GEF AGENCY RETREAT: guidance on climate risk screening of GEF projects

1. Background

In June 2019, STAP released a guidance document on climate risk screening[1] that presents a common standard for the screening of GEF projects for potential climate risks. The guidance proposed that the climate risk screening of GEF projects should include at least four steps that will help identify, rank, and develop management options for potential climate risk. The IPCC defines risk as the "potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain"[2], and is due to the interaction of a combination of possible hazards, the exposure of affected systems, and the vulnerabilities of the exposed systems.[3] However, in the most recent IPPC report vulnerability is defined as, "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt"[4], which STAP thinks is a better descriptor for this purpose.

Increasingly, climate change is a lens through which all GEF projects and programs should be viewed. STAP thinks that climate thinking should be 'mainstreamed' into the earliest stages of project design, e.g., considering the durability of the choice of interventions to implement Multilateral Environmental Agreements (MEAs) in the face of climate change right up front as the Project Information Form (PIF) is developed. STAP has therefore been encouraging GEF agencies to evaluate how climate change could affect defined project goals and develop contingency plans.

STAP notes that the Council has been pushing for climate risk screening for a decade; all the agencies now think it is important and most have begun their own screening. Implementing STAP's current guidance will, with practice, help to promote more transformational thinking about climate mainstreaming in future work programs. This paper focuses on what STAP and the GEF Secretariat will screen for when reviewing projects using STAP's June 2019 screening guidance.

The GEF Secretariat and STAP will look for evidence that PIFs have evaluated the role climate change may play in achieving desired outcomes, to ensure that PIFs have: identified the current and projected range of climate vulnerabilities at the project location, as well as to the planned project interventions/components, based on credible scientific and salient information; presented options for managing climate vulnerability to ensure the durability of the expected project outcomes; and devised a strategy for monitoring and evaluating the selected climate vulnerability management options.

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[1] STAP, 2019. STAP guidance on climate risk screening. A STAP Document. http://www.stapgef.org/stap-guidance-climate-risk-screening

[2] IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130.

[3] Based on IPCC 2012, Determinants of risk: exposure and vulnerability. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65-108; and IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32

[4] Ibid: IPCC, 2014.

As laid out in the STAP's June 2019 Guidance, and presented at the GEF Agency retreat session on Climate Risk Screening on October 3, and the December 2019 Council meeting, STAP set out guidance for following the elements of climate vulnerability and responses analysis,[5] which expects GEF project documents to address the following questions:

i. *Has the sensitivity to climate change, and its impacts, been assessed?*
ii. *How will the project's objectives or outputs be affected by climate risks over the period 2020 to 2050, and have the impact of these risks been addressed adequately?*
iii. *Have resilience practices and measures to address projected climate change and its impacts been considered? How will these be dealt with?*
iv. *What technical and institutional capacity, and information, will be needed to address climate risks and resilience enhancement measures?*

This paper standardizes guidance for the GEF Secretariat and STAP members so that screening is more coherent. The questions above are elaborated with relevant information on the expected content of an adequately prepared project document in which climate risks have been satisfactorily addressed. The paper also presents examples of potential climate risks to GEF investments across its focal areas in the Annex.

2. Adequately assessing climate vulnerability in project documents.

Climate change can impact projects in multiple ways: it might be a contributing driver to the problem being addressed by a GEF project, or it may be a hindrance to achieving a project's outcomes. Therefore, simply completing a section on climate risk in project documents is not enough. Instead, it will require integrating climate change vulnerability, impacts, and adaptation strategies into the overall project preparation, development, and implementation - including in the description of the problem, underlying drivers, barriers, theory of change, and proposed interventions.

