change-induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Climate change impacts including changing temperatures, rainfall patterns, sea level rise and related floods, droughts, soils erosion, fires and salinization (as set out within program 2) can have serious impacts on agricultural production, including arable and pastoral agriculture. Potentially increasing competition for resources including land, water, and other ecosystem services can have effects on supply and demand of products and land.	Although climate change impacts are not directly referred to within the program 4 strategy, considering the impacts of climate change and climate smart agriculture (program 2), as part of integrated landscape management is likely to be important for the long-term resilience of the wider landscapes. GEF project planners may need to consider the increased need for understanding and forecasting how these threats can impact land-degradation processes at the landscape scale, and thus increase pressure for declining resources, and increase competition between resource-users (See appendix for possible resources).	Physical changes including changi temperatures, rainfall patterns, s level rise and related floods, drough soils erosion, fires and salinization.
B. Biological processes		
Climate change can affect biological processes that play a key part in agricultural production, including the productivity and nutrient value of crops (see program 2).	When considering climate-smart agriculture (program 2) within landscape planning changing biological process should also be considered.	Changing biological process affecting the wider landscape.
C. Species and ecosystems		
Climate change is likely to have impacts on species currently used in a variety of land-uses. The potential species-level impacts documented in program 1 and 2 are likely to be relevant here.	When considering climate-smart agriculture (program 2) within landscape planning changes in species should also be considered (see program 1 above).	
D. Provisioning ecosystem services		
Climate change is likely to affect the competition for resources including land, water, and other ecosystem services through effects on supply and demand of key provisioning services including agricultural commodities.	There is a need for planners to recognise how competition for resources will change. This can be supported by using scenario planning and landscape scale land use modelling (see appendix).	Increased competition for resources

The potential societal response to climate change of increasing biofuels production is likely to impact upon landscapes in which the feed crops are grown, including increasing competition for resources such as land, water and nutrients.	Consider precautionary measures for protection of important landscape characteristics that increasing biofuels production threatens, and ensure that appropriate safeguards are used by producers of biofuels.	Increased biofuel demand.
E. Regulating ecosystem services		
Changes in supply (and demand) of regulating ecosystem services (e.g. soil erosion control, water purification, pollination, microclimatic control) can exacerbate other climate-related threats, and reduce the ability of the landscape to provide for multiple users. For example, • Forest fires may be more damaging if micro-climatic control is affected by climate change (through aforementioned pathways, such as forest dieback). • Storms and other natural hazards may be more damaging if climate change affects the capacity of the forest to control soil erosion. • Pollution may be increasingly toxic if climate change affects the water purification regulating services of the forest.	Consider the ecosystems that supply key regulating ecosystem services at the landscape scale, and make provisions for the protection of those ecosystems in strategic locations. For example, forests may be important to maintain in riparian strips, to provide microclimatic regulation for water resources, and preventing soil erosion. Consider the importance at the landscape scale of connectivity between key ecosystems to build resilience.	Changes to services such as wa purification and provision m interact with existing threats such pollution. Pollutants are likely to more toxic in areas experienci increased water stress.
F. Changing socio-economic systems and infrastructure		
Climate change policies may impact sustainable land management including mitigation policies such as REDD+ and ecosystem based adaptation policies and landscape scale energy infrastructure (wind and solar in particular).	Include consideration of climate change policies within sustainable land management plans.	
Interventions (including GEF interventions) designed to protect existing forest cover (for carbon sequestration and storage) may have the unintentional effect of shifting demand for forest resources such as timber and fuel wood to tree outside of protected forests, thus creating unforeseen pressures.	Consider supply and demand for at the landscape scale, and make provisions within planning processes for maintaining sources of forest resources if it is likely that some interventions will diminish access to resource stocks.	Displacement of pressures due REDD+ policies.
Climate change is likely to affect socio-economic conditions in many countries, sometimes offering opportunities, but often leading to declining living standards if it affects natural systems, such as agriculture, forestry, and fisheries. Additionally, competition for resources in some locations can be increased due to migration.	In some cases, it may be necessary to design monitoring programs to gather trend data for key livelihoods relevant to the project goals, as well as indicators of pressures on ecosystem services.	Increased competition for resour due to climate change.

7.2.4 LD-4: Maximizing transformational impact: Maintain land resources and agro ecosystem services through mainstreaming at scale

Program Priority 5: SLM Mainstreaming in Development

Outcome 4.1: SLM mainstreamed in development investments and value chains across multiple scales

- *Indicator 4.2: Increased investments in SLM*

Outcome 4.2: Innovative mechanisms for multi-stakeholder planning and investments in SLM at scale

- *Indicator 4.2: Innovative mechanisms, institutions, legal and regulatory frameworks functioning to support SLM*

Links between climate change-induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
B. Biological processes		
C. Species and ecosystems		
D. Provisioning ecosystem services		
E. Regulating ecosystem services		
F. Changing socio-economic systems and infrastructure		
Countries' processes for developing climate change mitigation and adaptation strategies that may be integrated across a range of departments and sectors can potentially relate to sustainable landscape management especially in relation to plans for ecosystem based adaptation and REDD+ policies.	Climate change mitigation and adaptation policies should be considered when developing plans for mainstreaming SLM at large scales.	

7.3 International Waters

7.3.1 IW 1 and IW 2: 1- Catalyze sustainable management of transboundary water systems by supporting multi-state cooperation through foundational capacity building, targeted research and portfolio learning. 2 - Catalyze investments to balance competing water-uses in the management of Transboundary surface and groundwater and enhance multi-state cooperation.

PROGRAM 1.1: Foster cooperation for sustainable use of transboundary water systems and economic growth.

Outcome 1.1.1: Political commitment/shared vision and improved governance demonstrated for joint, ecosystem-based management of transboundary water bodies.

Indicator 1.1.1.1.: # of SAPs endorsed at ministerial level; Indicator 1.1.1.2: Capacity of transboundary cooperation/ institution built and degree of active participation in national inter-ministry as per IW tracking tool score card; Indicator 1.1.1.3: Type and degree of involvement of civil society in transboundary dialogue and formulation of TDA and SAP –incl. NGOs, CSOs, academia, women groups, and private sector players; Public awareness of transboundary cooperation benefits (survey).

Outcome 1.1.2: On-the-ground demonstration actions implemented, such as in water quality, quantity, conjunctive management of groundwater and surface water, fisheries, coastal habitats.

Indicator 1.1.2.1: # and type of investments at demonstration scale (as reported in IW tracking tool score card.)

Outcome 1.1.3: IW portfolio performance enhanced from active learning/KM/science/experience

Indicator 1.1.3.1: GEF-6 performance improved over GEF 5 per data from IW Tracking Tool; Indicator 1.1.3.2. Positive feedback from stakeholders/participants, including civil society representatives and women groups.

Outcome 1.1.4: Targeted research influences global awareness upcoming critical global concerns.

Indicator 1.1.4.1: Reports and publications and/or uptake of results into GEF IW projects.

PROGRAM 1.2 – Increase the Resilience and Flow of Ecosystem Services in the Context of Melting High Altitude Glaciers

Outcome 1.2.1: Adaptive management measures identified, agreed and tested in limited transboundary basins/sub-basins with high- altitude melting ice to inform future GEF replenishments.

- *Indicator 1.2.1.1: Ministerial agreed transboundary action programs or sub-basin IWRM plans for demonstration basin testing of adaptive management strategies*

PROGRAM 2. 1 Advance Conjunctive Management of Surface and Groundwater Resources

Outcome 2.1.1 Improved governance of shared water bodies, including conjunctive management of surface and groundwater through regional institutions and frameworks for cooperation lead to increased environmental and socio-economic benefits.