It is, therefore, important that the focus is not only on the risk section of project documents when reviewing for climate risk screening compliance. Instead, all sections of the project document need to be examined to see whether the relevant information presented below has been adequately provided. If not, guidance will be offered on how to fix these deficiencies by the CEO-endorsement stage, if not sooner. Some additional help on the four key components follows:

(i) Has the sensitivity to climate change, and its impacts, been assessed? To amplify, does the PIF identify the current and projected climate vulnerabilities at the project location, based on credible scientific information?

An adequately prepared project document should present on climate exposure,[6] such as:

[5] *The four main elements of risk assessment include hazard identification, vulnerability and exposure assessment, risk classification or rating, and risk mitigation plan development. See STAP, 2019. STAP guidance on climate risk screening. A STAP Document. http://www.stapgef.org/stap-guidance-climate-risk-screening*

[6] *Exposure is the nature and degree to which a system is exposed to significant climatic variations, and refers to the presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected. Negative impacts occur when something is both vulnerable and exposed. See IPCC, 2014: Annex II: Glossary.*

a) Details of the historical (past to current) and the range of projected future climatic conditions[7] in the project location.
b) Information on the overall vulnerability (the product of exposure, sensitivity and adaptive capacity) of targeted natural resources in the project area to climate change.
c) Information on the vulnerability and exposure of the local communities in the project area to a changing climate.
d) Information on the role of climate change as a driver to the problem being addressed, if applicable.
e) Details on how climate and non-climate stressors might interact to exacerbate climate risks.

(ii) How will the project's objectives or outputs be affected by climate risks over the period 2020 to 2050, and have the impact of these risks been addressed adequately? To amplify, have the underlying drivers of the climate vulnerabilities at the project location been analyzed, and for the planned project intervention/components?

The kind of information that would be helpful includes:

a) Information on how the targeted project components (e.g., forests, wetlands, rivers, semi-arid croplands, parks, mangroves, chemicals, fishery, etc.) will be impacted by climate change and the level of severity.
b) Specific information on how different levels of projected climate change impacts, including climate variability, in the project location can affect the efficacy of proposed GEF interventions?
c) Information on how the proposed interventions may contribute to reducing the vulnerability to climate risks
d) Evaluation of the possibility that the proposed interventions increase vulnerability to climate risks or lead to maladaptation, and measures for preventing this.

Information on current and future climate risks and impacts in specific countries and regions can be sourced from, for example, the World Bank's Climate Change Knowledge Portal,[8] the USAID Climate Risk Profile,[9] relevant IPCC reports and data[10], NASA's Socioeconomic Data and Application Centre,[11] the World Meteorological Organization (WMO), the World Resources Institute's Climate Analysis Indicators Tool,[12] the Climate Impact Lab,[13] National Communication reports from countries submitted to UNFCCC, and Countries' National Adaptation Plans of Action, to mention a few. Sector-specific examples of climate risks are also available in the Annexes of the USAID Climate Risk Screening and Management Tool[14]. Specific studies on current and projected impacts of climate change across the various GEF focal areas can also be consulted; for example, the IPBES reports on climate change impact on biodiversity,[15] the IPBES Assessment Report on Land Degradation and Restoration[16], the IPCC Special Report on Oceans and

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[7] Climatic conditions and possible impacts include temperature, precipitation, drought, flood, sea-level rise, ocean warming, ocean acidification, shifting season patterns, heatwaves, storm surges, winds, frequency and intensity of extreme events, etc.

[8] https://climateknowledgeportal.worldbank.org/

[9] https://www.climatelinks.org/climate-risk-management/regional-country-risk-profiles

[10] https://www.ipcc.ch/library/ and https://www.ipcc-data.org/

[11] https://sedac.ciesin.columbia.edu/theme/climate

[12] http://cait.wri.org/?_ga=2.161610172.1417639714.1556917553-435254878.1556301068

[13] http://www.impactlab.org/

[14] https://www.climatelinks.org/resources/climate-risk-screening-management-tool

[15] https://ipbes.net/library

[16] https://ipbes.net/assessment-reports/ldr

Cryosphere[17] and IPCC Special Report on Climate Change and Land[18]. Some examples of risks across the GEF focal areas are presented in the Annex.

(iii) *Have resilience practices and measures to address projected climate change and its impacts been considered? How will these be dealt with?* To amplify, does the PIF consider options for managing climate vulnerability to ensure the durability of the expected project outcomes? This is looking for a recognition that adaptive management may be needed and steps to achieve it.

The kind of information that would be helpful includes:

a) How proposed climate risk management options address the identified current and projected climate risks
b) Details of the resilience enhancement practices, measures, and technologies proposed to manage identified current and projected climate risks
c) Evaluation of how to manage adaptively and project implementation proceeds.
d) Information on the feasibility, effectiveness, tradeoffs, and co-benefits of the proposed climate risk management option, and its alignment with project objectives and expected outcomes

(iv) What technical and institutional capacity, and information, will be needed to address climate vulnerability and enhance project and place-based resilience? To amplify, is there a Monitoring, Evaluation and Learning (MEL) strategy - implementing and evaluating the selected climate vulnerability management options over the project lifetime and evaluating the projected impact uncertainties beyond that period?

The kind of information that would useful includes:

a) Details of the technical and institutional capacities needed to address identified climate vulnerabilities and design resilience enhancement measures
b) Information on the financial implications of the proposed climate vulnerability management option.
c) Mechanisms for evaluation of the success of mechanisms to reduce vulnerability and improve resilience.

[17] https://www.ipcc.ch/srocc/
[18] https://www.ipcc.ch/srccl/

Table 1 below serves as a checklist for the GEF Secretariat and STAP panel members in reviewing PIFs.

An elaboration of STAP's climate risk screening questions

STAP Questions	What to look out for in PIFs and other GEF project documents					
1) Future Climate change impacts?	Range of future expected temperature, precipitation, sea-level rise, flood/droughts heatwaves, etc?	Changes to natural resources of interest from climate change?	Changes to communities, lifestyles, economies from climate change?	Is climate contributing to problem being addressed?	What might exacerbate future climate risks?	Other considerations? Future Recommendations?
2) Risk to Project outcomes?	How will climate change affect projects' component goals by sector?	How might GEF interventions be amplified or compromised by climate change?	Will planned interventions reduce vulnerability to climate change?	Potential for maladaptation and how to prevent?		Other considerations? Future Recommendations
3) Measures to address climate impacts?	Proposed climate risk management options?	Details of proposed resilience practices, measures, technologies	How to manage climate risk adaptively?	Feasibility, economic cost, tradeoffs, co-benefits?		Other considerations? Future Recommendations?
4) Future needs to enhance resilience & (Monitoring, Evaluation and Learning)	Technical and institutional capacities needed?	Financial implications of vulnerability management options	Mechanisms to evaluate success. (Monitoring, Evaluation and Learning)			Other considerations? Future Recommendations?

ANNEX: Examples of climate-related risks for GEF investment by Focal Area

This section presents non-exhaustive examples of potential climate risk across the various GEF focal areas.

Biodiversity

Biodiversity and biodiversity-based ecosystem services are intrinsically dependent on the climate. Changing climate leads to glacial retreat, a decrease in Arctic sea ice extent, a rise in sea level, and an alteration in the start and length of the seasons, with consequent negative biodiversity impacts. The IPBES global assessment report[19] showed that climate change and its associate effects, including increased warming, frequency and intensity of extreme events, wildfires, floods, droughts, sea-level rise, and ocean acidification, are contributing to widespread loss of biodiversity including in the marine, terrestrial and freshwater ecosystems globally. Changes in climate are causing migration of species and even entire ecosystems, with one in six species threatened globally[20]. Because of the inter-connectedness of ecosystems, species loss in one ecosystem results in knock-on effects on other ecosystems and ecosystem functions. The threats from climate change on biodiversity are projected to increase as climate change continues, hence the need to consider climate risk when designing projects aimed at reversing biodiversity loss. Examples of climate-related biodiversity risks that the GEF need to consider when designing projects include:

Risks to species

1. Outbreaks of a fungal disease due to rising temperatures leading to the decline of amphibian populations in several regions.
2. The severity and extent of drought are expected to increase under climate change in some regions, particularly in drylands. Drought can have a wide variety of impacts on species and ecosystems, including direct mortality of water-stressed animals and plants, decreased resource availability, and shift in vegetation type.
3. Increased mortality of pollinators due to a higher frequency of extreme weather events and virulence of pathogens can reduce flowering length and intensity, which can put global food production at risk.
4. Increased seawater intrusion in estuaries due to sea level rise has driven upstream redistribution of marine species and caused a reduction of suitable habitats for estuarine communities.

Risks to ecosystems and ecosystem services

5. Changes in temperature and precipitation will encourage fires and pest outbreaks, leading to increased tree mortality and reduced extent and condition of forest habitats.
6. Warmer and drier future conditions result in increased fire, drought, pathogens, and insect activity, which will lead to forest dieback or alter vegetation state. Future wildfire potential rises significantly in the United States, South America, Central Asia, southern Europe, southern Africa, and Australia. Some tropical and temperate forests may decline because of increased aridity, while savannas expand. Particularly vulnerable regions are Central and South America, the Mediterranean Basin, Southern Africa, and South Australia.

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[19] *IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn, Germany.* https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf

[20] *IPBES. Models of drivers of biodiversity and ecosystem change.* https://ipbes.net/models-drivers-biodiversity-ecosystem-change

7. A shift of major ecosystem types will occur as a result of climate change (at 1^{o}C, about 7%, and at 2^{o}C, 13% of ecosystems will need to shift). East African montane centers of biodiversity are particularly threatened since many represent isolated populations with no possibility of vertical or horizontal migration.
8. Extreme weather events, such as flooding, drought, and fire, will accelerate the degradation of already vulnerable habitats. African biodiversity with low mobility and located in flat and extensive landscapes may be at risk of change in seasonality and fires.
9. Increases in precipitation, especially in arid systems, can increase the vulnerability of flora to plant diseases and invasive alien species.
10. Tropical cyclones mainly, but not exclusively, affect coastal regions, threatening maintenance of the associated ecosystems, mangroves, wetlands, seagrasses, etc., with consequent impact on the ecosystem and livelihoods services that they provide including food, water and shelter for fish, birds and other wildlife, water quality improvement, flood reduction and carbon sequestration.
11. Interior freshwater wetlands are likely to be affected by changes in precipitation and temperature. Drier and warmer conditions can result in a shrinking of wetland areas.
12. Sea-level rise coupled with saltwater intrusion and extreme coastal storms may lead to suppression or change of the riparian habitat of terrestrial species due to permanent inundation. Coastal wetland plant die-off can result from increased stress due to salinity increases, or from submergence. If a decrease in precipitation and runoff accompanies sea-level rise, wetland stress and die-off may be further accelerated.

Climate Change Mitigation

Because climate change is already happening and its impacts are already being felt across all sectors, it is essential to consider how current and projected climate change could impact efforts to mitigate greenhouse gas emissions (mitigation). The implication of current and projected climate change for emissions mitigation projects such as energy and power generation systems, transportation and mobility systems, buildings, and energy efficiency systems need to be considered during project design. Some examples of climate risk to emissions mitigation projects include:

Risks to renewable energy

1. Increase greenhouse gas emissions into the atmosphere may influence atmospheric water vapor content, cloud cover, rainfall, and turbidity with consequent impact on the energy generation potential of renewable energy sources like solar and wind in different locations. Vulnerability studies[21] suggest that climate change can reduce the energy generation potential of solar and wind energy by up to 10% and hydropower and thermoelectric generation by up to 20% with impacts rising with increased global warming.
2. Increase warming reduces the efficiency and energy output of solar power cells.[22]
3. Changes in temperature, wind, and rainfall, as well as the alteration in frequency and intensity of extreme events due to climate change, may negatively affect the geographic distribution, variability, and quality of wind resources, and may require adaptation in wind turbine design and operation.[23]