Indicators 2.1.1.1. Level of capacity and sustainability of regional institutions as reported in GEF 6 IW tracking tool. Indicator 2.1.1.2: Functioning inter-ministerial committees at national level as reported in GEF IW tracking tool score card. Indicator 2.1.1.3: # and type of national/local reforms implemented.

Outcome 2.1.2 Increased management capacity of regional and national institutions to incorporate climate variability and change, including improved capacity for management of floods and droughts.

Indicator 2.1.2.1: Degree to which climatic variability and change in transboundary surface water basins and aquifers is incorporated into updated SAPs as reported in GEF IW tracking tool score card.

PROGRAM 2. 2 Water/Food/Ecosystem Security Nexus

Outcome 2.2.1 Increased water/food/energy/ecosystem security and sharing of benefits on basin/sub-basin scale underpinned by adequate regional legal/institutional frameworks for cooperation.

Indicator 2.2.1.1: #, results and type of investments within basin/sub-basin Strategic Action Programs or equivalent development plans balancing competing water uses, climate change and promoting conjunctive use of surface and groundwater implemented. Indicator 2.2.1.2: Amount of leveraged finance for SAP/SAP equivalent implementation from public/public-private partnerships. Indicator 2.2.1.3: Measurable water &natural resources related results and socio-economic benefits for target population, both women and men, on basin/sub-basin/ or areas of investments as reported in GEF IW tracking tool score card.

Links between climate change-induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Climate change is likely to have direct impacts on the hydrological cycle and lead to uneven, unpredictable, increasingly uncertain freshwater futures Climate change is also likely to have an effect on water resources through changes to air and water temperatures. A key impact of this change will be the changing evaporation rates of water bodies which can affect both water quantity and quality. Increased water scarcity could jeopardise efforts to 'foster cooperation for sustainable use of transboundary water systems and economic growth' by increasing competition for resources.	This Program (especially program 1.2) already specifically recognises the impacts of climate change and climate resilience, however there can still be a need to consider unexpected climate effects. All programs should include consideration of the potential impact that climate change may have on the hydrological cycle and water resources including as part of transboundary diagnostic analysis and strategic action programs (specified in program 1.1). Climate change increases the need for robust, integrated design and implementation of freshwater projects at all scales. Research on water resources should always include the likely impacts of climate change, using a range of methodologies including modelling, scenarios development, and community participation. Integrated planning processes (i.e. integrated water resource management) are increasingly required as scarcity and uncertainty increases. Plans should include planning at the watershed level with provisions for ecosystem-based water recharge and flood control programs to increase climate resilience. Integrated Water Resource Management will need to take into account changing land (and water)-uses, socio-economic conditions, and vulnerabilities	Uneven, unpredictable, increasing uncertain freshwater futures and t interaction between these and oth threats to water security

Program 1.2: Climate change is likely to cause changes to variability, intensity and overall trends in glacier-fed water systems. In many parts of the world, glaciers are predicted to decrease or disappear, which will have huge ramifications for the people and ecosystems dependent on glaciers as key components of their water supply.	The GEF strategy (Program 1.2) directly recognises the importance of climate change in relation to decreasing flows of provisioning services from high-altitude glaciers. However as such glaciers often form components (albeit key components) of hydrological systems in these areas, other sources and demands for water significantly affect the availability of freshwater, and thus are important to consider. For example, adaptive management of freshwater stocks in these areas may require integrated planning processes that go beyond glacial supply, including working to reduce unproductive and inefficient uses of water (i.e. little societal value compared to the amount of water produced).	
Climate change is predicted to increase sea levels, which is likely to increase coastal flooding, particularly when combined with the threat of increased extreme (storm) events. This will impact coastal and fisheries water management plans.	The impacts of sea level rise should be considered within water management plans.	Increased storm events may particularly hard to predict a manage and so pose most threat
Salinization is predicted to become a major threat in coastal areas. Salinization can increase due to sea level rise, and increased groundwater use (which may occur where climate change decreases available surface water) can lower the freshwater table in coastal areas and facilitate drawing of seawater into the groundwater resource.	The impacts of salinization should be considered within water management plans.	Increased risk of salinization.
B. Biological processes		
C. Species and ecosystems		
Climate change is likely to cause change in the distribution of invasive species and may enable new invasive species to establish in some freshwater ecosystems, which could impact the flow of regulating services such as water purification (see regulating services). Climate change may also cause changes in the densities of pests and pathogens in water supplies, with direct consequences for water quality (e.g. water borne pathogens). Increase temperatures may also affect water requiring disease vectors such as mosquito borne diseases.	The design of monitoring systems within projects should consider the need to detect and adapt to changes in distribution and density of invasive species, pathogens and pests.	Risk of new invasive species becomi problematic due to climate char and risk of increases in pathoge (including due to increas temperatures)

Climate change is also likely to have direct impacts on species that form components of ecosystems responsible for maintaining regulating services, such as wetlands, affecting the resilience of ecosystems that provide key regulating services and thus degrade the ability of the social-ecological system to adapt to decreased freshwater flows from glaciers.	Development of water management plans need to consider how changes in species and ecosystems services may impact ES important for water management. The design of monitoring systems within projects should consider the need to detect and adapt to changes species and ecosystems important for water management.	The interrelationship between clima change impact on ecosyste resilience, ES resilience and dire climate change impacts.
D. Provisioning ecosystem services		
Climate change may change the water requirements of different crops, as well as transpiration and evaporation rates from agricultural systems, and change the supply and demand of freshwater to other sectors (e.g. industry, households). Without adaptive management and appropriate monitoring mechanisms of both sources of freshwater and societal demand for water, decreased this may go unnoticed, threatening the sustainability of water supplies.	Monitoring mechanisms should thus be designed with appropriate frequency to catch changes in water stocks, and combined with flexible water management methods that can be initiated with enough speed to remedy the problem before the sustainability of the stocks is compromised.	Scarcity and uncertainty freshwater.
E. Regulating ecosystem services		
As noted in (C. Species), climate change is likely to impact ecosystems that help to maintain the resilience of freshwater stocks and flows through impacts on critical regulating ecosystem services such as water purification, pollination, microclimatic control, the loss or degradation of which could potentially exaggerate water scarcity.	Consideration of how changes in species and ecosystems may impact ecosystem services important for water management is needed within plan development, alongside explicit consideration of direct and indirect uses of freshwater and services by people and biodiversity. The design of monitoring systems should consider the need to detect and adapt to these changes.	Decrease in the resilience freshwater stocks and flows throu impacts of climate change on criti regulating ecosystem services.
F. Changing socio-economic systems and infrastructure		
Changing governance systems in response to climate change (e.g. new climate change programs or government departments).	Integrated Water Resource Management will need to take into account changing land (and water)-uses, socio-economic conditions, and vulnerabilities.	Changes in governance system project has been designed around.
Societal responses to climate-related events such as increased flooding and droughts may even exaggerate water scarcity in some areas, as dams and other adaptation infrastructure can have knock-on and detrimental effects on downstream users.	Integrated planning across sectors could avoid situations where conflicts increase and potential synergies lost. For example, consideration of dams as a hard-infrastructural adaptation measure may need to be undertaken in the context of potential increased water scarcity for downstream users. Participatory planning procedures can be important to ensure the needs stakeholders from different sectors are considered.	Unintended impacts of clima change policies if integrated planni is not undertaken.