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[21] Tobin et al. 2018. *Vulnerabilities and resilience of European power generation to 1.5 °C, 2 °C and 3 °C warming.* Environ Res Lett, 14, 4

[22] *Dubey et al. 2013. Temperature Dependent Photovoltaic (PV) Efficiency and Its Effect on PV Production in the World – A Review. Energy Procedia, 33, 311-321.* https://doi.org/10.1016/j.egypro.2013.05.072

[23] *IPCC, 2012. Renewable Energy Sources and Climate Change Mitigation. IPCC Special Report on Renewable Energy and Climate Change.* https://www.ipcc.ch/report/renewable-energy-sources-and-climate-change-mitigation/

4. The future technical potential for bioenergy could be influenced by climate change through impacts on biomass production, such as altered soil conditions, precipitation, crop productivity, and other factors.
5. Higher temperatures will lead to increased reservoir evaporation and evapotranspiration, which will lead to a decrease in the amount of water available for hydropower generation. Altered rainfall regimes will also affect energy generation from hydropower. These climate-induced factors will affect the effectiveness of hydropower-based renewable energy projects and can make them less desirable and feasible.

Risks to sustainable transport infrastructure

6. Increased frequency of flooding and other extreme events could lead to frequent damage to infrastructure, inhibited facility access, and high repair costs, especially for low carbon transport systems.
7. Premature deterioration of low emission transportation structures/equipment from thermal stress due to increased temperatures, wildfire, sea-level rise, permafrost thaw, increased intensity of storm surge, etc.

<u>Climate Change Adaptation</u>

Although climate change adaptation projects aim to prevent or minimize the impacts of climate change and to increase the overall resilience of people, proposed adaptation measures must also be scrutinized to ensure that they are not susceptible to climate impacts or lead to maladaptation. Because GEF adaptation projects are mostly focused on reducing vulnerability and strengthening adaptation capacity of communities who depends on natural resources of interest to other GEF focal areas, e.g., biodiversity, water, land, as well as energy and transportation systems, many of the climate risks in these focal areas are also applicable to adaptation projects designed to improve resilience in those focal areas. Examples of risk of climate change impact to adaptation measures include:

Risks to climate resilience

1. At a severe level of climate change impacts, adaptation/resilience measures such as agricultural insurance and climate-smart financing mechanisms may become too expensive, especially for example, for low-income subsistence farmers, due to higher climate-related losses.
2. Infrastructure for climate change adaptation/resilience, such as weather monitoring and climate early warning systems, and ICT solutions may become susceptible to climate change impacts such as floods, wildfires, and other extreme weather events.
3. Increased weather variability might affect the capacity of weather early warning systems to accurately predict the occurrence and intensity of extreme events, thereby affecting the assessment of vulnerability and adaptive capacity.
4. Climate change impacts such as increased temperature, frequency and intensity of extreme weather events, heat waves, and wildfires will affect the design and adoption of adaptation-oriented technologies such as climate-smart agriculture, energy-efficient cooling, low-carbon transportation, climate-smart storage facilities, renewable energy powered machinery, etc., and must be considered in project design.
5. Higher temperatures might lead to greater evaporation and lower groundwater tables, which might affect water pumping systems and water resilience.

Risks to nature-based solutions

6. Climate change impacts can undermine nature-based solutions, including ecosystem-based adaptation measures, which depends on harnessing biodiversity and ecosystem services to reduce vulnerability and build resilience[24]. Some of the climate risks listed under biodiversity, international waters, and land degradation will also affect related ecosystem-based adaptation measures. For example:
   a. Groundwater salinization in coastal areas due to rising sea levels might affect vegetation subsistence and, therefore, impact ecosystem-based erosion or storm surge control measures.
   b. Wildfires and heat stress can impact forests or agroforestry systems designed to increase crop resilience to erosion, droughts, or floods.
   c. Extreme weather events can affect the subsistence of urban green areas originally designed as resilient sources for climate regulation.
   d. Alterations in temperature and precipitation regimes can lead to outbreaks of insects and pathogens, which can cause the dieback of tree species and threaten different adaptation measures such as agroforestry and double cropping.

<u>Chemicals and Waste</u>

Changes in climatic factors, including temperature, precipitation, and wind, and their consequent impacts such as drought, flood, sea-level rise, heat stress, and other extreme weather events will affect the distribution and breakdown of chemicals in the environment. Studies suggest that climate change may make some chemicals to become more harmful. For example, an increase in temperature and changes in moisture content are likely to alter the persistence of some chemicals,[25] and increase the volatilization of persistent organic pollutants (POPs).[26] Studies also show that chemicals are generally more toxic to organisms with warmer temperatures[27]. It is, therefore, pertinent to be proactive and consider the implication of climate change in the design and implementation of projects aimed at managing chemical exposure to humans and the environment. Examples of climate-related chemicals and waste risks to GEF projects include:

Risks to the effective management of chemicals, wastes and contaminated sites

1. Sea-level rise, especially in Small Island Developing States (SIDS) and other coastal floodplains, can inundate contaminated lands and waste management facilities such as engineered landfills and hazardous chemicals/waste management sites, thereby exposing the environment and human beings to pollution and associated adverse effect. For example, the widespread release of contaminants during the flooding of Hurricane Katrina in New Orleans illustrates the risks of inadequately contained hazardous substances during an extreme weather event[28].
2. More intense and frequent storms will result in inundation and flooding at landfills and contaminated sites. Extreme temperatures may also compromise the integrity of landfills and other waste management

[24] *Example of ecosystem-based adaptation include integrated water resource management to cope with changing precipitation pattern; restoring coastal habitat such as coral reefs, mangrove forests, and marshes to prevent against storm surges; sustainable forest management to reduce erosion, reduce flooding and prevent landslides; and adoption of agroforestry to increase crop resilience to droughts or floods.*

[25] *Boxall AB, et al., 2009. Impacts of climate change on indirect human exposure to pathogens and chemicals from agriculture. Environ Health Perspect. 117, 508-14.*

[26] *UNEP/AMAP, 2011. Climate Change and POPs: Predicting the Impacts. Report of the UNEP/AMAP Expert Group, http://library.arcticportal.org/1214/; and Dalla Valle M, Codato E, Marcomini A. Climate change influence on POPs distribution and fate: A case study. Chemosphere, 67, 1287–1295.*

[27] *Chapman JC, Lim RP, Gehrke PC. 2003. Role of environmental stress in the physiological response to chemical toxicants. Environ Res. 92, 1-7; and Patra RW. 2007. The effects of three organic chemicals on the upper thermal tolerances of four freshwater fishes. Environmental Toxicology and Chemistry, 26, 1454–1459.*

[28] *Reibe, D. 2007. Hurricane Katrina: Environmental Hazards in the Disaster Area. Cityscape: A Journal of Policy Development and Research, 9, 53-68*

facilities. These will increase the likelihood of the transport of contaminants through surface soils, groundwater, surface waters, and/or coastal waters.[29]

3. Climate change might affect the cleanup of released hazardous substances and the restoration/rehabilitation of contaminated land and associated natural resources. The toxicity of some hazardous materials increases with temperature, which could make restoration to be more costly. More frequent and intense extreme weather events might also slow down the rate of recovery.[30]
4. Organic compounds are generally less soluble and more bioavailable in saltwater than in freshwater due to the "salting out" effect.[31] Thus, increased contaminant bioavailability and toxicity are possible in subtropical latitudes experiencing climate change-induced increased salinity, as well as in estuaries and coastal freshwater ecosystems subject to increased saltwater intrusion or droughts.[32]
5. Increased catastrophic weather events such as floods, storms, and wildfires may result in increased accidental releases and spills of hazardous substances from facilities. Flooding of warehouses and old stockpiles of chemicals such as paints, solvents, and pesticides will lead to potentially dangerous exposure situations.