Climate change may increase resource scarcity, which may increase the threat of conflict and rivalry. For example, reduce flows of freshwater, increasing coastal erosion, and large-scale migration of coastal populations may increase competition and tensions. Furthermore during times of stress, governance systems may weaken, and political willingness to engage in such issues may slacken.	Under the context of water scarcity, there will be an increasing need for governance measures that mediate conflicts over water resources and water rights issues and prevent conflicts developing. Building forecasts of future water scarcity and model how this scarcity will be distributed in the landscape can support developing governance mechanisms. GEF projects need to ensure that they are seen to be equitable and so the do not unwittingly contribute to conflicts	Increased risk of conflict ov resources may make the developme of internationally agreed manageme plans more difficult.
Climate change may increase the flow of inward migration into particular areas as migrants are forced to move as a result of a variety of climate impacts (such as sea-level rise, land degradation, and water scarcity) this may increase pressures on ecosystems that supply key regulating services and on demand for freshwater which can exacerbate water stress caused by glacier melt or declining rainfall.	Take into account future population pressures on water resource demands and adjust management plans accordingly. For example alternative livelihood projects which avoid deforestation and forest degradation of key ecosystems responsible for delivering freshwater flows.	Changing population pressu changing the baseline management plans.

7.3.2 IW 3: Enhance multi-state cooperation & catalyze investments to rebuild marine fisheries, restore & protect coastal habitats, reduce pollution of coasts & LMEs.

PROGRAM 3.1 Reduce Ocean Hypoxia

Outcome 3.1.1 Elimination or substantial decrease in frequency and extend of "dead zones" in sizeable part of developing countries' LMEs.

- *Indicator 3.1.1.1: #, result and type of investments and reforms for nutrient reduction; demonstration of innovative policy, economic and financial tools and functioning national inter-ministry committees.*

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Climate change will shift ocean circulation, resulting in changes to physical conditions including temperature, stratification, oxygen content, nutrient levels and acidity. For example, increasing sea surface water temperatures and altered ocean circulation act to reduce subsurface oxygen concentrations, thereby decreasing upwelling of oxygen-rich waters and leading to marine dead zones	Development of monitoring systems may help identify and adapt to changes in ocean circulation due to climate change.	Shifts in ocean circulation (whi cannot be addressed in sing projects).
Climate-change is likely to lead to changes in precipitation. Decreased precipitation and thus decreased freshwater run-off into oceans is associated with increased salinities and higher accumulation of organic carbon content that have been associated with hypoxia events. At the other extreme increasing severity of rainfall events (i.e. the intensity of individual events in contrast to total precipitation levels) is associated with increased surface water run-off to oceans and seas, as well as increased pollution and nutrient loads.	Hypoxic events (i.e. dead zones in marine and freshwater) can arise swiftly and unexpectedly (for example due to discharges from flooding or increased concentration of pollutants during drought). Awareness of the risks of these critical transitions in water bodies of interest may enable planners to be more observant of potential indicators that such tipping points may be nearing. Monitoring can also be needed for identifying when tipping points may be reached or have been passed.	Increased extreme events (droug and floods) increasing the chances swift and unexpected hypoxic event
B. Biological processes		
Climate change is leading to increases in dinoflagellates which are a principle organism in algal blooms, which are associated with ocean hypoxia as they quickly deplete the oxygen supply of a given area.	Monitoring of the build up of dinoflagellates in a particular area may allow project managers to use practices that remove dinoflagellates from the water body, whether through biological or non-biological controls.	Potential increased in dinoflagella blooms.

C. Species and ecosystems		
Climate change could impact species that are important for maintaining water quality as they graze on species which would otherwise multiply to the extent that water quality and clarity is affected.	Management plans that explicitly deal with the threats of hypoxia should take into account the role played by ecological interactions and species higher up the food chain. Restoring healthy populations of such keystone species is likely to be an important component of resilience to hypoxic events.	Impact on species important f maintaining water quality decreasi the resilience of systems.
D. Provisioning ecosystem services		
E. Regulating ecosystem services		
Climate change can move the goal posts for restoring degraded (and eutrophicated) water bodies by changing the requirements necessary for transforming the ecosystem back to a healthy stability state characterised by clear and oxygen-rich water. For example by changing the suitability of the areas for species previously important for maintaining the ecosystem.	Consider the current climate and its impacts on restoring ecosystems in developing restoration plans.	Climate change may mean that it not possible to restore an ecosyste to the exact conditions of its previc state.
Changing socio-economic systems and infrastructure		

PROGRAM 3.2 Preventing the Loss or Degradation of Coastal Habitats

Outcome 3.2.1: Coasts in globally most significant areas protected from further loss and degradation of coastal habitats while protecting and enhancing livelihoods

- *Indicator 3.2.1.1: Adoption and implementation of ICM plans and reforms to protect coastal zones (% of country coastline under ICM, # of countries adopting and applying ICM) as reported in GEF IW tracking tool score card.*

PROGRAM 3.3 Fostering Sustainable Fisheries

Outcome 3.3.1: Introduction of sustainable fishing practices into xx % of globally depleted fisheries

- *Indicator 3.3.1.1: # of Management plans and appropriate measures implemented for rebuilding or protecting fish stocks including alternative management approaches.*

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Freshwater habitat in coastal areas is likely to come under increased risk of saline intrusion (and thus significant changes in ecosystem assemblages and functioning) as a result of sea-level rise and coastal flooding.	The risk of salinization needs to be considered within the development of coastal management plans. Monitoring for changes in salinity is important where it poses significant risks	Saline intrusion
Decreasing rainfall could lead to reduced coastal ecosystem (including fisheries) productivity (mangroves and saltmarshes) and greater relative subsidence, as less sediment is deposited.	The larger range and varying impacts of climate change on coastal ecosystem need to be considered within the design of monitoring systems to enable adaptive management.	Reduced sediment deposition

Sea-level rise and resulting coastal erosion are likely to impact key coastal habitats such as coral reefs, saltmash, seagrass beds and mangrove forests. This will have knock-on effects on fish species that depend on these ecosystems.	Proactive planning to accommodate for potential landward migration of coastal vegetative habitats under different sea-level rise projections. Ecosystem-based adaptation practices and climate change vulnerability assessments will be increasingly important.	
Changing ocean currents and physical properties of the ocean that affect the survivability and reproduction of fish and the ecosystems upon which they depend. Increased ocean stratification due to climate change reduces the upwelling of deep, nutrient-rich ocean waters which can reduce ocean primary productivity (plankton growth) and associated biomass production in higher trophic level ecosystems (including fisheries) that ultimately depend on these nutrient supplies.		Changing ocean currents a increased ocean stratification.
Increased risk of natural disasters such as storms, cyclones. Increased intensity and frequency of storms will have negative impacts coastal ecosystems including mangroves, coral reefs and saltmarshes through habitat damage, stress, and changes in sediment surface elevation through erosion, deposition, and compression. In turn, these can lead to wide-ranging effects on populations of fish and shellfish that depend upon these coastal habitats	Management plans which reduce the other pressures on costal ecosystems are likely to make them more resilient to storm events.	Increasing frequency and sever of storms.
Both cold and warm water corals are likely to be threatened by a combination of climate-related impacts including temperature and ocean acidity changes. Increasing episodes of coral bleaching events are strongly associated with unusually warm sea surface temperatures		Increased risk of coral bleaching
B. Biological processes		
Increasing acidity of the oceans and seas is likely to reduce the ability of calcifying organisms to form carbonate structures. This includes plankton, molluscs, and corals, which are essential for maintaining biodiversity. Some fish species are particularly susceptible to the effects of ocean acidification, which has already led to economic impacts following build up of acidity in water used for aquaculture.	Aquaculture-focussed projects might consider the potential for selective breeding of species with less vulnerability to decreasing ocean pH, or (if capital is sufficient) may alter the pH of seawater into the aquaculture farms. Reducing local anthropogenic stressors is also important for maximising resilience and adaptability of species/habitats to increasing acidity.	Reduced ability of calcifyi organisms to form carbona structures.