Risks of increased release of pesticides and other chemicals into the environment

6. Increased temperature and alteration of the growing season will modify cropping patterns and crop pest and pathogen distribution, resulting in increased pesticide use and changes in application timings. This will lead to a shift and increase in human, wildlife, and ecosystem exposure to pesticides. For example, the 2019/20 plague of locusts in East Africa has been linked to climate change and is leading to increased use of pesticides.[33]
7. An increase in vector-borne diseases anticipated with the changing climate could stimulate more widespread use of a variety of chemicals to control insect, rodent, and other disease vectors. Pharmaceutical used to treat these diseases is also likely to increase, which may further overwhelm waste and wastewater treatment facilities. Studies suggest that the use of DDT may surge due to the increasing need for malaria control caused by the anticipated widespread of mosquitoes[34].
8. Extreme precipitation, storms, and floods will increase urban and agricultural runoff of petrochemicals, industrial chemicals, chemical waste, pesticides, and fertilizers into surface waters and enhanced their charging of groundwater.

<u>International Waters</u>

Marine and freshwater resources are disproportionately impacted by climate change. Climate change causes changes in water temperature, ocean acidification, and deoxygenation, leading to changes in oceanic circulation and chemistry, rising sea levels, increased storm intensity, as well as changes in the diversity and abundance of marine species. These have consequent effects on the ecosystem services that marine and freshwater provide, such as climate regulation, shoreline storm protection, carbon sequestration, and

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[29] EPA. Projected Climate Threat to Waste Facilities. https://www.epa.gov/arc-x/projected-climate-threat-waste-facilities

[30] Rohr, Jason R., et al. 2013. Implications of global climate change for natural resource damage assessment, restoration, and rehabilitation. Environmental toxicology and chemistry, 32, 93-101.

[31] Whereby water molecules are strongly bound by salts making them unavailable for dissolution of organic chemicals.

[32] Noyes, P. D. et al. 2009. The toxicology of climate change: Environmental contaminants in a warming world. Environ Inter, 35, 971–986.

[33] Stone, 2020. A plague of locusts has descended on East Africa. Climate change may be to blame. https://www.nationalgeographic.com/science/2020/02/locust-plague-climate-science-east-africa/

[34] Lake IR, et al. 2005. Effects of river flooding on PCDD/F and PCB levels in cows' milk, soil, and grass. Environ Sci Technol. 39, 9033–9038.

habitats for biodiverse species. Marine and freshwater also provide livelihoods and food security for many, which are under threat in a changing climate. It is crucial, therefore, to consider the effects of climate change when developing International Waters projects. Examples of climate risks to International Water projects include:

Increased pollution risks

1. Increased temperature, sea-level rise, and disturbed hydrological cycles can enhance nutrient fluxes and ocean deposition, which can increase eutrophication, and consequently harmful algal blooms and hypoxia, which threatens aquatic organism, modify marine ecosystems and alter food webs.
2. Extreme precipitation, storms, and floods, as well as ice cap melting in some regions, will lead to increased urban and agricultural runoff of petrochemicals, industrial chemicals, chemical waste, pesticides and fertilizers, and other pollutants into surface water, groundwater and oceans. This will threaten water quality in various parts of the world, and the increased pollution levels will stress marine ecosystems.
3. Reduction in water quality due to saltwater intrusion and inundation of coastal aquifers caused by sea-level rise resulting in a decrease in the supply of freshwater.