Climate change may induce altered tropic interactions, having knock-on effects on commercially important fish populations (e.g. anchovies and cod). For example increasing ocean acidification is likely to lead to shifts in plankton community structures, in turn impacting the abundance and distribution of major fish taxa.	Include climate change impacts on biological processes in sustainable yield models	Changes in biological process making sustainable yield mod unreliable.
C. Species and ecosystems		
Climate change is likely to cause changes to fish maturation, growth rates, and distributions. This may result in declines in fish stocks, leading to greater probability of fisheries perturbation, and especially behaviour of fish species is likely to become more stochastic and unpredictable. Major, predominantly poleward shifts in pelagic fisheries (such as Sardine and Mackerel) are already being observed across a wide range of LMEs. This has very significant consequences for GEF projects targeting specific species of economic importance. Climate change is also leading to changes in the maximum abundance of fish populations through varied interconnected pathways. For example, sardine abundances have been shown to be synchronous with changing wind direction, velocity, and plankton production and changes to one or more of these physical factors will have unpredictable consequences to their population numbers.	Sustainable' off take optimisation models need to be made more dynamic and take into account increasing uncertainty and fluctuations in species abundance and behaviour. Models producing sustainable yield will also need to be adjusted for changing environmental conditions, target-species resilience/vulnerability, and spatial distribution patterns May require information and awareness raising about alternative fish stocks that might be faring better with climate change (e.g. herring may increase as a result of declining cod stocks). Networks of MPAs are likely to become increasingly important to build resilience against climate change impacts. The size, shape, spacing, habitat representation and connectivity between such protected areas will help in risk spreading and maintaining critical ecosystem functions.	Project planners may need to consic the potential of target fish stocks migrate out of project areas. This likely to be of particular relevance marine spatial planning processes.
Species range shifts (particularly poleward) and changes in distribution due to climate change are likely to alter the assemblages of coastal habitats in both tropical and temperate regions. This may mean that some species that were not previously present become invasive as their range shifts into new environments. Changes to trophic interactions and food webs may mean that some species increase in density to the extent that the resilience in these ecosystems is adversely affected.	Incorporate species range shift modelling into marine spatial planning.	Invasive species

D. Provisioning ecosystem services		
Coastal ecosystem losses and degradation due to climate change impacts such as sea level rise and increasing storms will lead to the loss of these ecosystems and to a reduced supply of provisioning ecosystem services including commercially targeted fisheries. In turn, this will lead to a reduction in human well-being and livelihoods. Increased risk of natural disasters such as storms, cyclones, droughts, and flooding as well as other events expected to increase with climate change, may cause reductions in agricultural production, which may in turn increase the demand for marine fisheries, driving up fishing pressure beyond already unsustainable limits. Additionally, agricultural failure could increase the need for alternative livelihoods such as charcoal production and firewood collection in coastal forests and mangroves.	Incorporate alternate livelihood development strategies into project planning. There is a need to consider future changes in both legal and illegal harvesting within planning efforts.	Changing demand can pla increasing pressures on sustainabil of yields.
E. Regulating ecosystem services		
Habitat degradation due to climate change may lead to a reduction in their ability to provide important regulating services such as global climate regulation through carbon storage and sequestration, and the maintenance of water quality and cycling of nutrients, with potentially severe but unpredictable consequences.	Incorporate coastal ecosystem protection and restoration to enhance ability for these systems to withstand climate change impacts and maintain their regulating ecosystem services.	Complex interactions in clima change impacts causing sever b unpredictable consequences.
F. Changing socio-economic systems and infrastructure		
Increased focus on the negative impacts of climate change, and the adaptation possibilities of coastal ecosystems including mangroves and coral reefs	May provide increased resources and willpower for the protection of coastal habitats.	

7.4 Sustainable Forest Management

7.4.1 *SFM-1: Maintained Forest Resources: Reduce the pressures on high conservation value forests by addressing the drivers of deforestation*

Program 1.1: Integrated land use planning.

Many developing countries need to review and revise their policies and laws pertaining to forests, agriculture, infrastructure development and mining to effectively address the drivers of deforestation. Providing tools and methodologies for valuing natural resources and identifying appropriate policy and economic incentives are key supporting capacities for this programmatic priority. Supporting forest, agriculture, and energy policy and related legal and regulatory frameworks reformulation and action plans for land use and land-use change driven by agriculture and bio-energy production can address the drivers of deforestation.

Outcome 1.1: Cross-sector policy and planning approaches at appropriate governance scales, avoid loss of high conservation value forests.

- *Indicator 1.1: Area of high conservation value forest identified and maintained.*

Program 1.2: Identification and maintenance of high conservation value forests.

Outcome 1.2: Innovative mechanisms avoid the loss of high conservation value forest.

- *Indicator 1.2: Number of incentive mechanisms to avoid the loss of high conservation value forests implemented.*

Program 1.3: Identifying and monitoring forest loss.

This programmatic priority supports the development of technical and institutional capacities to identify and monitor forest loss. Countries will be able to make sustainable land-use decisions, target specific drivers of deforestation, and engage with forest carbon and REDD+ initiatives, including mechanisms that allow for generation of revenues from forest carbon.

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Changes to physical/chemical properties can influence forests and forest landscapes both by directly impacting the forests and by impacting the wider landscape (including agriculture). For example, changing natural hazard regimes, changing rainfall and temperature patterns have the potential to reduce forest resilience, and cause changes to forest composition. Increased fires may be associated with conversion to grasslands.	Integrated land use planning which assesses the potential of the impact of climate change directly on the forest can facilitate supporting long-term resilience. In the context of Program 1.3, understanding the potential for forest loss due to climate change may be supported by and influence monitoring of forest loss.	There is a potential that if clima change will cause large decrease resilience of forest, a high discou rate will be applied to the value their natural resources
Additionally, changes in rainfall and temperature are also likely to impact the wider landscape and change competition for land within the landscape. For example, decreased moisture availability may increase competition between land-uses (see land degradation section).	Integrated land use planning should take account of the impact of climate change both directly on the forest and on the wider landscape.	Impacts of climate change on t wider landscape impacting forests.

B. **Biological processes**		
Changing biological processes can impact sustainable forest management in a variety of ways including: seed dispersal (through impact on individual species and dispersal mechanisms), herbivory, decomposition, and disturbance. These can lead to changes to forest structure and functioning that make the forest more or less resilient to threats such as logging, poaching, invasive species, and forest regeneration following disturbances. Levels of harvesting that were once considered 'sustainable' may become unsustainable.	The potential impacts of climate change on forest structure can impact requirements for forest monitoring; monitoring can support understanding of changing forest structure.	The interaction between changes biological processes and the resilier of forests to other threats.
Changes in biological process can also impact agriculture and wider land use (see land degradation section).	Integrated land use planning needs to consider climate policy in the wider landscape including climate smart agriculture (see land degradation focal area program 2)	
C. **Species and ecosystems**		
Climate change can lead to changing productivity/yields of agricultural crops that affect the conversion pressure of natural forest. For example, the climate response of soya and palm oil may make these crops more or less profitable in forested areas, affecting the incentives for conversion of natural forest in the absence of regulations that constrain these drivers.	Consideration of the ways these policies and action plans might need to take account of changing demands for agricultural commodities. Tools exist to help model changes in commodities; see appendix for more details.	Changing pressure due to changi agricultural demands.
There will almost certainly be species-specific responses to climate change which can cause changes to forest structure, functioning, and extent. Examples include increasing mortality, forest dieback, changing species composition, and changes to forest productivity from carbon dioxide fertilisation. It is however difficult to predict how species will adapt to future climate changes.	Monitoring of forests may be designed to support understanding of changes due to climate change.	Unpredictable changes in fore species.
Climate change is likely to change the distribution of pest species and pathogens, in some cases with negative effects for forest conservation. For example, large-scale bark beetle outbreaks causing extensive forest death have been linked to climate change.	Sustainable management plans should consider the risk of pathogen outbreaks.	New or more extensive pathog outbreaks (such as bark beetles).

D. Provisioning ecosystem services		
Climate change is likely to have impacts on the demand for and supply of provisioning ecosystem services of food and bioenergy. Bioenergy demand may increase as a potentially renewable energy source and food demands may change as productivity of different crops change due to climate change (see Land Degradation focal area). Some provisioning ecosystem services (such as wild foods) may also be important for climate change adaptation, as communities can depend on them in times of stress. If food from agriculture declines due to climate change, bush meat hunting may increase as a result, thus creating a threat of overexploitation.	Changes in the supply and demand for food and bioenergy are important to consider in integrated land use planning as food and biofuel production are key drivers of deforestation. The inclusion of the potential role ecosystem services (including those related to forests) in climate change adaptation within land use planning can support wider adaptation planning and increase the multiple benefits from planning.	Provisioning services such as wa may interact with existing thre such as pollution. Pollutants are lik to be more toxic in areas experienci increased water stress. Furthermo decreased freshwater flows increa the susceptibility of the forest to fir
E. Regulating ecosystem services		
Climate change impact (and societal responses) can change the demand for regulating ecosystem services important for climate change mitigation (e.g. carbon storage) and adaptation (e.g. flood control). In a future scenario in which mitigation of climate change through mechanisms such as REDD+ is prioritised, forests which are 'most important' in terms of carbon sequestration and storage may become increasingly valued over other types of characteristics such as species richness.	Integrated land use planning should take account of the potential role of ecosystems in both climate change mitigation and adaptation.	Potential displacement of pressu from high carbon areas protected REDD+ to lower carbon areas.
Climate change can cause changes in supply of regulating ecosystem services (e.g. soil erosion control, water purification, pollination, microclimatic control). There can also be complex interactions involved, for example, forest fires may be more damaging if micro-climatic control is affected by climate change. Storms and other natural hazards may be more damaging if climate change affects the capacity of the forest to control soil erosion.	Consider prioritising the protection or enhancement of ecosystems that provide key regulating services that maintain landscape resilience.	Complex interactions betwe climate change and regulati ecosystem services.

F. Changing socio-economic systems and infrastructure		
Climate change mitigation and adaptation policy can have significant impacts on integrated land use planning and valuation of economic resources. In particular policies related to mitigation of emissions from the forest sector including those related to REDD+ and ecosystem based adaptation approaches. Inclusion of such approaches in integrated planning can increase the potential for multiple benefits to be achieved. There are also potential risks from policies (such as REDD+ actions displacing pressure to non-forest ecosystems).	Integrated land use planning should consider the potential benefits and risks of mitigation and adaptation policies.	Consideration of the impact mitigation measures including for carbon and REDD+ initiatives drivers of deforestation (e.g. risk conversion of natural fore conversion of peatlands etc.)
Migration due to climate change (e.g. away from coastal areas) can increase the deforestation threats in areas where climate-migrants settle. Common pool resources may then be exploited if there is lack of access to land.	Integrated land use planning should consider the potential impact of migration due to climate change, including changes in demand for agriculture land and forest resources.	Changing pressures on forest due climate induced migration.
Climate change may induce increasing resource scarcity, which may increase the threat of conflict and rivalry. For example, reduced flows of freshwater, increasing coastal erosion, and large-scale migration of coastal populations may increase tensions.	Increasing conflicts and tensions are likely to impact the ability of international interventions, decreasing the institutional capacity and political will to engage in monitoring and enforcement activities.	Increased competition and confl over resources.

7.4.2 SFM-2: Enhanced Forest Management: Maintain flows of forest ecosystem services and improve resilience to climate change through SFM.

Program 2.1: Developing and implementing model projects for Payments for Ecosystem Services.

This programmatic priority supports activities such as modifying the policy and regulatory frameworks, building human and institutional capacity, or setting up and implementing pilot PES schemes and initiating public-private partnerships for the inclusion of market forces into PES schemes.

Outcome 2.1: Increased application of good management practices in all forests by relevant government, local community and private sector actors.

- *Indicator 2.1: Area of sustainably managed forest.*

Program 2.2: Capacity development for SFM within local communities.

This programmatic priority provides support for SFM that builds on the conservation of traditional knowledge and management practices, local communities will be empowered to develop a range of sustainable livelihoods based on SFM which will also maintain forest resources and ecosystem services as well as support climate change adaptation efforts and activities for capacity building for women to include leadership and other important skills, including technical aspects of REDD+. Providing capacity building and incubation support for the private sector will help develop sustainable market links between local communities and the wider private sector. Attention will be paid to the fact that evidence shows that product commercialization is generally associated with male dominance in value chains, while greater support to informal markets is more likely to improve benefits to women.

Outcome 2.2: Increased contribution of sustained forest ecosystem services to national economies and local livelihoods.

- *Indicator 2.2: The valuation and accounting of economic, social and environmental benefits and services within forest policy and decision making.*

Program 2.3: Supporting sustainable finance mechanisms for SFM.

National assessments of the net benefits of SFM and the incorporation of forests within natural capital and resource accounting initiatives are crucial for improving public and private decision making on forests and land use and are the focus of this programmatic priority. These assessments would then be integrated into national policy and planning processes by identifying sustainable uses of forest resources and developing mechanisms for sustainable finance, in particular the injection of greater private sector investment.

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Climate change induced changes to physical/chemical properties can affect the ability of ecosystems to provide ES. For example, changing natural hazard regimes, changing rainfall and temperature patterns can in turn reduce forest resilience (and the resilience of forest ES) and cause changes to forest composition. Additionally, climate change can directly impact the ES, for example, decreased precipitation levels can reduce the flow of freshwater from ecosystems. This can impact PES schemes (depending on the payment method).	climate change impact the most appropriate sustainable management approaches should be taken into account, for example if the fire risk increases due to climate change management regimens may need to be adapted to reduce this risk. PES schemes may need to consider how payments should be made and the baseline flow of the ecosystem under different climate change predictions, so as to distinguish what the efforts of the intervention have made beyond that which climate change has caused. Sustainable finance also needs to consider the impacts of shifting baselines on results based finance.	ES provided by forest decreasing d to climate change and climate chan interactions with other threats.

B. Biological processes		
Changing biological processes can impact forest ecosystems and function such that ES provision may be impacted (for example due to climate change impacts on dispersal of important species) and the most appropriate sustainable management within an area may be altered. For example, levels of harvesting that were once considered 'sustainable' may become unsustainable, requiring reductions in harvesting levels.	Climate change impact the most appropriate sustainable management approaches should be taken into account. PES schemes need to consider how payments should be made including predicting the baseline flow of the ecosystem service under different climate change scenarios, so as to distinguish what the efforts of the intervention have made beyond that which climate change has caused. Sustainable finance also needs to consider the impacts of shifting baselines on results-based finance.	The interaction between changes biological processes and the resilier of forests to other threats.
C. Species and ecosystems		
Climate change is likely to change species' growth characteristics, climate envelopes, life cycle characteristics, and mortality rates.	It is difficult to predict how species will adapt to future climate changes meaning that adaptive management can be important for SFM and so capacity development may need to cover adaptive management approaches.	Unpredictable impacts of clima change on species.
D. Supply of, and demand for, provisioning ecosystem services		
Climate change, through its direct impacts and impacts on species and ecosystems, can affect the ability of ecosystems to provide ES. For example, increased drought may impact important wild food sources.	Assess in the potential for climate change to impact the most appropriate sustainable management approaches can be important. PES schemes (and sustainable finance) may need to consider the baseline of the ES under different climate change predictions, so as to distinguish what the efforts of the intervention have made beyond that which climate change has caused.	Changes in species ability to provi ecosystem services and the mo appropriate sustainable manageme approach.
Some provisioning ES (such as wild foods) may also be important in climate change adaptation as communities can depend on them in times of stress.	Sustainable forest management, PES and sustainable finance should consider the importance of some provisioning ES for climate change adaptation (as is mentioned within program 2.2)	
E. Regulating ecosystem services		
Climate change, through its direct impacts and impacts on species and ecosystems, can affect the ability of ecosystems to provide ES. For example, decreased precipitation levels can reduce the flow of freshwater from ecosystems. This can impact PES schemes (depending on the payment method) and in turn jeopardise the sustainability of these schemes.	Understanding the thresholds beyond which an ecosystem cannot support an ES is likely to help landscape planning. Assessing the potential for climate change to impact the most appropriate sustainable management approaches support adaptive planning. PES schemes (and sustainable finance) may need to consider the baseline of the ES under different climate change predictions, so as to distinguish what the efforts of the intervention have made beyond that which climate change has caused.	Climate change impacting forests such an extent that they can no long provide ES (including those th support adaptation and mitigation)