Risks to marine and coastal ecosystems and species

4. Increased seawater intrusion in estuaries due to sea level rise has driven upstream redistribution of marine species and caused a reduction of suitable habitats for estuarine communities.
5. Tropical cyclones mainly, but not exclusively, affect coastal regions, threatening maintenance of the associated ecosystems, mangroves, wetlands, seagrasses, etc., with consequent impact on the ecosystem and livelihoods services that they provide including food, water and shelter for fish, birds and other wildlife, water quality improvement, flood reduction, and carbon sequestration.

<u>Land Degradation</u>

Climate change and land degradation are closely intertwined. The deterioration of land reduces its ability to store carbon, thereby exacerbating climate change. On the other hand, climate change effects such as increased temperature, evapotranspiration rates, rainfall intensity, flooding, drought frequency and severity, heat stress, dry spells, wind, sea-level rise and wave action, and extreme events are major factors aggravating land degradation processes. The IPCC Special Report on Climate Change and Land[35] indicates that the observed mean land surface air temperature has risen considerably due to changing climate and show that land-use change and intensification, as well as climate change, have contributed to desertification and land degradation. Global warming is also changing climatic zones in many world regions resulting in changes in the ranges, abundance, and seasonal activities of many plants and animals. These impacts are expected to increase under business as usual scenario. For example, the frequency and intensity of droughts are projected to rise, especially in the Mediterranean region and southern Africa. Hence, these must be considered when designing land degradation-related projects. Examples of climate-related land degradation risks to GEF projects include:

Risks to land productivity

[35] IPCC 2019. Summary for Policymakers. IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems. https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf

1. High temperatures will increase rates of evapotranspiration, reducing soil moisture. This may lead to drought, shift, or change in the length of the growing season, resulting in reduced crop yields due to fertile soil loss. It can also increase the prevalence of pests and invasive species.
2. Some land areas will have extreme decreases in renewable groundwater resources at 2°C, with strong drying trends in the Mediterranean region and southern Africa. A loss of 7–10% of rangeland livestock globally is projected for approximately 2°C of warming, with considerable economic consequences for many communities and regions.
3. Change in temperature will alter the balance in soil moisture gain/loss through evapotranspiration, which may lead to further land degradation and desertification, thereby triggering or exacerbating pressures on productive areas – the occurrence of increased land degradation or aridity in one area will inevitably increase tensions in existing production areas.[36]
4. Global climate changes, for example, temperature changes, can interact very closely with changes in the availability of water and soil nutrients, thereby affect crop growth cycle and geographical range of different crops. This could lead to possible changes in the cropping pattern and extent in some regions.[37]
5. Extreme precipitation and flood caused due to changing climate can lead to massive soil erosion in plains and coastal areas, inundation of low-lying areas, landslides in mountainous and hilly areas, and consequently loss of crops and vegetation. Coastal erosion is also expected to be increased by sea-level rise and in some areas in combination with rising intensity of cyclones.
6. The rate of expansion of soil salinization worldwide is expected to increase due to climate change-induced sea-level rise and groundwater depletion due to heat stress. This can consequently lead to the use of lower-quality water for irrigation, which could further exacerbate dryland salinization through irrigation-induced salinization and causing saline intrusion into aquifers.[38]

Risks to terrestrial ecosystems

7. Climate change and desertification are projected to cause reductions in crop and livestock productivity in dryland with a resultant modification of plant species mix and reduction in biodiversity. Dryland populations vulnerable to water stress, drought intensity, and habitat degradation are projected to increase significantly as global warming temperature progresses.[39]
8. Increases in precipitation, especially in arid systems, can increase vulnerability to plant diseases and alien species invasion.
9. Drier soil conditions due to increasing temperature can intensify the severity of heat waves with feedback effects on humans, soil, biodiversity, ecosystem services, and agriculture.[40]

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