F. Changing socio-economic systems and infrastructure		
Climate change is likely to affect socio-economic conditions in many countries, sometimes offering opportunities, but often leading to declining living standards if climate change affects natural systems, such as agriculture, forestry, and fisheries. Additionally, competition for resources in some locations can be increased due to climate driven changes migration.	Projects need to assess how socio-economic conditions can change the level of engagement in sustainable management capacity development, including increased community reliance on PES systems, and the risks that this may entail with climate change.	Climate change may impact peopl willingness to engage in PES scheme
If climate change occurs to a larger extent that current local variability, traditional knowledge and management may need to be supported in understanding how SFM may need to be adapted.	Project may wish to explore the traditional and local knowledge from communities that experience analogous climates to those expected in a location under climate change	Novel conditions that occur due climate change may be outside t scope of current local knowledge.

7.4.3 SFM-3: Restored Forest Ecosystems: Reverse the loss of ecosystem services within degraded forest landscapes.

Program 3.1: Building technical and institutional capacities to identify degraded forest landscapes and monitor forest restoration.

The implementation of restoration at scale is hampered by a lack of capacity. In particular there is a need for improved landscape level planning processes to rehabilitate ecosystem services and create livelihood opportunities. Additionally, this programmatic priority will support innovative finance mechanisms for restoration, including PES and testing of public-private approaches that allow for generation of revenues from options such as forest carbon, will result in forest landscape restoration at scale. **Outcome 3.1:** Integrated landscape restoration plans maintain forest ecosystem services.

- *Indicator 3.1: Plans and programs support integration of forest, agriculture and other land uses in restored landscapes.*

Program 3.2: Integrating SFM in landscape restoration.

Broad-scale landscape restoration requires the combination of mixed land uses in order to support extensive restoration operations. Such restoration remains an elusive goal. The opportunity exists to capture potential synergy between reforestation efforts, local community livelihood opportunities, and the restoration of forest ecosystem services. By supporting the development of integrated natural resource management including agroforestry techniques, especially for small scale land users, a mix of conservation, commercial, and community focused restoration can be achieved through this programmatic priority.

Outcome 3.2: Forest restoration techniques implemented at appropriate scales by government, private sector and local community actors.

- *Indicator 3.2: Area of forest resources restored in the landscape.*

Program Priority 4: Scaling-up sustainable land management through the Landscape Approach

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
Climate change impacts such as changes in temperature and rainfall regimes can impact the long-term resilience of restoration activities, the locations most suited for restoration and the types of restoration approaches required. For example, restoration is only likely to be successful where the future climate is projected to remain favourable to the restored ecosystem. Changes in, for example, the frequencies of fires, is likely to mean that restoration activities may need to be adapted, for example by including fire control measures. Restoration may be most important where it can help in adapting to climate change through supporting regulating ES (such as wetlands role in flood control). Agroforestry plantations and restoration activities themselves can impact the hydrological regimes of the areas in which they are conducted. In areas of water stress, new plantations and trees	Restoration planning including identification of areas in need of restoration and as part of SFM need to take account of how climate change will impact the success of the restoration activities and whether restoration approaches need to be adapted. The potential interaction of restoration activities and local climate change impacts (both restoration exacerbating and mitigating impacts) needs to be considered. Restoration planning should also consider the importance of restoration in different areas (including for adaptation to climate change).	Agroforestry plantations a restoration activities interacting wi climate change impacts on wa resources to cause water scarcity.

may contribute to water scarcity because of higher uptake and transpiration rates. However trees can also have positive effects within 'integrated' systems and production landscapes by drawing water to the top layers of soil from below, and increasing micro-climatic regulation.		
B. Biological processes		
Climate change-induced changes to ecological interactions between species can impact forest restoration, through for example, changing levels of seed dispersal, herbivory, decomposition and disturbance. This can decrease the sustainability of the restoration activity once the forest has become re-established by reducing the functioning of the restored forest ecosystem. Such changes can also impact the persistence of mechanisms to rehabilitate ecosystem services.	Consider ways in which important ecological interactions will be impacted by climate change, prioritising those that risk the persistence of the activity, and where such interactions are lost, mimicking natural processes such as mechanical disturbance.	Changes in important ecologi interactions (such as seed dispers due to climate change.
C. Species and ecosystems		
Climate change can affect species used for restoration activities through for example, changing the growth and mortality rates, that can impacts on scheme effectiveness, and undermine incentives for PES and livelihoods projects.	Consider the climate resilience of species used in interventions, including resilience to water stress, salinity, or fires. Consider how natural adaptation by species to climate change may be supported, such as through assisted movement of species to areas of future suitability.	Species used for restoration m become less suited to the area.
climate change can cause shifts in the range of potentially invasive or pathogenic species including into landscapes where integrated forest restoration activities are taking place, with potential consequences for the success of such schemes and the societal benefits that are derived from them.	Damage from invasive or pathogenic species may also be reduced by maintaining general ecosystem resilience by addressing existing drivers of ecosystem degradation and maintaining patches of intact natural forest that provide for example refuges for biological controls.	Potentially increases in invasive pathogenic species due to clima change, such as the spread of ba beetles.

D. Provisioning ecosystem services		
Climate change is likely to cause changes to the provision of freshwater, which could exacerbate water stress in areas where restoration activities are taking place. Restoration activities undertaken in places undergoing such changes to water availability could exacerbate water scarcity.	Consider restoration and agroforestry projects in the context of potential water availability predicted for the area, including which areas of the landscape will be suitable for restoration activities. Examples include sighting reforestation where benefits from increased forest cover may enhance water conservation in the landscape (such as through microclimatic regulation near water bodies), or for increasing infiltration rates on steep slopes. Consider the possible negative effects on the landscape of poorly-placed restoration activities or the use of 'thirsty' species.	Possible negative effects on landscape of poorly-placed restora activities or the use of 'thirsty' speci
climate change impacts on demand for food and bioenergy by, for example, reducing land available for agriculture, thus increasing prices and pressure to intensify production in the landscape for these crops, reducing willingness to set aside areas for restoration or agroforestry. Such scarcity of land within the landscape may also increase conflicts that may affect the success of integrated landscape planning initiatives.	Consider putting in place conflict-resolution mechanisms in places where land-scarcity is likely to provoke conflicts that may undermine integrated landscape-level planning. Therefore, it is importance to identifying potential areas of high conflict. Consider using tools to predict future supply and demand of food, bioenergy and forestry resources.	Land-use conflicts
E. Regulating ecosystem services		
F. Changing socio-economic systems and infrastructure		
climate change may affect many livelihoods negatively thus worsening living standards in communities, increasing the pressure for people to engage in subsistence activities, and reducing health, which may combine to reduce the capacity for communities to undertake capacity-building activities for identification and monitoring of forest restoration.	Consider incentives for attending capacity-building schemes as a means to mitigate the effects of climate change on livelihoods as well as ensuring adequate willingness and capacity to participate in the schemes.	Impacts on livelihoods and heal that reduce community capacity undertake activities.
Ecosystem restoration is closely related to the REDD+ action of enhancement of forest carbon stocks.	Policies and potential funding from REDD+ policies should be considered.	

7.4.4 *SFM-4: Increased Regional and Global Cooperation: Enhanced regional and global coordination on efforts to maintain forest resources, enhance forest management and restore forest ecosystems through the transfer of international experience and know-how.*

Program 4.1: Private sector engagement.

Outcome 4.1: Improved collaboration between countries and across sectors on the implementation of SFM.

- *Indicator 4.1: Development and strengthening of networks to promote regional and global cooperation.*

Program 4.2: Global technologies for national progress.

Outcome 4.2: Increased capacity to monitor the implementation of SFM.

- *Indicator 4.2: Use of shared tools and methodologies.*

Links between climate change induced changes and GEF projects	***Ways GEF goals objectives, and intervention may need to be adapted due to climate change***	***New threats GEF projects may ne to consider***
A. Physical/chemical properties and resources		
The impacts of changing physical/chemical properties (e.g. changes in rainfall patterns and temperature), can potential impact the sustainability of forest management systems (program 1, 2 and 3) and so can impact private sector engagement and investment in SFM as well as the technologies needed for monitoring and implementation.	Where climate change is expected to have large impacts on the forest, projects on monitoring the implementation of SFM will need to consider how to differentiate the impacts of climate change from management activities. Monitoring may also be especially important for enabling adaptive management in the face of climate change.	Climate change may impa incentives for the private sector invest, for example if climate chan is predicted to cause forest dieback decreased regenerative capacity forests.
B. Biological processes		
Similarly to physical and chemical impacts, climate change impacts on biological process can impact the sustainability of forest management systems (program 1, 2 and 3) and so can impact private sector engagement and investment in SFM as well as the technologies needed for monitoring and implementation.	Where climate change is expected to have large impacts on the forest, projects on monitoring the implementation of SFM will need to consider how to differentiate the impacts of climate change from management activities.	climate change may impact incentiv for the private sector to invest
C. Species and ecosystems		
Similarly to physical and chemical impacts, climate change impacts on species can impact the sustainability of forest management systems (program 1, 2 and 3) and so can impact private sector engagement and investment in SFM as well as the technologies needed for monitoring and implementation.	Where climate change is expected to have large impacts on the forest, projects on monitoring the implementation of SFM will need to consider how to differentiate the impacts of climate change from management activities. Monitoring may also be especially important for enabling adaptive management in the face of climate change.	

D. Supply of, and demand for, provisioning ecosystem services		
Climate change impacts on provisioning services are especially important in terms of private sector engagement. Climate change can increase the importance of some ES which support adaptation to climate change which may provide an opportunity for engaging the private sectors. Climate change may also pose a risk to the provision of ES which could threaten private sector investment.		climate change may impact incentiv for the private sector to invest, f example if climate change is predict to cause forest dieback or decreas regenerative capacity of forests
E. Regulating ecosystem services		
Climate change impacts on provisioning services are especially important in terms of private sector engagement. Climate change can increase the importance of some ES which support adaptation to climate change which may provide an opportunity for engaging the private sectors. Climate change may also pose a risk to the provision of ES which could threaten private sector investment.	Consider the potential opportunities for private investment in PES schemes that protect key regulating services for climate change adaptation.	Climate change may impa incentives for the private sector invest, for example if climate chan is predicted to cause forest dieback decreased regenerative capacity forests.
F. Changing socio-economic systems and infrastructure		
Policies on climate change mitigation and adaptation, as well as society's attitudes to it may have large impacts on private sector engagement in PES.	Consider the impact of climate change policies within planning for private sector engagement.	

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9 Appendix: Useful tools and resources for building climate resilience

A wide range of tools and resources are available which can support planning to increase the climate resilience of projects. These include tools and resources that both help to assess likely impacts of, and vulnerability to, climate change, as well as, the most appropriate methods for reducing these impacts and adapting to climate change. The potential tools and resources which could be used to support each of the assessment factors (across all of the focal areas) are highlighted along with specific tools and resources that are likely to be most important of each individual focal area.

It is also useful to note that a number of general resources that have been developed to support human climate change adaptation and resilience screening can also be used for supporting the climate change resilience of GEF projects.

> For example: *UNFCCC Nairobi Work Programme (2008) Compendium on methods and tools to evaluate impacts of, vulnerability and adaptation to, climate change, available at: http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/2674.php* Although last updated in 2008, it is a centralised source of information on methodologies and tools to evaluate impacts of, and vulnerability to, climate change, and to support adaptation planning. It includes information on: climate downscaling techniques, socioeconomic scenarios, stakeholder engagement, and sector-specific tools on agricultural, water, coastal, human health, and terrestrial vegetation.
>
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> Suggests five criteria that vulnerability assessments should possess in order to inform the decision-making of specific stakeholders about options for adapting to the effects of global change and suggest an eight step methodology for conducting VIA.
>
> *Bours et al., (2013) Monitoring & evaluation for climate change adaptation: A synthesis of tools, frameworks and approaches*
> Is a synthesis of frameworks and approaches for monitoring and evaluating climate change adaptation projects.

Despite a large number of resources already existing it is important to recognise that new and ongoing monitoring and research can be needed in order to both better understand the specific local conditions of a particular intervention or project and to fill in the current gaps in our broader understanding and knowledge. Therefore, this appendix also highlights information which would be useful for planning but for which tools and information still needs to be developed.

9.1 Tools and resources useful for addressing each assessment factor

9.1.1 Physical and chemical properties and resources

One of key pieces of information for planning for climate change resilience is to projections of the likely climate change in the location of the project. This includes downscaling current and future climate large-scale data and projections to the area in question. Resources for accessing such information include:

The World Bank's [Climate Change Knowledge Portal (climate changeKP) Beta].

This online tool provides for access to comprehensive global, regional, and country data related to climate change (rainfall, temperature), available in map and graphical form. The datasets are taken from the World's top meteorological and climatologically research institutions to show past, present, and future (predicted) climate patterns. Biophysical parameters including warm and cold days incidence, maximum precipitation, and others.

Climate change projects are constantly increasing in resolution and accuracy, however, more fine scale are still needed in some areas and generating accurate projections for the medium term is still an ongoing area of scientific research. Although, projections of average temperature now have increased certainty, research continues to be needed on improving projections in changes in precipitation and frequency of extreme events.

Understanding the impacts of physical changes on the local area, and local populations, can also be supported by participatory approaches that utilise local people's knowledge.

For example: *Participatory Scenario Planning (PSP)*,

This approach, developed by Care International, aims to facilitate access to, and develop shared interpretation of, seasonal climate forecasts, impacts, and opportunities by bringing together communities with meteorologists and other stakeholders to validate past seasons' climate predictions.

9.1.2 Biological processes and C. Species and ecosystems

A key component to planning for changes in biological processes is to assess likely changes in the distribution and characteristics of different species and assemblages, including the interactions between them. In many places this data is not easily available however information on changes in species can come from:

a. *Species envelop modelling* is a tool used to assess potential change in species distributions under different climate scenarios based on the current conditions of their current distribution. Projections of future distributions will already have been modelled for some species. Carrying out new modelling can be data and resource intensive.

b. *Species vulnerability assessments* aim to assess species vulnerability due to the species characteristics. IUCN are starting to include climate change vulnerability assessments as part of the Red List assessment process.

Data on changes on biological interactions and processes can be more challenging to produce, and research in this area is ongoing. See the inland waters section of particular issues with marine species modelling.

Changes in species causing changes in invasive species, pathogens and pests also need additional resources and tools to assess what species are likely to have negative impacts from becoming invasive, pathogens or pests. Databases of current invasive species can help in such assessments (although it is also important to consider where the species is native to). For example:

Global Invasive Species Database www.issg.org/database/welcome/

Understanding the 'background' resilience of ecosystems, as a result of past disturbances and other pressures is can also aid the understanding of future resilience.

For example, *Munroe et al., (IN PRESS) The Guidance for Vulnerability and Impact Assessments as part of Ecosystem-based Adaptation to Climate Change*, Outlines a methodology for assessing ecosystem adaptivity based on four factors: degradation/disturbances, reduced biodiversity, fragmentation and unnaturalness. Annex 3 provides a list of key elements to consider for determining important parameters for ecosystem functioning.

9.1.3 Provisioning ecosystem services and E. Regulating ecosystem services

Increasing resilience in the face of changing ecosystem services would ideally be supported by: projections of future changes in ecosystem services and methods for monitoring changes in ecosystem services.

The most appropriate tools, resources and methods will vary greatly depending on the ecosystem services under consideration (see individual focal areas below for more details). However, for most ecosystem services projections of future changes are still challenging to model and an ongoing area of research. Therefore, vulnerability assessments, which include assessments of the current state of ecosystem services, can also help planning.

Several general tools are available for assessing current state of ecosystem services and future trends including:

UNEP-WCMC, (2011) Developing ecosystem service indicators: Experience and lessons learned from sub-global assessments and other initiatives

This report contains information and advice on developing practical ways to measure and assess ecosystem services – which may support adaptive management within GEF projects.

ENDA and SEI Adaptation toolkit

Contains information on mapping resources and for monitoring trends in ecosystem service supply.

TESSA (toolkit for rapid assessment of ecosystem services at sites of biodiversity conservation importance)

Covers harvested wild goods, water-related services, cultivated goods, nature-based recreation (including tourism), coastal protection, cultural services and global climate regulation. The tool works on the basis of deciding upon a plausible alternative state for the area assessed and then identifying a site that represents that state so that data can be gathered to understand how change impacts the supply of the ecosystem services.

A key tool in terms of considering the impacts of changes in provisioning ecosystem services are land use change models including:

Geographic land use models

For example Landshift:

Economic land use models

For example: The *GLOBIOM model* developed by IIASA is used to analyze the competition for land use between agriculture, forestry, and bioenergy,

9.1.4 Socio-economic factors and infrastructure

Changes in socio-economic factors and infrastructure can be hard to predict, and therefore including consideration of potential future scenarios (which include climate change) can be important for climate change planning. A range of tools are available to support such scenario development, for example:

climate changeAFS Regional Scenarios Planning

A tool focused on the agriculture sector to help development of scenarios based on key regional (interacting) future socio-economic, political, and climate changes uncertainties.

Tools are also available to support understanding of the adaptive capacity and likely future disaster loss and damage that society's face.

For example:
UK Department for International Development, Sustainable Livelihood Framework and Guidance sheets - Focus on the ability of governance frameworks to facilitate or constrain adaptation. They enable the user to break down the concept of adaptive capacity into the various capitals including financial and social capital.

La Red The disaster loss and damage inventory system (DESINVENTAR)
Is a disaster loss and damage inventory system currently being used in over 60 countries worldwide with databases for Latin America, India, Iran, Sri Lanka, Nepal and Mali, providing an in-depth geographical overview of disaster loss and damage.

9.2 Biodiversity focal area.

As the one of the key issues in considering the climate change resilience of the biodiversity focal areas is potential changes in species distributions, resources and tools for assessing changes in species distributions are of key concern (see section on species above).

Projecting likely changes in community abundance due to a range of factors including, but not limited to, climate change can also support climate resilient planning. A range of models are available to support assessments of the impacts of human pressures on biodiversity including:

PREDICTS 'Projecting Responses of Ecological Diversity in Changing Terrestrial Systems'
This model uses a meta-analytic approach to investigate how local biodiversity responds to human pressures such as land-use change, pollution, invasive species, and infrastructure.

GLOBIO models are a framework used to calculate the relative importance of environmental drivers on biodiversity, including land-use change, infrastructure, and climate change.

Projections of future land use, including under climate change and climate change policies, can support the biodiversity assessments above and also be used to directly evaluate the potential impacts and risks from future scenarios and policy options which project plans may need to address. A wide range of land use models are available including (see ecosystem services section above)

More specifically a range of resources and guides are available on how protected area management should and can be adjusted to help adapt to climate change. For example:

The GEF PARclimate change project, is assessing climate-change related risks to West African Protected Area (PA) ecosystems using both species envelop modelling and trait based vulnerability assessments.

UNEP-WCMC, CGIAR-climate changeAFS, ENDA, SEI (in press) Guidebook for Integrated Multi-Stakeholder Adaptation Planning in the context of Protected Area Management
Describes a series of participatory activities to be undertaken over the course of a 3 day workshop, designed to support vulnerability assessments and inform adaptation actions of communities near to marine protected areas. The participatory activities are accompanied by expected outcomes, timeframes, facilitation and equipment requirements, and output lists. Example workshop schedules are also provided.

9.3 International Waters

A key resource need for terrestrial projects within this focal area are hydrological and water resource models modelling tools that can take account of changes in processes expected due to climate change. For example:

WaterWorld, provides detailed process-based modelling of water quantity, quality and some regulation ecosystem services, which can be used to understand the impact of climate change, land use change, land and water management on hydrology and water resources. The tool is offered freely online and with free training courses (online and London-based).

MIKEBASIN supports the optimization of water allocations, reservoir operation, and water quality issues at the basin scale.

CALVIN can assist IWRM strategies including integrated assessment of surface and groundwater options, evaluating water resource adaptation, and regional supply and demand analysis under climate change

Guidance on how to include climate change consideration within water resource management is also available, for example:

Global Water Partnership Integrated Water Resources Management Toolbox
An organized collection of case studies, reference documents, reader lists, external web sites and other supporting materials.

Specific tools are also available to help coastal planning, for example:

ReefResilience Toolkit provides the latest information, guidance, and resources to help managers address the impacts of climate change and local threats to coral reefs.

The main tools and resources needed to support the climate resilience of the fisheries part of the Inland Waters strategy include tools for developing sustainable yield models which take account of climate change. For example:

9.4 Land Degradation

Tools and resources on land use modelling which considers climate change and/or climate change policies can support resilience planning. This can also be supported by assessments of the resilience of crop production systems to climate change and changes in suitable areas of production.

Land use change models which can support planning include both geographical and economic models (see ecosystem services generic section). Specific agricultural models also exist. Economic models can support consideration of the impacts of changing land values, supply and demand, and commodity production resulting from climate change. Many agricultural models are crop specific or applicable only to particular regions. Section 4.1 of the Nairobi Work Programme Compendium of methods and tools provides details of many crop process models that address the impact of management and climate-change scenarios on single and multiple crops and entire ecosystems.

Other tools and approaches are also available for assessing the impact of climate change, for example:

CGIAR research program on Climate Change, Agriculture, and Food Security (climate changeAFS) Climate Analogues

Sets out a method for assessing potential climate change impacts by identifying analogous sites to the expected future climates. The online tool is a user-friendly and readily accessible platform that will facilitate quick identification of likely analogue sites. The Analogues R-package allows a more detailed analysis to be performed within the R software program with the potential introduction of user defined data and improved uncertainty quantification (a slightly more resource/data intensive approach).

Water resources management tools set out under the inland waters section can also be relevant to landscape planning.

9.5 Sustainable Forest Management

Specific tools are available that can support understanding climate impacts on forests, for example:

CIFOR Methods and tools for assessing the vulnerability of forests and people to climate change, which provides examples from the Tropical Forests and Climate Change Adaptation (TroFclimate changeA) project in Central America, West Africa and Asia.

CIFOR Guidelines for Applying Multi-Criteria Analysis to the Assessment of Criteria and Indicators, provides guidelines for developing forest change indicators

Land use change models are also important tools for planning for the potential impacts, particularly of climate change policies. Mitigation policies such as REDD+ will have major impacts on land use and models which assess REDD+ scenarios can help climate resilient planning.